Supporting Sustainable School Practice within a Partnership Model.

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Abstract.

Following the UN Earth Summit in 1992, Eco-Schools was established with the aim of engaging pupils in the environmental management of their schools. Participation in Eco-Schools involves the implementation of an environmental management system (EMS). Education for sustainable development (ESD) was also an outcome theme of the Earth Summit and EMS have the potential to engage pupils in effective ESD through active engagement with their environment. However, there are many challenges to both EMS and ESD implementation in schools including lack of time and lack of resources and funding. EMS were originally designed for industry and have proven to be an effective tool in this sector. Here, many of the challenges faced by schools are not encountered as there are specialists appointed to implementing and overseeing these systems. Therefore, there is a wealth of tacit knowledge in this sector in the design and implementation of EMS.

The purpose of this study was to explore how schools can be supported in EMS implementation, for both the management of the school and as a tool for ESD. To utilise the existing expertise in industry, a model was created that extends communities of practice (CoP) theory. Within this Extended CoPs model, expertise from researchers at Waterford Institute of Technology, facilities personnel at Bausch + Lomb and teachers at a local primary school was utilised to support and enhance EMS implementation at the school. The research was set within the pragmatic paradigm and to maximise participation from all social actors, a transdisciplinary approach was applied. The methodology consisted of mixed-methods, with an embedded case study used to explore the feasibility of the model.

The findings of this research demonstrate the ways in which knowledge was transferred from the facilities team to the school. This knowledge was brokered by the researcher across two boundary types. At the semantic boundary, knowledge was translated so that the perspective of the facilities team could be understood by the teachers. At the pragmatic boundary, the knowledge was transformed for new applications at the school site. The findings show that when the participating teachers were supported in their practice, but had full control over the direction of the EMS, they created meaningful learning experiences for their pupils. The teachers reported increased participation in the EMS by both themselves and their pupils. Their ESD knowledge increased and a number of the teachers reported a personal shift towards more sustainable lifestyles.

Using the empirical findings from the case study, the Extended CoPs model was reconceptualised as a Transdisciplinary CoP for ESD. This contributes to the field of CoPs theory and the case study contributes to knowledge in EMS and ESD. When given the opportunity to develop their EMS with the support of the researcher and facilities team, the teachers took on the role of education expert. They consciously sought to identify all teaching and learning opportunities that the EMS had to offer and used the building and grounds to support this learning.

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List of Abbreviations.

AuSSi	Australia Sustainable School Initiative
BER	Building Energy Rating
B+L	Bausch + Lomb
BMS	Building monitoring system
CBD	Convention on Biological Diversity
CoP	Community of practice
CPD	Continuing Professional Development
CRP	Community of Research and Practice
D.A.R.T.	Design, Awareness, Research and Technology
DEC	Display Energy Certificate
DES	Department of Education and Skills
E.E.	Environmental Education
EfS	Education for sustainable development
EMS	Environmental management system
EnMS	Energy management system
EPA	Environmental Protection Agency
ESD	Education for Sustainable Development
EUI	Energy use intensity
F.E.E.	Foundation for Environmental Education
FM	Facilities management
H.E.	Health Education
H.E.I.	Higher Education Institution
HVAC	Heating, ventilation and air conditioning
IAQ	Indoor air quality
ICT	Information and communication technology

IEQ	Indoor environmental quality
ISGA	International School Grounds Alliance
LEED	Leadership in Energy and Environmental Design
LPP	Legitimate peripheral participation
NCCA	National Council for Curriculum and Assessment
NEEAP	National Energy Efficiency Action Plan
ppm	Parts per million
RCE	Regional Centre of Expertise
ROI	Return on investment
SD	Sustainable development
SDP	School development plan
S.E.A.I.	Sustainable Energy Authority of Ireland
S.E.S.E	Social, Environmental and Scientific Education
SFM	Sustainable Facilities Management
SLT	Situated learning theory
S.P.H.E	Social, Personal and Health Education
TCS	Transdisciplinary case study
TGB	Teaching Green-school Building
TLSF	Teaching and learning for a sustainable future
UN	United Nations
UNCED	UN Conference on Environment and Development
UNDESD	UN Decade of Education for sustainable development
UNECE	UN Economic Commission for Europe
UNEP	UN Environment Programme
UNESCO	UN Educational, Scientific and Cultural Organization
WEEE	Waste electrical and electronic equipment

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1. Introduction

> *"Education is the most powerful weapon which you can use to change the world."*
>
> Nelson Mandela.

Today, our planet is faced with serious global challenges. Halting biodiversity loss, mitigating climate change and contending with a series of social injustices are to name but a few. If our critically expanding population is to learn to live sustainably on this earth, then it is crucial that society develops not only the knowledge and skills required for such a lifestyle, but also an understanding of and empathy for both the natural and social world. Furthermore, critical skills that allow us to see and understand the connectivity between social and ecological systems will be imperative. Education for sustainable development has the potential to move society towards such understandings, but, in order to do so, it needs to become central to our education systems.

1.1 Sustainable Development

Sustainable development, as it is understood today, has its origins in the 'Report of the World Commission on Environment and Development: Our Common Future' (Brundtland, 1987) , a document more commonly referred to as The Bruntland Report. This report was written for the UN by a committee chaired by Dr. Gro Harlem Bruntland, a former Prime Minister of Norway. The famous definition

> '*Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs'* (1987:41)

has been discussed extensively in the literature, and is quite widely accepted (Ang and Passel, 2012). This intergenerational facet of SD has become central to the dialogue, demanding stewardship of the Earth in order that we pass it on in the condition we received it, or indeed in better condition. The Bruntland Report portrays the tension between society's ambitions for growth and improvement on the one hand with nature's limitations on the other (Kuhlman and Farrington, 2010). This conflict between the natural environment and economic development is at the core of all SD issues. The Bruntland Report contends that both of these vast and complex issues require integration and advise that both (ie. environmental deterioration and economic development) have to be resolved in a reciprocal fashion (Robinson, 2004). This was a move beyond the discourse on environmental protection towards a more holistic approach that was to include issues of poverty, justice and social equality. While progressive, the Bruntland Report has been criticized with regards to a number of issues. Robinson (2004) points out that there is no emphasis on spiritual values or individual responsibility, with all focus on the collective response. Others feel there is too much emphasis on development and not enough focus on nature and the environment (Kuhlman and Farrington, 2010; Robinson, 2004). Kuhlman and Farrington (2010) argue that environmental concerns are important, but the basic argument is one of welfare, viewed within the framework of inter-generational equity. However, the authors of 'Our Common Future' did intend for the environment to be seriously considered in the discourse and policy of economic development. As stated in the report '*In its broadest sense, the strategy for sustainable development aims to promote harmony among human beings and between humanity and nature.*' (1987:57).

This idea of coupling environmental protection with development had been highlighted before (for example at the Stockholm Conference in 1972), but this was the first time that it took a global foothold. It was agreed to at the UN Conference on Environment and Development (UNCED) in 1992 in Rio de Janeiro by national governments with wider engagement from business leaders and other invested government organizations (Agyekum-Mensah *et al.*, 2012). The key outcome document from this conference was Agenda 21 (UNCED, 1992), which is an action plan for achieving SD. Sustainable development gathered further momentum with the Earth Summit or Rio +10 in Johannesburg in 2002 and the UN Conference on Sustainable Development or Rio +20 in 2012. At each meeting, governments reconfirmed their commitment to Agenda 21.

The 2002 World Summit on Sustainable Development (Rio +10) expanded Bruntland's definition by defining the three pillars of SD as the economy, society and the environment. These three pillars were readily accepted but there was no universal agreement as to their details (Kates *et al.*, 2005). However, it gave clarity to the areas with which SD was concerned and this 'triple bottom line' approach added to the evolving nature of SD. In 2015, at the UN Summit in New York, the 2030 Agenda was adopted (United Nations, 2015) which outlined the 17 Sustainable Development Goals (SDGs) and 169 specific targets which are aimed at the three pillars of sustainability and also issues of governance.

As issues of SD gain continued attention, there is increasing pressure on governments to act sustainably, including reducing carbon emissions, being more resource efficient and improving biodiversity conservation. Much of this pressure takes the form of international agreements. For example, Ireland is committed to reducing its greenhouse gas (GHG) emissions by 20% by 2020 compared to 2005 levels (SEAI, 2016b). As buildings account for 40% of total energy consumption and 35% of the total CO_2 emitted in the EU (Thewes *et al.*, 2014), they are a necessary target in Ireland's energy reduction plans.

Education will be a key component in moving towards a sustainable society. Education for Sustainable Development (ESD) is the UN term for education that targets sustainability issues and focuses on teaching towards a sustainable future. ESD can be incorporated into education systems in many ways and needs to be connected to local issues, traditions, culture and beliefs. As education has been highlighted as a crucial component in achieving a sustainable society, schools need to be developed and managed as models of sustainability. This means that sustainability must permeate all aspects of school life – teaching and learning, management, the campus and the wider community. One potential tool for engaging with ESD is an environmental management system (EMS). An EMS is a system that organizations can use to identify, manage, monitor and control their environmental issues (ISO, 2015). This research looks at environmental management systems (EMS) as a tool for a whole-school approach towards sustainability.

1.2 Research Overview

Sustainability in education is an extremely broad topic, and this research sought to engage schools with ESD through EMS implementation, thereby aligning sustainability on the curriculum with sustainable management of the school building and grounds. Following an extensive literature review and a preliminary investigation into the current situation with relation to sustainability in schools in the south east of Ireland, a model was created to support EMS implementation in primary schools with the support of a higher education institution (HEI) and a facilities management (FM) team. This model then became the focus of the research.

1.2.1 Origins of the project.

At Waterford Institute of Technology (WIT), in the School of Lifelong Learning and Education, there is a Master's programme for school leaders – Master of Arts in Management in Education. A lecturer on this course, Dr. Jane Russell-O' Connor, noted that school principals were increasingly expressing concern regarding the sustainable management of the school building and grounds and the increased workload in this area. Principals felt that there was little guidance in this area in terms of policy or guidelines and that they did not have the skills required for building management. Dr. Russell-O' Connor felt there was a need to conduct research in this area and outlined a Ph.D. proposal. At the same time, Bausch + Lomb (B+L) Ireland, an international medical devices company located in Waterford, had reoriented their approach to facilities management in line with sustainability principles and were aiming to increase their 'sustainability' image. As part of this, B+L wished to support research into sustainability in schools as they felt skills and knowledge of sustainability would be essential competences of future workers. On contacting WIT, it was agreed that B+L would part-fund the above-mentioned Ph.D. into supporting sustainability in schools and that three professionals at B+L would be enterprise mentors to the Ph.D. student.

1.2.2 Research participants.

This research consisted of three 'groups' of participants. These groups were selected based on the conceptual model that was devised following the literature review. The first, from Waterford Institute of Technology, was myself, the Ph.D. researcher. I was a primary school teacher with fifteen years' experience across all class levels. My curricular interests included Science and Geography and I had conducted research in science education at Master's level.

The second group of participants were engineers from B+L Ireland. These participants worked in FM and had a keen interest in sustainability. They all had experience in initiating energy and environmental management systems and in spearheading a variety of successful sustainability projects. Under the leadership of the FM team, B+L have successfully attained international standards in both energy management and environmental management.

The third group of participants were seven teachers from a local primary school. All teachers held degrees in Education and engaged in continuing professional development. The teachers' experience ranged from one year to over thirty years and all were highly committed to high-quality education at their school.

1.2.3 Research Approach

This research was embedded in a pragmatic paradigm. As pragmatism is problem focused, it is suited to researching sustainability topics. Language, meaning and interaction are central elements of pragmatism (Morgan, 2007), all of which were central to the model developed in Chapter 5. As the success of this model depended on leveraging all voices from the three cohorts of participants, a transdisciplinary approach was essential. Transdisciplinarity integrates subject disciplines and this research focused on integrating education and FM to support and enhance work towards becoming a sustainable school. The transdisciplinary approach also involves integrating views from various sectors of society beyond academia – in this case, primary school principals and teachers and facilities personnel. As this approach involves actors from diverse backgrounds and disciplines, it is possible that individuals may hold different or opposing values and opinions. Therefore language was identified early on as a potential issue within the research. This became further evident when writing the thesis as the two disciplines come from two very different schools of thought – education and engineering. Both disciplines have their own established methodologies and approaches and their own style of academic writing. While most of this thesis is written in the third person, some sections that specifically discuss my participation (such as reflexivity for example) as an integral part of the research, are written in the first person.

As there was the need to 'understand complex social phenomena' (Yin, 2009, p. 4) through the exploration of the model, a case study methodology utilising mixed methods was chosen. This facilitated the gathering of rich data which allowed these social phenomena to be explored and analysed. Overall the design was flexible in nature to ensure participation was maximised and unforeseen events could be managed.

1.2.4 Research Aims.

This research sought to investigate the current situation with regards to sustainable management and ESD in schools and to develop a means by which schools could be supported in this endeavour. As such, the research aims are as follows;

1. To identify and assess current approaches to sustainability management in primary schools in Co. Waterford.
2. To explore the ways in which schools can be supported in sustainable management through community partnerships involving industry and third level institutions.

3. To explore the ways in which ESD can be supported in schools through community partnerships involving industry and third level institutions.

1.3 Organisation of the Thesis.

This thesis is organised into ten chapters. Although this work is presented in a linear fashion, the process was, in fact, iterative, with each chapter being revisited following subsequent investigation. Particularly from Chapter 5 onwards, there was a constant revisiting of theory as '*continuous interaction between the theoretical issues being studied and the data being collected*' occurred (Yin, 2009, p. 68).

Chapter Two consists of a literature review that spans literature in the fields of facilities management (FM), environmental management systems (EMS) and education for sustainable development (ESD). This chapter highlights the many challenges facing school leaders who wish to engage with sustainability and the need to connect with external expertise for both EMS and ESD. As a result, there was a need to further investigate EMS and ESD practice in schools in the South East to determine the current situation in local schools.

Chapter Three outlines the research design for the project. This chapter describes the pragmatic paradigm in which the research is embedded. It is argued that pragmatism allows the focus to be on the social actors, their experience and the practical consequences on the school as a whole. The case study methodology is justified as is the transdisciplinary approach.

Chapter Four is dedicated to a preliminary investigation which involved distributing survey questionnaires to school leaders in the south-east to gauge current practice and opinions in this area. In many ways, these results mirrored the findings of the literature review and the need to develop a model to support EMS implementation in primary schools became clear.

This then led to the development of a conceptual model for supporting sustainable school practice which is presented in Chapter Five. This model is triadic in nature, involving social actors from HEIs, industry and primary schools. It is embedded in communities of practice theory where the focus is on the social actors and the harnessing of the expertise that becomes available when social actors from various disciplines are involved.

Chapter Six outlines the first stage of exploring the model and involved analysing and synthesising the sustainable FM approach used by experts in the area. This was done by means of interviews with engineers at the B+L plant and the methods, results and discussion are presented in this chapter.

Chapter Seven is the case report which outlines how this FM knowledge was used to create and implement an environmental management system with the participating primary school. A detailed description of the school is given to enable the reader to engage in naturalistic generalisation (Creswell, 1998, p. 186) – i.e. to generalise what findings may be applicable to their own school/setting.

Chapter Eight analyses the data from the case study including the teachers' reflective journals and a focus group. From this data, six main themes emerged. These themes are explored and a picture is created demonstrating how the EMS was generated and implemented at the case study school and the outcomes that ensued.

Chapter Nine uses the empirical evidence from Chapter Eight to further develop the conceptual model. The components of people, place and process are explored as facets of the embedded case study. The path of knowledge flows is examined and two boundary types are identified within the model. The model is then considered for application in other settings.

The thesis concludes with Chapter Ten where there is a summary of the overall work. Limitations are recognised and recommendations for future work are presented.

2. Literature Review

Facilities management (FM), the management of an organisation's buildings and services, is a relatively new discipline in its own right. Despite its youth, however, many companies are now recognising the strategic importance of FM within the broader vision for the organisation. Furthermore, with increased environmental legislation and public pressure on companies to develop a 'green' agenda, sustainable facilities management (SFM) is emerging as a sub-discipline of FM. SFM aims to manage the whole system – buildings, use, maintenance and management practices – to contribute to SD . Taking a sustainable approach can provide many benefits, but many barriers have also been identified in the literature (Pajunen *et al.*, 2016; Phan and Baird, 2015; Martín-Peña *et al.*, 2014). Renukappa *et al.* (2013) state that sustainability concerns the management of an organization's total business impact upon its immediate stakeholders, the society and the environment within which it operates. This definition highlights the scope of pursuing a sustainable strategy and consequently the potential difficulties in engaging in sustainable management. Many of these difficulties are mirrored or even amplified in the Irish primary school sector where there are no building specialists on site and where financial and human resources are limited. Furthermore, school staff must also address the pedagogical requirements of the school within a sustainable management framework and many challenges have been cited in the extant literature regarding embedding sustainability in school curricula (Kanyimba *et al.*, 2014; Rickinson *et al.*, 2015). However, if developed and implemented effectively, it is argued here that an EMS can be a tool for both SFM and ESD in the primary school setting.

This review is a narrative review of the literature focusing on a number of themes within the areas of EMS and ESD. Narrative reviews summarize and critique a body of literature and are selective in the studies included (Cronin *et al.*, 2008). The broad areas for inclusion in this review were decided upon based on the research aims and the need to inform the reader of the areas pertinent to this study. Google Scholar and EBSCO host were used to identify peer-reviewed papers (including conference papers) in each area. National and international policy documents were also used to inform the discussion. This literature review was exhaustive in nature (Cooper, 1988) and a section was deemed complete when chosen studies were citing authors already included in the review and therefore saturation in coverage was reached.

Section 2.1 focuses on facilities management, looking at both FM in industry and the use of EMS as tools for SFM. Key search words included 'facilities management', 'sustainable facilities management' 'environmental management systems' and 'Eco schools' and key authors identified included Alexander (2008; 2010; 2013) and Anker Jensen (2010; 2012). Sections 2.2 to 2.4 look at the four key areas of EMS in schools – energy, waste, water and biodiversity. There was a broad range of literature available for energy management in schools and biodiversity and school grounds but the literature was quite limited in waste and water management in schools. Section 2.5 explores the area of ESD. The literature on this theme is very broad and there are numerous policy documents at both national and international level. Key UN documents were used as was the key Irish policy document 'Education for Sustainability' (Department of Education and Skills, 2014a). Finally, in order to link the two areas of EMS and ESD, section 2.6 looks at harnessing the physical school environment for sustainability. Key authors in this section included Orr (1993; 1997; 2002) and Cole (2014; 2015) and the nascent concept of using the built environment for pedagogy is explored. The chapter finishes with a summary of the literature review and a presentation of the research questions.

2.1 Facilities Management.

Facilities management is the operation, maintenance, improvement and adaption of an organization's buildings to create an environment that is strongly supportive of the primary objectives of that organization (Barrett and Baldry, 2013 in Junghans and Olsson, 2014). Although originating in a technical field, FM has developed over the years to become more holistic in nature, taking into account users, occupancy and wider social phenomena. This more encompassing nature is reflected in current definitions of FM, such as the definition provided by the International Facility Management Association;

> *'Facility management is a profession that encompasses multiple disciplines to ensure functionality of the built environment by integrating people, place, process and technology'* (IFMA, 2019).

As '*people, place, process and technology*' will differ from organization to organization, FM needs to be sector-specific. Chen (2017) argues that it is essential for FM to support the core business of clients. If the clients of a school are the pupils and teachers, then the core business of schools is teaching and learning. Therefore, FM in schools must integrate the school building and grounds, the people who work and learn there, the processes and pedagogies in place and the available technology.

Originally, the focus of FM was mainly on reducing operating costs, but the extant literature is revealing a change towards the need for FM to create added value (Anker Jensen, 2010). For an industry or company, added value may be in the form of increased reliability or productivity, improved environmental outcomes or enhanced customer satisfaction (Anker Jensen *et al.*, 2012). These could also be potential outcomes in a school setting through effective FM, but it is also argued in this chapter that as running the school building is the largest financial cost to a school, there is added value in harnessing the building for pedagogical purposes. In this way, pupil engagement in managing and operating the building creates novel engagement with an ESD curriculum and an improved building, in turn, creates an improved learning environment in which pupils can thrive. Lindahl *et al.* (2012) maintain that when the building is viewed as a tool, focus is not only on how the building itself functions but also how the building helps create value for the organization. They believe that the occupants should ask the following questions; What do we want to achieve?, What do we want the building to contribute?, and How can our premises create added value for the organization? (p110). By answering these questions, a school can identify the type of teaching and learning they wish to occur, consider how the building can support this and what value this adds to the school community. For a school that wishes to engage in sustainable practice, answering these questions will help ensure the diffusion of ESD through curriculum, campus and community (see Section 2.5.4).

Another aspect that is getting increased attention in the current FM literature is 'usability'. Usability concerns how a space/artefact is actually used and the effects of that use (Lindahl *et al.*, 2012). Usability requires looking at buildings as a means for occupants to achieve their overall goals and objectives (Lindahl *et al.*, 2012). For any school, this requires looking at the building as a means of achieving learning goals (see Section 2.2.6 on Indoor Environmental Quality). For a sustainable school, it would require looking at the building as a tool for ESD.

2.1.1 Sustainable Facilities Management.

Within the FM literature, sustainability is addressed in many ways, from a narrow view of CO_2 emissions to a broad appreciation of complex socio-technical systems (Nielsen *et al.*, 2016). The goal of SFM is not only to produce facilities and services that place the least constraint on the environment but also to contribute to a long-term societal transition to sustainability (Galamba and Nielsen, 2016). With this in mind, SFM within a school setting should not only aim to manage the building sustainably, but also engage pupils in environmental stewardship of the built and natural environments, as a societal transition to sustainability will be more fully enabled if pupils are engaged with the issue from an early age.

SFM will need to take into account the three pillars of sustainability to deliver the increasingly demanded holistic service (Elmualim *et al*. 2009, in Price *et al.*, 2010). Through FM, solutions can be developed for environmental, social and economic challenges. In industry, environmental performance is perceived to be a source of competitive advantage (Tung *et al.*, 2014) and there are numerous ways a company can go about managing its environmental performance. One way that companies may endeavour to pursue their environmental commitments is through management systems. A management system is a set of policies, procedures and plans that an organization must follow in order to meet its targets. Management systems do not have to be certified, however many companies choose to do so. Two of the most popular certified management systems regarding environmental sustainability are the ISO 50001; the international standard for energy management and the ISO 14001; the international standard for environmental management. Certification to a standard such as the ISO 14001 shows commitment by a company to engage in best practice when it comes to environmental issues. Management systems were originally developed for industry and therefore this sector has much more experience in this area. Bausch and Lomb is ISO 50001 and ISO 14001 certified and have much experience with successful energy and environmental management. WIT have also just received ISO 50001 certification. ISO 50001 is a voluntary international standard and gives organizations the requirements for energy management systems (EnMS). It is intended to provide organizations with a recognized framework for integrating energy performance into their management practices (ISO, 2011). This standard is based on the Plan-Do-Check-Act (PDCA) framework and incorporates energy management into everyday organizational practices (ibid). Such a standard can provide great benefit to companies, reducing energy costs as well as their environmental footprint. While very relevant to large industries, EnMSs may not be as suitable to smaller businesses or indeed schools. As they only focus on one area of sustainability, the effort, time and skills required are more than likely too extensive to realize improvements in only one area. An environmental management system (EMS) may prove more suitable as all areas of sustainability with which a school is concerned can be incorporated within its framework.

More recently, schools have begun to implement EMSs in an effort to enhance their environmental management. The ways in which buildings are operated and managed will have a significant impact on a building's environmental footprint and one way to use the building as a tool for ESD is the implementation of an EMS. Campbell and Campbell (2017) argue that FM outcomes rely heavily on the way in which end-users interact with and use services and equipment. An EMS has the potential to teach occupants about their immediate built and natural environments and how to effectively interact with them. An EMS can be an effective learning tool and experience within the framework of ESD (Kanyimba *et al.*, 2014).

2.1.2 Environmental Management Systems.

An Environmental Management System is a system that organizations can implement in order to facilitate environmental sustainability. Implementing an EMS can help a company to build its 'environmentally friendly' reputation and therefore provide many benefits. ISO 14001 is the international standard for an EMS. It helps organizations to identify, manage, monitor and control their environmental issues (ISO, 2015). These issues may include, but are not limited to, water management, waste reduction and pollution control. Each organizational sector will have its own environmental issues and challenges and the management system can reflect this. Once certified, the company has to follow the PDCA cycle.

The literature associates many benefits with the implementation of an EMS and organizations are motivated to adopt an EMS due to these benefits (Tung *et al.*, 2014). The findings of Inoue *et al.* (2013) confirm the positive roles of ISO 14001, as do the findings of Martín-Peña *et al.* (2014) and Qi and Chang (2012). The reduction in costs and improvement in productivity are widely recognized benefits (Martín-Peña *et al.*, 2014). Martín-Peña *et al.* (2014) analysed EMSs in the Spanish motor industry and found improvements in resource use, stakeholder relations and waste processing to be among the benefits. Successful sustainability initiatives create value for shareholders (Pajunen *et al.*, 2016) and some studies have reported a positive association between environmental management practices and financial performance (Tung *et al.*, 2014). However, there are also difficulties associated with the implementation of an EMS. Companies experience difficulties mainly in the areas of cost, time and complexity (Martín-Peña *et al.*, 2014; Tung *et al.*, 2014). A number of studies have looked at the cost of implementing an EMS, which include the auditor's fees and the time and effort taken to prepare the relevant paperwork and ensure correct compliance with the specifications. Some managers consider that firms do not always obtain sufficient benefits to compensate for these costs (Martín-Peña *et al.*, 2014).

The literature on EMS stresses the importance of a comprehensive approach. Organizations with more comprehensive EMS were found to experience higher levels of environmental performance (Phan and Baird, 2015; Raar, 2015; Tung *et al.*, 2014). Phan and Baird (2015) focused on the intensity of use of environmental management practices associated with an EMS and found much variation in the extent of usage of these practices across industries and organizations. Research has suggested that the longer ISO 14001 is implemented by an organization the more impact it has as it becomes internally ingrained (Inoue *et al.*, 2013).

Küçüksayraç (2015) states that sustainability practices of companies differ according to their size. Tung *et al.* (2014) examined the adoption of EMS in Australian manufacturing companies and found that the organizations that did adopt an EMS were larger in size. Martín-Peña *et al.* (2014) found that small firms in the Spanish motor industry gained less from developing an EMS than medium-sized and large firms. Perhaps smaller firms feel the afore-mentioned costs more as they may not have the financial resources, human resources or the in-house expertise that larger firms have. Therefore, return on investment (ROI) may take significantly longer, resulting in smaller firms choosing not to implement the systems in the first place. These challenges could very well be mirrored in the school sector as staff count is lower than industrial companies, there is a lack of expertise in the area of energy and engineering, and financial resources for implementing management systems are limited.

Tung *et al.* (2014), when investigating the effectiveness of environmental management in Australian manufacturing organizations, found that while organizations with an EMS did achieve higher environmental performance, actual ISO 14001 certification did not affect environmental performance. Similar findings have been presented with regards to ISO 50001 (Jovanović and Filipović, 2016). So, while international certification for management systems is very popular and examples of benefits have been supplied in the literature, there are some disadvantages and there is certainly not a one-size fits all solution. Smaller sized firms and industries do not appear to achieve the same advantages (Küçüksayraç, 2015) and some studies note that sustainability issues are highly industry-specific (Renukappa *et al.*, 2013), highlighting the demand for approaches that have more specific assessment performance (Ness *et al.*, 2007). Finally, as implementing a management system, and in particular a certified one, can be time- and resource -consuming, it would be beneficial to integrate systems thereby preventing 'doubling up' of workload and methodologies. Qi and Chang (2012) found that ISO 9001 (Quality Management), ISO 14001 and OHSAS 18001 (Occupational Health and Safety Assessment Series) are positively correlated with each other, suggesting that the certification of one sustainable management system will decrease the cost of certifying others. Amundsen (2000) is also of the opinion that integrating energy management and environmental management avoids parallel management systems, thereby enabling greater economic savings and more successful environmental performance.

2.1.3 Eco-Schools.

The challenge in education is to create an EMS that complies with pedagogic requirements as well as managerial and environmental ones (Hens *et al.*, 2010b). The most widely used framework for EMS in schools is that provided by Eco Schools. Eco Schools was established in 1994 following the Earth Summit in Rio de Janeiro in 1992 and the subsequent publication of Agenda 21. It is coordinated by the Foundation for Environmental Education (FEE), an international, non-profit organization. It has developed from a programme run in four European countries to one of UNEP's preferred global model programmes for EE, environmental management, sustainability and certification at an international level (Eco Schools, 2019). Eco Schools now operates in 51 000 schools in 67 countries (ibid.).

Eco Schools is designed to encourage curriculum based action (Hens *et al.*, 2010b). Through the objectives set by national curricula, teachers and students can pursue topics such as energy, waste and water. It is hands-on as pupils monitor, record and improve aspects of their school environment. Eco Schools aims to better their schools in two ways; through the implementation of the EMS and indirectly by changing the way pupils perceive and interact with the natural environment (Pauw and Petegem, 2013). The Eco Schools EMS is ISO-based (Plovie, 2015) and certification to the Eco Schools standard is by means of the Green Flag award. Although awards are often seen as an important instrument to encourage schools to continue with an EMS (Hens *et al.*, 2010a), Pirrie *et al.* (2006) found that the status of the Eco Schools programme in Scotland as a recognized award scheme was considered the least important dimension of the programme. Furthermore, in some countries, such as Ireland, there is now a 'flag culture' whereby many organizations are awarding flags for various achievements including Active Schools (the Active Flag), positive mental health (the Amber Flag) and the promotion of the Irish language (an Ghaelbhratach). A study by Birney *et al.* (2011) reported on school leaders' feelings of being overwhelmed by the amount of initiatives a school is expected to implement. As stated in Section 2.1.2, actual ISO 14001 certification in industry did not affect environmental performance (Tung *et al.*, 2014). Whether or not achieving the Green Flag effects environmental performance is unconfirmed and it is important that awards such as these do not become tokenism or induce pressure on schools to live up to various standards as 'flying the flag' is a visible sign to communities about the achievements of a school.

In Ireland, Eco Schools operates through An Taisce in the form of the Green Schools Programme. Schools work through themes set out by Green Schools Ireland and achieve a Green Flag upon successful completion of each theme. Flags must be renewed every two years (www.greenschoolsireland.org). There are seven steps in the process of attaining a Green Flag – establish a Green Schools Committee, carry out an environmental review, create an action plan, monitor and evaluate the plans implementation, connect it to curriculum work, inform and involve the wider school community and create the school's Green Code. The themes are as follows; 1) Litter and Waste, 2) Energy, 3) Water, 4) Travel, 5) Biodiversity, 6) Global Citizenship – Litter and Waste, 7) Global Citizenship – Energy, and 8) Global Citizenship – Marine Environment. While the first five flags tend to be focused on the school environment, succeeding flags are focused on global issues and give the school a chance to readdress the issue of energy or waste in their own school while simultaneously studying the topic from a global perspective. This links in with one of the key principles of ESD whereby local action is connected to global issues. Also, by participating in activities to understand and improve the school environment, there is the potential to engage in meaningful ESD at a local level. The Green Schools initiative in Ireland is about promoting long-term, whole-school action for the environment (www.greenschoolsireland.org).

A number of authors have researched the effectiveness of Eco Schools in various countries, but the extent to which Eco Schools has achieved educational objectives remains a topic that has not received the necessary attention (Pauw and Petegem, 2013) and there is limited investigation into its effectiveness as an environmental management tool. In 2001, O'

Mahony and Fitzgerald considered the performance of the Irish Green Schools programme. The programme had been in place for four years at this point. The first flag of the programme is *litter and waste* and it is apparent from the results of this study that a significant waste to landfill reduction occurred within the schools progressing through the early stages of the programme. Prior to participation in the Green Schools programme, waste averaged at 53.16g/capita/day compared with an average of 29.04g/capita/day in schools that had been awarded a Green Flag for waste (O'Mahony and Fitzgerald, 2001). The same study reported that environmental awareness and knowledge levels were almost identical between Green School pupils and non-Green School pupils. Environmental behaviour however, differed significantly between the two groups. Green School pupils achieved higher scores in all the behaviours assessed and Green School pupils were found to be stronger opinion leaders (ibid). Pauw and Petegem (2013) found contrary results in their study in schools in Flanders. They found that Eco Schools have no effect on students' environmental behaviours or preservation values. Furthermore, they found that preservation values impact environmental behaviour and not utilization values which were improved through Eco School participation. The Irish study, conducted in 2001, was carried out in the very early stages of the programme when it was a new and different approach and when interest levels were most likely at a high. There is no evidence to suggest that this level of success was sustained, particularly as new topics were introduced or if the same success was achieved in later topics. Green Flag assessors do survey pupils on the Green School themes when they visit schools, but it appears that this data is unpublished. Following a number of emails and phone calls to inquire about this data, no information was received from Green Schools Ireland. There are statistics published on the website. For example, under the theme 'Litter and Waste' accessed on 25/10/2017, the following fact was present: *16g of waste per person, per day, was diverted from landfill by students in Green-Schools during 2016 – the equivalent weight in total of 2618 polar bears!* (www.greenschoolsireland.org). There are no details, however, as to how this figure was calculated. The website also publishes case studies on individual schools which show the success of various participants.

The success of an EMS in schools depends on a number of factors. Hens *et al.* (2010b) developed and implemented an EMS in primary schools in South Africa with the assistance of universities. They found that a key feature of a successful EMS was the involvement of all members of the school community. Pirrie *et al.* (2006) when evaluating the Eco Schools programme in Scotland noted that involving the wider community was the area of greatest challenge for schools. Given the importance of wider community involvement in EMS implementation, it is important that schools plan for this aspect in the early stages of the EMS. How and when information will be circulated needs to be mapped out from the beginning. Another highly important factor in the area of participation was identified by Cincera and Krajhanzl (2013) when evaluating Eco Schools in the Czech Republic. The pupils' action competence positively correlated with the level of perceived participation. Indeed, what was most meaningful in this study were the pupils' participatory roles. Active participation by pupils is an important aspect of an ESD framework in schools.

There are a number of factors that appear to hinder the implementation of an EMS. Cost, time, skills, meeting stakeholders' expectations and underestimating requirements such as the audit cycle (Hillary, 2004 in Kanyimba *et al.*, 2014) as well as the volume of paperwork (Pirrie *et al.*, 2006) have all been identified as difficulties in the literature. Also, some target areas may be more difficult to obtain results in than others. Hens *et al.* (2010a) and Hens *et al.* (2010b) found that energy related activities did not improve greatly in primary schools upon the implementation of an EMS while water, waste and 'greening' activities all improved significantly. Pirrie *et al.* (2006) evaluated the Eco Schools programme in Scotland and found that the main focus of initiatives was on various types of recycling schemes and other highly visible initiatives such as improving the school grounds.

As many schools around the world invest significant time and effort implementing Eco School initiatives, it is surprising that the literature investigating the effects is quite limited. The literature calls for more attention in the following areas; the extent to which EMS realise the official curriculum targets of schools (Hens *et al.*, 2010b), the extent to which they can harmonise the three pillars of sustainability through ESD (Kanyimba *et al.*, 2014) and the extent to which teachers' environmental values and behaviours can impact EMS implementation (Pauw and Petegem, 2013). Also, as some of this research was completed in the early days of the Eco Schools programme, such as the Irish and Scottish examples, studies are needed that investigate the long-term impact of such projects. When Lewis (2013) was investigating education for sustainability (EfS) at primary schools in Perth, it was found that participation in AuSSI (Australia Sustainable Schools Initiative) resulted in improved systems thinking and behaviour. However, after three years in the programme, pupils' understandings and actions reverted to a siloed approach, highlighting the importance of longer-term studies. Conversely, industrial EMS literature suggests that the longer an EMS is implemented the more embedded it becomes and therefore the more impact it has (Inoue *et al.*, 2013). Whether progress plateaus or more impact accrues over time in Eco School participation is undocumented. Furthermore, this data raises the question as to what systems or strategies result in EMSs becoming ingrained in industrial settings and how could we transfer this success to the schools' sector.

Supporting the implementation of an EMS with an industrial partnership (such as the proposed partnership with B+L) has many potential benefits. As identified in the literature, involving the local community can be a challenge (Pirrie *et al.*, 2006). Creating partnerships with local business and industry is one means by which schools can connect with the wider public. Another difficulty identified was that of a skills deficit. Connecting with industry and third level experts will provide valuable information and training for school personnel while complementing ESD in schools and social sustainability in industry.

Environmental management in schools can focus on a number of issues, including travel, but this research project focused on the areas of energy, water, waste and biodiversity on the school grounds. These are four key areas identified in the literature and are pertinent to all schools regardless of size or location.

2.2 Energy Management in Primary Schools.

Energy efficiency initiatives have been the focus of much research worldwide. Energy efficiency in schools has received a sizable amount of attention, particularly in developed countries. However, despite several attempts to tackle energy in schools, including upgrades and refurbishments, CO_2 emissions continue to rise in the school sector (Kershaw and Simm, 2014; Lourenço *et al.*, 2014). With almost 3300 primary schools in Ireland (Department of Education and Skills, 2016a), this section of building stock makes up a significant portion of the public sector built environment. Buildings have been identified for quite some time now as a necessary target in the reduction of CO_2 emissions, as buildings account for 40% of total energy consumption and 35% of the total CO_2 emitted in the EU (Thewes *et al.*, 2014). As targets for energy reduction have been set through the EU 2030 Energy Strategy (De Vos *et al.*, 2014), the EU Energy Efficiency Directive (2012b), NEEAP (Department of Communications

Energy and Natural Resources, 2014) and others, it is essential that the cause of rising CO_2 emissions in schools be identified and addressed. Energy conservation is associated with activities and behaviours while energy efficiency is associated with technological improvements (Pérez-Lombard *et al.*, 2009). Both are central to reducing CO_2 emissions and mitigating climate change in pursuit of SD (ibid).

2.2.1 The Sustainable Energy Authority of Ireland.

The Sustainable Energy Authority of Ireland (SEAI), Ireland's national energy authority, was established in 2002 under the Sustainable Energy Act 2002. The mission of the SEAI is '*to play a leading role in transforming Ireland into a society based on sustainable energy structures, technologies and practices*'. SEAI aims to advance Ireland to be recognized as '*a pioneer in the move to decarbonized energy systems*' (Sustainable Energy Authority of Ireland, n.d.). SEAI runs numerous initiatives and programs aimed at the domestic, industrial and tertiary sectors.

SEAI are dedicated to improving energy use in schools through the building, management and education. 'Energy in Education' is a partnership initiative run by SEAI and the Department of Education and Skills (DES). It provides energy management courses for school staff and resources for energy management in schools. SEAI encourage the involvement of pupils by supplying resources for teaching about energy, providing energy workshops and running projects and competitions such as 'Explore our Energy' and 'One Good Idea'. SEAI also provide grants to schools for energy efficient upgrades and refurbishments. However, the uptake of training courses has been somewhat slow, with only 174 schools attending energy management courses during the 2012-2013 academic year (SEAI, 2013). This should increase as mandatory reporting of energy consumption in schools began in accordance with statutory instrument 426 of 2014. Monitoring and reporting (M&R) will help schools to track, benchmark and improve their energy performance (Sustainable Energy Authority of Ireland) as well as allowing SEAI to track targets towards those set out for 2020 in NEEAP. In 2014, 977 schools (primary and secondary) uploaded their data to the online national energy M&R system (SEAI, 2015), and in 2015 this increased to 1792 (SEAI, 2016a). SEAI deemed this a good response due to the technical complexity of the data requirements (ibid.).

The Planning and Building Unit of the DES, in conjunction with SEAI, developed the DART (Design, Awareness, Research and Technology) Programme which develops sustainable, energy efficient school buildings. The design maximizes both the natural resources of the local environment and energy efficient technologies. Gaelscoil an Eiscir Riada in Co. Offaly was the first building project to comprehensively draw from the DART programme (Dolan, n.d.). The completed project was deemed a huge success and won a number of awards. In the first year, energy usage amounted to less than 30kWh/m^2 (ibid). All new primary schools which are now built under the guidance of the DART programme must reach a minimum of A3 on the BER (Building Energy Rating). Some argue that focusing on the operation stage of a building's lifecycle will produce more rapid advances in sustainability making this phase more critical than the design phase (Nielsen *et al.*, 2016). Therefore, while these new school buildings have significant advantage over older schools when it comes to sustainable buildings management, they should still implement an EMS as part of their environmental management practices to monitor environmental impacts and monitor user behaviour.

2.2.2 Energy Use in Primary Schools.

Irish schools do not have building management specialists on site and energy conservation is not a core function of a school (Department of Education and Skills, 2014b). Indeed, most schools may have no one on either the staff or the Board of Management (BOM) who has any knowledge regarding building management. Therefore, energy management is likely viewed as a challenge among school leaders. Due to the relatively short operational hours of primary schools, there tends to be an intensive block of energy use each operating day. Being a central building in most communities, schools are often used after hours for evening classes or other community events, adding to the energy use of the building. Space heating tends to be a predominant activity putting pressure on energy use (Lourenço *et al.*, 2014). In Irish schools, 66% of energy consumption is for space heating. However, in China, analysis of energy consumption in 270 schools in Tianjin revealed that ¾ of the total energy consumption was for space heating (Xing *et al.*, 2015), while in the USA, space heating accounts for 47% of total energy consumption (Pereira *et al.*, 2014). These figures highlight the differences that may occur in trends between countries, climates and/or cultures. Where they are in use, HVAC systems (heating, ventilation and air conditioning) noticeably increase energy consumption. Katafygiotou and Serghides (2014a) note heating, cooling and ventilation as the main running costs for the schools in their study. Lighting, water heating and computer systems are the other services to which the literature attributes significant energy consumption. The GAP Report 2006 (in Godoy-Shimizu *et al.*, 2011) predicted that 'the fastest growth in emissions may come from electricity consumption by ICT'. Schools are becoming more reliant on computer technologies as pedagogical tools and this increase will inevitably effect energy consumption. There are also unintended consequences such as equipment left on unnecessarily (Cohen and Bordass, 2015), again drawing our attention to user behaviour.

There are notable differences in energy consumption patterns between levels of educational facilities. Different school levels generally have different occupation densities, time-tables and building types and therefore different energy consumptions (Pereira *et al.*, 2014). Primary schools have been found to be much less energy intensive that secondary schools. Hong *et al.* (2013) found that primary schools used significantly less electricity per pupil and energy for heating per pupil. Godoy-Shimizu *et al.* (2011) also found significant variations in emissions between primary and secondary schools due to large differences in electricity consumption. They attribute this difference in electricity usage to the greater use of ICT (information and communications technology) in secondary schools.

Despite differences in energy consumption patterns between country or school type, there is one constant – that energy consumption, and therefore CO_2 emissions, is on the rise.

2.2.3 New vs. Old Buildings.

Older buildings, when under construction, did not have access to the materials, technology or design knowledge available today. As a result, many older buildings have dated heating systems or less efficient building services. The building envelope in particular is often of a lesser standard due to poor insulation and degradation over time. This is reflected in the higher space heating needs of such buildings. Sekki *et al.* (2015) in a study of Finnish educational buildings found that newer buildings consume less heating, as did Robertson and Higgins (2012) when investigating energy management at Albuquerque schools. Many studies note that fossil fuel consumption for space heating has decreased over the past number of years (Hong *et al.*, 2013; Issa *et al.*, 2010). This is most likely due to tighter building envelopes (Robertson and Higgins, 2012) but could possibly be influenced by increased internal heat gains from electrical equipment and/or higher pupil densities (Kershaw and Simm, 2014). Katafygiotou and Serghides (2014a) studied the energy consumption of school buildings in Cyprus and found that density of pupils and the equipment in classrooms directly affect the internal heat gains of the buildings.

Reduced heating requirements mean less combustion of fossil fuels and less CO_2 emissions. However, any carbon saving is offset by a larger increase in the electricity consumption patterns in new schools (Kershaw and Simm, 2014). Many studies have found that in contrast to space heating patterns, electricity consumption has been on the rise in recent years. Lourenço *et al.* (2014) used eight Portuguese case study secondary schools to analyze energy consumption patterns. Interestingly, this study followed a School Building Modernization Programme, which upgraded 106 public secondary schools between 2007 and 2011. Lourenco's (2014) research highlights a significant rise in energy utilization after the refurbishment, with electricity rising on average by 200%. Sekki *et al.* (2015) when studying energy consumption in educational buildings in Finland, noted that the electricity consumption in newer buildings had a rising trend. Similar results were noted by Thewes *et al.* (2014) with school buildings in Luxembourg and Robertson and Higgins (2012) with schools in Albuquerque. Thewes and colleagues (2014) found that primary energy consumption of new buildings has risen in recent years due to increased electricity usage.

There have been a number of explanations put forward in the literature regarding this widespread increase in electricity consumption, particularly evident in newer school buildings. While there has been much improvement in the efficiency of electrical appliances, this has been counteracted by their increasing numbers and extended use (Cohen and Bordass, 2015). ICTs are being increasingly used as pedagogical tools. Another theory put forward to explain this growth in electrical consumption is the increased complexity of building systems in newer buildings. Robertson and Higgins (2012) found that as more electric power is needed for these complex building systems, the electricity EUI in their study tended to be higher in newer buildings (the natural gas EUI showed the opposite trend). Yet another explanation put forward in the discussion on increased electricity usage in schools is that of HVAC systems. Ventilation in particular is an influencing factor as building envelopes become tighter and legal ventilation rates must be complied with. Hong *et al.* (2013) observed a significantly different pattern of electricity use between naturally and mechanically ventilated school buildings. Robertson and Higgins (2012) found the increased use of refrigerated air conditioning systems in new schools in Albuquerque a significant challenge. Thewes *et al.* (2014) studied 68 educational buildings in Luxembourg, including Passive, low-energy and standard buildings. They note that one of the main reasons electricity consumption is higher in Passive and low-energy school buildings is the use of mechanical ventilation systems.

Buildings with energy efficiency equipment, on average, use more energy than buildings that do not have this equipment (Robertson and Higgins, 2012). While this seems counter intuitive, it is a recurring theme in the literature – an increase in the use of energy efficiency technologies is followed by an increase in energy usage. The Khazzoom-Brookes postulate predicted this rising trend in electricity use. They argued that increased energy efficiency would encourage the use of technologies and services that otherwise would not be used (Khazzoom, 1980 and Brookes, 1990 in Issa *et al.*, 2011). This highlights the importance of occupancy behaviour and the role of energy conservation alongside energy efficiency. User behaviour is a decisive factor impacting energy consumption in buildings, yet behavioural issues are still among the areas least covered by scientific literature (Lourenço *et al.*, 2014). Energy consumption is continuously growing despite energy efficiency technologies and measures, and conservation measures are vital in attaining a balanced use of energy mainly through behavioural changes (Pérez-Lombard *et al.*, 2009). In their study of eight educational buildings in Portugal, Lourenco and colleagues (2014) noted that the one school that had a computerized BMS (building management system) was the school with the lowest CO_2 emissions. They noted that the BMS emerged as an important tool only if a number of prior criteria were met such as users' proficiency and their ability to communicate data. Robertson and Higgins (2012) stated that one of the reasons the older schools in their study were more energy efficient was because the HVAC systems were occupant controlled. In the same study however, post occupancy evaluations revealed that newer schools performed better with regards to occupant satisfaction. Interestingly, the only area where the newer schools did not score better was in the control of the HVAC systems. Predictive or smart systems do not take into account users' apparent preference for exercising control (Lourenço *et al.*, 2014) and as noted in the Robertson study, occupants dislike when control of the immediate environment is taken from them. Katafygiotou and Serghides (2014b), following their study on energy performance of buildings and indoor comfort, believe that occupants' ability to make their own decisions and control their immediate environment is essential to their contentment as end users. The impact of occupant behaviour on energy performance is significant and many variables are essentially dependent on the occupants and can result in considerable variations in energy use among schools (Pérez-Lombard *et al.*, 2009; Sekki *et al.*, 2015).

Energy awareness is another important factor that influences user behaviour and Katafygiotou and Serghides (2014a) found that the energy awareness of pupils and teachers is very important in improving the energy performance of a school. Each person in the school is an energy user and, as such, is responsible for the conservation and efficient use of energy in the school. Building occupants have a major impact on a building's energy consumption. Sekki *et al.* (2015) state that that the significant differences in the consumption patterns of the buildings they studied could not be explained only with technical details. These differences between the schools occurred irrespective of the age or building type, again highlighting the importance of user behaviour.

2.2.4 Benchmarking Energy Consumption in Schools.

In order to control energy consumption in schools it must be measured, monitored and analyzed. Benchmarking is a vital step in the reduction of emissions from buildings (Hong *et al.*, 2013). Similar to industry, a number of attempts have been made to try and develop usable energy benchmarks for the education sector. Benchmarks can help to identify best practice and allow schools to compare their energy performance to that of their peers.

Hernandez *et al.* (2008) outlined a methodology to develop energy benchmarking in Irish primary schools and identified the median use of 96kWh/m^2/annum. Currently SEAI are collecting data on energy consumption in Irish schools with the aim of feeding into the future design of sustainable schools (Department of Education and Skills, 2014b). In Ireland, all schools with a floor area greater than 250m^2 must display their DEC (Display Energy Certificate) in the main entrance (SEAI, n.d.-b). The BER (Building Energy Rating) was introduced as a measure under the EU Energy Performance of Buildings Directive (European Parliament, 2002). It is the calculated energy use for space and hot water heating, ventilation and lighting based on standard occupancy (Sustainable Energy Authority of Ireland). It has a rating from A to G, with A being the most energy efficient. Using the BER/DEC, schools can monitor how well their school is doing with regards to energy usage. It raises awareness about how much energy is being used and its public display can be a source of motivation to improve the efficiency of the building (Hong *et al.*, 2013). The DEC is also accompanied by an advisory report recommending works for efficient upgrade and improvement.

The UK has done a significant amount of work in relation to data collection for monitoring and benchmarking energy. While there is a lack of empirical data for the generation of energy benchmarks in Ireland, UK benchmarks can provide a viable basis of comparison for buildings in Ireland (SEAI, n.d.-a). In the UK, energy benchmarks for schools are calculated separately for fossil fuel and electricity. This allows schools to establish performance against each benchmark for each type of energy use thereby avoiding the difficulties associated with one energy benchmark (Pereira *et al.*, 2014). Both benchmarks are measured in kWh/m^2/p.a. In Northern Ireland, typical electricity use is 18 kWh/m^2/p.a. for primary schools and 22 kWh/m^2/p.a. for secondary schools. Typical fossil fuel consumption is 119 kWh/m^2/p.a. and 120 kWh/m^2/p.a. for primary and secondary schools respectively (Keohane, n.d.). This results in annual average energy consumption of 137 kWh/m^2/p.a. for primary schools and 142 kWh/m^2/p.a. for secondary schools.

In Cyprus, Katafygiotou and Serghides (2014a) calculated annual average consumption of schools at 62.75 kWh/m^2. Lourenço *et al.* (2014) calculated the mean primary energy consumption of eight Portuguese secondary schools, in 2012, to be 67 kWh/m^2, from which 16 kWh/m^2 referred to gas use and 51 kWh/m^2 referred to electricity use. Xing *et al.* (2015) determined the space heating of primary schools in Tianjin at 67.22 kWh/m^2/p.a. and the non-heating consumption at 13 kWh/m^2/p.a. This sample of results shows the diversity among the findings.

There are many examples for benchmarking energy for schools in other countries also. However, different countries use different variables in their calculations, including different energy types and reference values, making wide scale comparability difficult. In the Finnish study by Sekki *et al.* (2015), gross heated floor area including the exterior walls was used as a benchmarking metric. It has been argued that as floor area is a key driver of energy use in schools, the EUI kWh/m^2 is a more fitting metric than the number of pupils (Hong *et al.*, 2013). Alternatively, Godoy-Shimizu *et al.* (2011) believe that kWh/pupil must also be considered as pupil density can differ between schools. They also consider kWh/pupil may be a more engaging metric as many other matters relating to schools are presented 'per pupil'. Other variables amongst studies include building volume, pupil density and heating degree days. Primary energy, consumed energy and billed energy are among the energy types investigated while results vary between mean, median, average and best practice (Pereira *et al.*, 2014).

External benchmarking can be used to set goals against the better performing schools. However, establishing a set of reference buildings is costly and time consuming. Cluster analysis is one possible solution to this problem as large groups of buildings can be broken down into smaller homogenous groups (Lara *et al.*, 2015). Crowd sourced building intelligence is another possibility whereby live building energy data could be gathered from intelligent buildings and smart systems (Robertson *et al.*, 2015). A critical component in the success of external benchmarking is the level of comparability with the buildings that create the basis of the benchmarks (Hong *et al.*, 2013) thereby highlighting the importance of the data-gathering phase. Consequently, historical or internal benchmarking can prove to be an easier method for schools. Managers of schools can gather and collate their own data on the energy consumption of their school and use it to establish benchmarks against which improvement can be measured. Indeed, some authors argue that internal benchmarks are more valuable in terms of identifying energy wastage and overall performance (SEAI, n.d.-a). Internal benchmarks also allow the school to adapt year on year as improvements occur and to reestablish their baseline and define new benchmarks. Static external benchmarks can prove problematic in this regard. In the UK, CIBSE's TM46 is one of the main sources of benchmarks, yet it has been found that they do not accurately reflect the actual energy consumption patterns in some sectors (Robertson *et al.*, 2015). Bruhns, Jones and Cohen (2011 in Robertson *et al.*, 2015) found that in school buildings there was a tendency for higher electricity use and lower heat consumption than the benchmark values. Therefore, while many schools will concentrate on reducing electricity use to come in line with the benchmark values, the fossil fuel benchmark will prove to be unenticing for many schools if they are already meeting or surpassing it (Robertson *et al.*, 2015). So while there is much difficulty associated with benchmarking and it is a far from standardized procedure, it still remains a valuable tool in combating the over-use of energy.

2.2.5 Indoor Environment.

The indoor environment relates to thermal comfort, air quality, visual comfort and acoustic comfort of a building. Katafygiotou and Serghides (2014b), on investigating occupant satisfaction in secondary schools in Cyprus, found that the pupils were not contented with the indoor comfort conditions of their schools. This is significant as each of the four areas of indoor environmental quality (IEQ) can affect teaching and learning in classrooms.

Thermal comfort is always affected by the energy efficiency of buildings and vice versa (Katafygiotou and Serghides, 2014b). Haverinen-Shaughnessy *et al.* (2015) found that temperature as well as indoor ventilation rate, is potentially related to student health and academic performance. In the majority of schools, management members are unaware of CO_2 concentration levels as an indicator of comfort and do not relate them with indoor air quality (Lourenço *et al.*, 2014). There is a considerable body of literature that suggests that recirculated air systems, often used in newer schools, have considerably poorer indoor air quality (IAQ) when compared with 100% outside air systems (Robertson and Higgins, 2012). On top of this, as pupils breathe a greater volume of air relative to their body weight in comparison with adults, it is possible that they are more sensitive to indoor air pollution (Katafygiotou and Serghides, 2014b). High levels of CO_2 have been found to have a negative impact on pupils' learning ability (Griffiths and Eftekhari, 2008) and the findings of Clements-Croome *et al.* (2008) indicate that CO_2 levels can rise to levels of about 4000 ppm during classroom occupancy periods (as opposed to acceptable levels of 1000ppm). Katafygiotou and Serghides (2014b) identified an association between poor indoor quality conditions and low energy efficiency of schools, possibly due to the mismanagement of heating, ventilation and air conditioning systems or inefficient insulation.

The energy performance of a building and its indoor environment are inextricably linked. A healthy indoor environment is an essential component of a school where pupils spend a high concentration of their time and where they are required to focus and work for a significant portion of the day. It has been shown that less energy is consumed if the indoor conditions of a building are better (Katafygiotou and Serghides, 2014b) as well as better performance from pupils (Clements-Croome *et al.*, 2008)

2.2.6 School Retrofitting.

Upgrading or refurbishing older buildings in order to make them more sustainable and reduce CO_2 emissions is a necessary step in reducing energy consumption. However, there are mixed views in the literature with regards to the value and success of school retrofits. While effective school building retrofits have been proven to reduce CO_2 emissions, particularly with regards to fossil fuel fired space heating, there are examples in the literature where electricity usage has increased following a refurbishment. Cost has also been identified as a barrier to carrying out retrofits in schools. Nevertheless, retrofitting has its role in conserving energy and creating a better learning environment for school occupants (Hong *et al.*, 2013).

Space heating is the largest energy consumer of older buildings. Katafygiotou and Serghides (2014a), when investigating structural elements of the school building stock in Cyprus, concluded that the selection of the proper construction elements and design strategies is very important at the renovation stage for a school building and that insulation of the building envelope is the most appropriate design element for an energy efficient school building. The heating demand of a school can be lessened through improved air tightness and wall insulation, both of which are reasonably simple and widely available upgrades (Thewes *et al.*, 2014). In Ireland, improved insulation was targeted in existing school buildings in 2009 with the attic and cavity wall insulation scheme (Department of Environment Community and Local Government, 2009).

Katafygiotou and Serghides (2014a) identified the main building practices in school construction in Cyprus and simulated six retrofitting scenarios based on the energy categorization of the building. They believe that it is impossible to improve the situation with regards to energy in schools without an energy efficient renovation of the existing buildings. Issa *et al.* (2010) concur that retrofits designed to improve energy efficiency in traditional buildings have a substantial impact on energy consumption. In their investigation of energy consumption at Toronto's public schools, Issa and colleagues found that energy retrofitted buildings not only utilize less electricity and gas than conventional buildings but that they also use it more efficiently.

However, there are examples that contradict these findings. As previously mentioned, when Lourenço *et al.* (2014) studied energy use in recently refurbished secondary schools, they found that energy consumption had risen dramatically. Issa *et al.* (2011) query the financial value of retrofitting older buildings as they found that energy retrofitted and green schools spent 37% more on electricity than conventional schools in Canada. The size of the building and occupancy density have also been found to influence the outcomes of upgrades. Issa *et al.* (2011) also noted in their study that energy savings in smaller retrofitted schools with fewer occupants were more significant than the savings of larger retrofitted schools.

Regardless, there is the possibility of modifying older schools relatively easily such as installing new or refurbished windows (Robertson and Higgins, 2012) or insulating wall or attic cavities. Energy retrofits must play their part in the mix of energy efficiency initiatives aimed at reducing overall energy use. It is imperative however, that these retrofits are suited to the building and underpinned by sound engineering and are not implemented without investigation or just to give a ‘green label’ to the building.

Studying the literature, it becomes apparent that there are many variations in approaches and methodologies, including choosing parameters and metrics and identifying variables in the case of benchmarking. Lack of consistency is proving to be a key difficulty, even within EU countries who are working from the same directives. Also, studies conducted on energy in schools thus far cite the need for further research (Godoy-Shimizu *et al.*, 2011; Lourenço *et al.*, 2014) especially on a more focused case study basis (Robertson and Higgins, 2012).

The analysis of Vance *et al.* (2015) show that modest reductions in energy demand can influence the trend toward sustainability and that the required changes at a personal level are relatively small. Schools, in particular primary schools, are ideal to target energy efficiency and energy conservation. They make up a large portion of the building stock and due to their educational purpose, they play a key role in local communities. Implementing energy efficiency initiatives in schools, involving behavioural changes, energy awareness, improved management and building retrofits can reduce energy consumption, yield savings and encourage younger generations to carry forward the lessons learned.

2.3 Resource Management in Primary Schools.

Resource Management is third on the list of key accountabilities of the Principal as set out by Hay Group Management for the Irish Primary Principals Network (2003), but there is virtually no literature on efficient resource management in Primary schools and very little policy from the Department of Education and Skills pertaining to this area in Ireland. Resource management (not including human resource management) consists of the management of physical assets such as buildings and grounds, building facilities including energy, water and waste, as well as educational resources and IT equipment. School systems rely on a broad range of resources (OECD, n.d.) and the management of these resources can significantly impact on the quality of teaching and learning in schools (Mestry and Bodalina, 2015). For the purposes of this research, and with a focus on sustainable management, it is proposed to focus on the areas of water management and waste management.

2.3.1 Water Management in Schools.

Water is an essential natural resource and an indispensable input of both industrial (Alkaya and Demirer, 2015) and school activities. Education and awareness of water usage is one of the seven themes in the Green Schools programme (see Section 2.1.3) and is supported and funded by Irish Water. With the establishment of Irish Water in 2013 and the introduction of metering, water utilization and consumption has received much attention as a national and global issue. Water usage in industry has received a sizable amount of attention, owing to the high demands certain industries place on water as a resource. To date, research on water usage in schools has been mostly concentrated around the areas of pupils' water intake, contamination and sanitation.

Although water conservation must be encouraged in schools, it is also a priority that pupils are encouraged to drink sufficient water each day as part of a healthy lifestyle. Low water intake among young people is quite prevalent (Kenney *et al.*, 2016; Patel *et al.*, 2014) and problematic. Poor hydration has been connected to poorer cognitive function and moods (Masento *et al.*, 2014), poorer wellbeing, decreased physical activity and urinary tract infections (Jasper *et al.*, 2012). In comparison, adequate consumption of water is associated with obesity prevention, dental caries reduction with fluoridated tap water (Patel *et al.*, 2014), improved memory recall (Elbel *et al.*, 2015) and proper circulatory and metabolic function (Kenney *et al.*, 2016). Studies in this area have highlighted problems in schools with regards to student access to drinking water. Kenney *et al.* (2016) investigated the extent to which schools provide drinking water access in the USA and found that overall, drinking water access was not ample enough to adhere to state or federal drinking water policies. Muckelbauer *et al.* (2009) studied a combined environmental and educational intervention in drinking water promotion in German elementary schools. They reported an increase in daily water intake and a decrease in the risk of pupils being overweight. Elbel *et al.* (2015) looked at the influence of 'water jets' (large, clear, plastic jugs with push levers that dispense cooled, aerated tapwater) on water consumption in New York City public schools. Following the installation of the water jets, and with no other school-based promotion of water consumption, students almost tripled their water intake at lunchtime. This study highlights the value of access to drinking water. Access to free and appealing drinking water in schools is important as children spend much of their time in this setting (Patel *et al.*, 2014) and water consumption is essential to a healthy mind and body. This can be a challenge for schools, especially those with older infrastructure (Kenney *et al.*, 2016). However, providing clean, fresh, palatable drinking water for pupils is an essential consideration when managing the water needs of a school.

The majority of other papers in this area have focused on the issue of contamination and/or sanitation. Research has shown that schools in both developing and developed countries lack adequate water and sanitation services (Jasper *et al.*, 2012). Lead contamination in drinking water has been noted as a significant problem in many developed countries. High lead concentrations have been reported in large buildings in particular, such as schools (Deshommes *et al.*, 2016). In the USA, lead is the most prevalent toxicant in school drinking water (Lambrinidou *et al.*, 2010) and a number of studies have highlighted concerns regarding pupils' access to contaminated drinking water at school (Bryant, 2004; Lambrinidou *et al.*, 2010; Sathyanarayana *et al.*, 2006). More recently, Deshommes *et al.* (2016) looked at lead contamination in Canadian schools and other large buildings and found that the measured lead concentrations at the tap of 8530 buildings were generally low. However, they did find that some daycares and elementary schools presented system-wide lead release which is a cause for concern. In Ireland, Irish Water's records show that there are no lead water mains in Ireland (although there are still some in the public network) and the Irish public is exposed to very little lead (Irish Water, 2016). However, prior to the 1970s in Ireland, lead pipework and plumbing was in widespread use and is quite likely to be prevalent in properties constructed in the period prior to this time (Department of Environment Community and Local Government and Department of Health, 2015, p. 3). As no level of lead in drinking water is considered safe and current EU limit for lead in drinking water is 10µg/l, any lead piping or fittings on a property should be identified and replaced. As young children are at particular risk from lead in drinking water, schools should be a particular focus for identifying and rectifying this issue. The National Strategy to Reduce Exposure to Lead in Drinking Water (Department of Environment Community and Local Government and Department of Health, 2015) will ensure that water in both public and private buildings is monitored over the coming years. The Department of Education and Skills conducted an initial assessment of schools in

Ireland and it would appear that a considerable amount of school buildings may be at risk of having lead plumbing and pipes based on their age profile. However, in the majority of cases in this country, the DES is not the owner of school buildings and therefore it will be necessary for school owners and Boards of Management to carry out their own assessment and if lead is present, create a plan to mitigate any risks (Department of Environment Community and Local Government and Department of Health, 2015, p. 25).

Outside of these areas of pupils' water intake, contamination and sanitation, there is very little research on how water is used in schools, water utilization patterns in schools or water conservation programmes in schools. Barua *et al.* (2015) conducted a study to model water use in schools in Melbourne with the aim of influencing resource management and planning and this appears to be the first published paper on modeling water use in schools. There are a small number of empirical studies in this area also. The Municipality of Bologna in Italy looked to monitor water consumption in the city with the aim of better analyzing and providing for water demand and water management (Farina *et al.*, 2011). After identifying consumption over a four-year period across a number of municipal buildings it was decided to focus on schools for further analysis. Out of the nine areas studied, schools used the second highest volume of water. The subsequent research conducted on schools provided many interesting insights into how water is consumed in schools but it is difficult to assume comparisons for Ireland as here our schools are, for the most part, smaller, we don't use water for irrigating school grounds and our opening hours differ. It has been noted in the literature that improving efficiency in water usage in primary schools can save considerable water (Cheng and Hong, 2004). Monitoring and analyzing water usage in Irish primary schools would provide insights into consumption trends here and highlight inefficient practices and therefore provide guidelines for policy development in this area.

In Ireland, full metered water charges for schools came into effect on 1st January 2010. Prior to this, the Department of Education and Science (2008) issued a circular to schools to advise on how best to reduce water wastage and how to establish a Water Management Plan. There was also advice given on simple and easily installable water saving technologies and these were encouraged over more technical measures such as rainwater and greywater recovery. Research has shown that CO_2 emissions can be greatly decreased through common use of water saving fixtures (Scholz, 2013). All new school builds in Ireland consider rainwater harvesting and if feasible, these systems are provided for in the school design (Building and Planning Unit, 2012). However, retrofitting rainwater recovery into existing schools is more difficult as significant interventions into the internal fabric of the building is required. Many Irish schools have expressed interest in using harvested rainwater but at present it is not economically viable. Nevertheless, harvesting rainwater for use for non-potable purposes is doable and produces benefits. Jha and Shah (2015) evaluated a rainwater harvesting system for rainwater collection for non-potable purposes in North Carolina and observed both financial and environmental benefits. They note that while the financial benefits may vary from site to site, the environmental benefits will always be there. Jones and Hunt (2010) had previously conducted a study of rainwater harvesting systems in schools in the same state and identified a number of difficulties in getting people to use the harvested water for non-potable purposes. They observed a number of situations where workers at the school chose to use the mains water over the harvested water. This would suggest that public perception is an issue – one that could be addressed through education (Jones and Hunt, 2010). As a relatively small percentage of potable water supplied to buildings is actually used for potable purposes (Marlow *et al.*, 2013) there are opportunities in schools to encourage conservation measures and reevaluate how water is used. Lowered water consumption alongside a lower hydrological footprint is a significant step in the move towards sustainability.

2.3.2 Waste Management in Schools.

Waste management is a key issue for policy makers in Ireland and '*A Resource Opportunity'* (Department of the Environment Community and Local Government, 2012) sets out how Ireland will become a recycling society and virtually eliminate landfilling of municipal waste. Schools have the potential to play a significant role in the continued reduction of waste and a rigorous auditing system could offer key insights into waste in primary schools from production to disposal and encourage movement up the waste hierarchy. While waste is covered as one of the Green School's themes and there are many resources available to teachers when teaching this topic, there is very little by way of advice for school managers on how to manage school waste and create a long-term plan. Coupled with the fact that there is no policy relating to waste disposal in Primary schools, waste management is an area that is receiving little attention or is being overlooked entirely.

The past two decades in Ireland have been a significant period of transition in the area of waste management. In a relatively short timeframe, Ireland has moved from almost total reliance on landfill for waste management to a high level of recovery of particular recyclable materials (EPA, 2015). Ireland produces less total waste per person than the EU average and is among the top performing countries in the EU with regards to municipal waste recycling (ibid). There are many components that must come together in order to realise such a momentous social and cultural shift, including national infrastructure, government policy and public awareness campaigns. Ireland's first contemporary waste policy document '*Changing our Ways'* (Department of the Environment and Local Government, 1998) began the move towards separate collection and recycling and has since been followed by policy documents covering various areas of waste management including '*Delivering Change - Preventing and Recycling Waste'* (Department of the Environment and Local Government, 2002), *'National Biodegradable Waste Management Strategy'* (Department of Housing Planning Community and Local Government, 2006) and '*A Resource Opportunity. Waste Management Policy in Ireland'* (Department of the Environment Community and Local Government, 2012). These policies are influenced by a range of EU directives including the Waste Directive 2008/98/EC (European Parliament, 2008) and the EU directive on Electrical and Electronic Equipment (WEEE) (European Parliament, 2012a). '*A Resource Opportunity'* presents how Ireland will progress towards becoming a recycling society, focusing on resource efficiency and the virtual elimination of landfilling of municipal waste. Segregating waste for selective separate collection necessitates full public acceptance and participation (Grodzinska-Jurczak *et al.*, 2003) and the transition in Ireland was backed by public awareness campaigns and dissemination of information by bodies such as the Environmental Protection Agency.

While huge strides have been made in this area on a national level over the past two decades, there have been problems and limitations. There have been inadequate levels of prevention and reuse of waste (Department of the Environment Community and Local Government, 2012) which are the top ranks of the waste hierarchy management options as they signify the most efficient and sustainable use of resources (EPA, 2015). There have also been insufficient levels of waste segregation with particular problems in organic waste disposal to landfill (Department of the Environment Community and Local Government, 2012). On top of this, forecasts predict that municipal waste volumes are set to climb over the coming decade, calling for continued investment in waste management infrastructure (EPA, 2015). Similar to the areas already discussed –energy and water – schools are an ideal forum in which to tackle the issue of waste management with far reaching benefits, both in terms of the number of people influenced and positive effects stretching into the future. Much of the research in the area of waste and schools has investigated the success or otherwise of waste education programmes (Grodzinska-Jurczak *et al.*, 2003; Silo, 2011). Grodzinska-Jurczak *et al.* (2003) evaluated the impact of a waste education programme not only on pupils, but on parents and teachers also. More recent research has investigated this potential for pupils becoming teachers in their own households and influencing family behaviour in waste management practices at home (Maddox *et al.*, 2011). However, research on sustainable waste management practices from a school management perspective is extremely limited. Rada *et al.* (2016) present the first paper to both quantitatively and qualitatively assess waste management in schools. This research was carried out in Trento, Italy and highlighted a number of issues that impact waste production including school size, number of occupants, various activities carried out within the school and the habits of pupils and staff.

The types of waste generated in schools appear to differ between countries. In Ireland, sweet wrappers, drink cartons and tinfoil were found to be among the most common waste types destined for landfill in the Green Schools study by O'Mahony and Fitzgerald (2001), although this may differ if repeated today due to the Health Promoting Schools initiative and a change in lunchbox habits. In Nigeria, Elemile and Benjamin (2011) found paper to be the most frequently generated waste followed by plastics. It is probable that food waste could make a significant portion of overall waste in schools also, as it is currently a wider issue. Assessing how this produced waste is managed in schools is highly important (Rada *et al.*, 2016).

Moreover, waste management is becoming more complicated due to increases in the types and volumes of waste materials (Kayihan and Tonuk, 2012). Electronic waste, more commonly referred to as e-waste, has been recognised as the fastest growing waste sector globally (de Jager, 2015). This is worrying as e-waste has a worse effect on the environment when compared to other waste types (ibid). Chemicals from e-waste, including lead, cadmium, lithium and mercury, can leak into groundwater and soil. As ICT becomes more and more ingrained in school life, how this waste is managed is a new question in the waste management agenda of schools. Research has begun to look at integrating e-waste management into school curricula (de Jager, 2015) but to the best of the author's knowledge, there is no literature at present on how to manage e-waste in schools.

As each member of a school community is a producer of waste, each person has a role to play in waste management. The waste hierarchy – waste prevention, reuse, recycling, other recovery and disposal - should guide any waste management plan that a school produces. School management should focus on prevention and reuse despite the difficulties associated with these actions. Waste prevention requires a shift in social attitudes and behaviours alongside a sustainable outlook on how we use our resources. Integrating this ideal into primary school curricula can help foster a deeper environmental awareness and respect in our future adults. Reuse has been identified as quite challenging due to lack of public confidence in the reuse of products. '*A Resource Opportunity*' declares the importance of the public sector's role in demonstrating a commitment to reuse "*both in order to ensure the most effective and efficient use of resources and to help engender a broader confidence in the approach to reuse*" (Department of the Environment Community and Local Government, 2012, p. 38). Recycling is the management option that has been most targeted, both in the literature and in the field. Ward *et al.* (2014) developed a system to implement a recycling program in New York City elementary schools. They view source separation as an inexpensive and uncomplicated approach to apply the values and principles of SD. The success of recycling plans is directly related to levels of motivation and the actors behind the program (Smith *et al*., 1997 in Ward *et al.*, 2014) and this particular programme encountered difficulty due to challenges co-ordinating with maintenance staff. This highlights the importance of full participation in waste management and clear communication between all parties.

Segregating organic waste and composting on site is challenging, but presents opportunities in outdoor education, compost creation for school gardens and reduction of waste for disposal. Kayihan and Tonuk (2012) found that only 18.9% of schools that participated in their study in Istanbul composted organic waste which would appear quite low. Rada *et al.* (2016) found the production of organic waste at primary schools in Trento, Italy was ample enough to warrant a specific separate collection, although it was not justified in secondary schools. Diverting organic waste from landfill through composting activities would appear to be beneficial to schools but needs more investigating, particularly in the Irish context.

Prudent and conscious usage of resources and materials is as important as waste management in sustainable life perspectives (Kayihan and Tonuk, 2012). School principals need to be mindful in the management of their current resources and the purchasing of new resources. '*Green Procurement. Guidance for the Public Sector'* (EPA, 2014) aims to establish green public procurement (GPP) as a central tenet in driving sustainability and promoting resource efficiency in a circular economy. At times, GPP does require higher upfront capital (EPA, 2014) and this could be potentially off-putting for schools that are often operating on a restricted budget. However, items such as paper, IT equipment and cleaning products are used in all schools and Irish GPP criteria for these products are among those set out in '*Green Procurement'*. Schools can gain environmental benefits as well as possible financial benefits over the lifetime of various resources while also reducing their waste production.

Students also need to fully participate in waste management and be aware of the infrastructure in place in their school and their responsibility in utilising it. Students' knowledge, values and attitudes all play a part in their environmental consciousness and their willingness to participate in sustainable practices such as waste prevention and reduction – although it has been shown that knowledge does not always lead to improved practices (Tikka *et al*., 2000 in Grodzinska-Jurczak *et al.*, 2003). Kolbe (2014) found that student theoretical knowledge about various waste management concepts was not well developed. Ward *et al.* (2014) noted small changes could produce results – for example, when bin function was identified with more than just a colour difference, separation rates increased significantly. This underlines the importance of ensuring younger pupils understand the behaviours expected of them and how to use the structures that are in place.

Essentially, successful waste management programmes to date have involved the entire school community (Rada *et al.*, 2016). Moreover, studies have found that higher participation rates are found in schools where source separation is integrated into a sustainable education agenda (Ward *et al.*, 2014). Solid leadership, dedicated administrative support and clear policy are all required to ensure success in waste management (Zhang *et al*., 2011 in Ward *et al.*, 2014). Going forward, schools must view waste as a resource as part of a wider, national movement to fully exploit the potential of waste as a resource (Department of the Environment Community and Local Government, 2012). Bausch and Lomb have embraced this concept and today dispose of zero waste to landfill and have learned valuable lessons that they can share with the school sector.

Water management and waste management, essential components of sustainable development, need to be embedded in the management practices of schools. Akin to sustainable energy management, it offers environmental and economic benefits while teaching our future generations' valuable lessons.

2.4 Biodiversity.

The school grounds, regardless of size, are an important resource for the school community – a resource that is all too often overlooked or undervalued. The school grounds offer respite from a busy schedule, a creative means of engaging with the curriculum and a space where children can play and explore. If effectively managed, the school grounds could advance curriculum learning and the holistic development of the child. Moreover, with a focus on sustainability, the school grounds present an environment where biodiversity can be developed, observed and used in a way that would support both the curriculum and ESD. Contact with natural environments provides a broad range of benefits, including educational, health, cultural and social (Dillon and Dickie, 2012) and a natural environment that is rich in biodiversity and easily accessible would undoubtedly be a rich resource for schools.

2.4.1 The Value of Biodiversity.

Biological diversity, or biodiversity, the outcome of biological evolution concerns 'the variety and variability among living organisms and the ecological complexes in which they occur' (Crisci *et al*., 2014). Biodiversity is vital to our way of life and our wellbeing as a result of the ecosystem services it provides (European Parliament, 2011). These ecosystem services include pollination and food production, purifying our air and water, ensuring nutrient rich soils, regulating climate, curtailing the spread of disease and numerous other supports. Yet, across the globe, biodiversity is seriously under threat meaning our very way of life is also threatened. Threats include habitat change, over-exploitation, pollution, invasive alien species and climate change (Department of Arts Heritage and the Gaeltacht, 2011). Species are being lost up to one thousand times faster than the natural rate (EPA, 2013) and response to this problem has been slow. In 1986, Edward O' Wilson stated in his book *Biophilia* that '*the one process now going on that will take millions of years to correct is the loss of genetic and species diversity by the destruction of natural habitats*' (Wilson, 1984, p. 121).

While the problem has since been acknowledged, the rates and methods of response have been less than desirable. On a global scale, responses to the issue of biodiversity conservation, including legislation, are informed by the United Nations Convention on Biological Diversity (CBD). Ireland, as a signatory to the CBD, undertook to endorse the conservation and sustainable use of biodiversity (Department of Arts Heritage and the Gaeltacht, 2014). Ireland ratified the CBD in 1996 and this, along with EU directives – the most important being the Habitats Directive 92/43/EEC- underpin the Irish legislative framework (Lucey and Doris, 2001). Of the Irish habitats listed under this directive, the greater number are of poor or bad conservation status (EPA, 2013).

In 2001, at the EU summit in Gothenburg, Sweden, targets for halting biodiversity loss by 2010 were established. Unfortunately, 2010 came and went and the targets were unfulfilled. In 2011, the EU adopted the 2020 Biodiversity Strategy which aims to halt biodiversity loss in the EU and under this, Ireland set out its National Biodiversity Plan 2011-2016 which articulates how Ireland will meet its commitments (EPA, 2013). However, before a conservation plan can be put in place, it is necessary to assess the current situation and evaluate current biodiversity levels. The setting of benchmarks and reference values for biodiversity has been a difficult task (Lucey and Doris, 2001) if not an altogether neglected one (Feld *et al.*, 2010). Nevertheless, a significant effort has gone into cataloguing biodiversity levels around the world. In Ireland, The Heritage Council commissioned '*A Guide to Habitats in Ireland*' (Fossitt, 2000) which would aid habitat identification and in 2007 the National Biodiversity Data Centre was established to collect, collate, manage, analyze and disseminate data on Ireland's biodiversity (The National Biodiversity Data Centre, 2013). This improved collection of data on biodiversity has facilitated the development of a more accurate picture of the main pressures and threats to Ireland's biodiversity (Department of Arts Heritage and the Gaeltacht, 2011). In Ireland, the main threats to biodiversity are from modern agricultural practices, mechanized peat exploitation and eutrophication of rivers and lakes (Lucey and Doris, 2001). These threats cause direct habitat damage and place numerous species at risk. One group that are particularly threatened and in need of protection are pollinator species. Over one third of Irish bee species and over 15% of butterfly, dragonfly and damselfly species are threatened (EPA, 2013). As most flowering plant species are dependent on pollinators, these statistics are worrying. Of the 100 crops that provide 90% of the world's food supply, 71 are pollinated by bees (Muldoon, n.d.). Bees are in decline due to a number of causes including destruction of habitats, such as hedgerows and spraying of pesticides.

School grounds have much to offer the natural environment and could play a significant role in biodiversity conservation. As a national environmental resource, and in many countries integral to the delivery of local authority's wider environmental and social strategies (Foster, 2006), school grounds could become unsprayed, unpolluted havens where species, such as pollinators, could thrive. Furthermore, these safe, biodiverse grounds could be used to explore sustainability principles in the curriculum, and thereby have a positive influence on future generation's biodiversity knowledge, awareness and skills. However, qualified persons, such as ecologists, are required to survey, record, map and plan future developments of a site and currently schools lack the expertise and funding to carry out such evaluations.

2.4.2 Public Awareness and Education.

Undoubtedly, biodiversity is one of the most pressing global challenges today and its restoration requires a population that is understanding, knowledgeable and aware of the issues. However, public awareness of biodiversity concerns would appear to be seriously lacking and this will need to be strategically and efficiently dealt with if the problem is to be addressed in a timely manner. Formal education can only be a part of this solution - albeit a very important part – as broader public awareness is vital to its success.

The year 2010 was the International Year of Biodiversity, during which a campaign was run by the UN to raise awareness around the globe on biodiversity issues. Following this, the decade 2011- 2020 was deemed the UN Decade on Biodiversity which is hoped will help capitalize on the gains made in biodiversity awareness to date. One of the key purposes of this Decade is to raise awareness on the value of biodiversity for human wellbeing (Secretariat on the Convention on Biological Diversity, n.d.). The Irish National Biodiversity Plan was rolled out in November 2011 with the vision that

> '*biodiversity and ecosystems in Ireland are conserved and restored, delivering benefits essential for all sectors of society and that Ireland contributes to efforts to halt the loss of biodiversity and the degradation of ecosystems in the EU and globally.*' (Department of Arts Heritage and the Gaeltacht, 2011, p. i).

One of the main objectives of the plan is to engage the public at large through targeted education and public awareness programmes (Department of Arts Heritage and the Gaeltacht, 2011, p. 13). At both a national and global level, it has been acknowledged that education, both formally in schools and more informally across the population, is a central tenet of biodiversity protection and conservation.

It is vital that societies value biodiversity so that participation and support for conservation measures can be stimulated (Department of Arts Heritage and the Gaeltacht, 2011). The UN used the International Year of Biodiversity to raise awareness around the world and individual countries are also running their own campaigns in order to mobilize the population into action and build support. '*Notice Nature'* is the official campaign in Ireland to promote biodiversity , although it would appear this is still relatively unknown among the general public. In fact, promoting awareness has proven to be a difficult task. The human ecological footprint surpasses the planet's biological capacity by a greater margin now than it did in the year 2000 (Department of Arts Heritage and the Gaeltacht, 2011). This would suggest that society's awareness of the issue hasn't improved significantly enough to initiate action. Or perhaps awareness is improving but it is knowledge that is lacking. In Ireland, knowledge of biodiversity is below the EU average. In a Eurobarometer survey, only two in ten Irish people felt they were well informed about biodiversity loss, a figure that has remained static since 2007 (Fanning, 2010). People are still unaware about what they can actually do to protect biodiversity or of actions they are currently taking that may be harmful. The UN (Secretariat on the Convention on Biological Diversity, n.d.), the European Parliament (2011) and the Department of Arts, Heritage and the Gaeltacht (2014; 2011) have all clearly stated in their documents that public awareness is still limited and there is an urgent need to communicate issues relating to biodiversity to a wider audience.

The European Parliament (2011, p. 8) stresses the need to coordinate biodiversity awareness and information campaigns for all ages and social categories and believes this '*should be organized first and foremost in the school setting*'. Crisci *et al.* (2014) also argue that schools must endeavour to do more in education of biodiversity to generate global public awareness. People have not yet linked biodiversity with other environmental or SD issues (Secretariat on the Convention on Biological Diversity, n.d.) and schools present a setting where this can be done in a structured manner while all the time developing knowledge, awareness and skills.

Research has shown that children often take home lessons learned and try to implement them in domestic settings (Boudet *et al.*, 2016). There is no reason that lessons on biodiversity could not filter into the community in the same manner.

'*To the degree that we come to understand other organisms, we will place a greater value on them and on ourselves'* (Wilson, 1984, p. 2). Instilling biodiversity principles through both the formal and informal school curricula will help people develop a knowledge that will impact on their values and actions. The school ground can provide the practical resources and the hands-on experience required to ensure success in this challenge and really impact on biodiversity awareness in society.

2.4.3 Designing and Managing School Grounds.

Despite the potential value of school grounds, many school grounds in Ireland and indeed around the world are barren, hard and unimaginative spaces (Lucas and Dyment, 2010). The process of designing school grounds is a complex one (Lucas, 1995) and requires skills that are, for the most part, unavailable on school staff. This lack of expertise poses difficulties and requires the appointment of appropriate professionals which can be costly. However, it is this team -school staff and pupils in conjunction with landscape professionals – that must work together in order to create effective and meaningful school grounds.

Stereotypical school grounds are a wasted resource and this has long been recognized (Titman, 1994). Undoubtedly, the easiest point to plan and design school grounds is at the beginning – the design phase of a new build. The school building and the school ground should be treated as a single entity. Indoor and outdoor spaces should be developed as a continuum (Foster, 2006) allowing the natural movement of classes and lessons between the built and natural environments. Also, ease of access to outdoor spaces heightens the usability of the outdoors. Planning the school grounds within the overall planning of a new build allows all site components to be addressed including driveways, parking, drop-off points, sports fields, etc. (Wagner, 2000). Planning the grounds at this stage also allows for other sustainable management issues to be addressed such as waste (areas for composting), water (water harvesting) and transport (cycle routes and footpaths). This is also the most economical time to incorporate these features into the school grounds.

School grounds need to be developed in a sustainable manner, not only for environmental sustainability but also that they will provide lasting enjoyment to all those who have extended effort in developing them (Lucas, 1995) and to all who will attend and work in the school. Malone and Tranter (2003b) examined school grounds with regards to both children's play and environmental learning. They found that schools had a propensity to 'over-design' the grounds as a means of keeping control of children's play activities. This over-regulating of the grounds meant that the degree to which pupils could engage in natural environmental learning was literally 'designed-out'. Schools often use large, open areas of tarmacadam to facilitate supervision and lack objects of interest that can be manipulated or incorporated into children's play. Studies have shown that when given the choice, children will choose to play in natural areas (Lucas and Dyment, 2010). Natural, green spaces are not only environmentally sustainable, they also promote social sustainability. Paechter and Clark (2007) state that paved areas in school yards are more suited to male-dominated sports, and therefore it is unsurprising that these areas are dominated by male students. Lucas and Dyment (2010) found that the most populated area profiled in their study was the green area and it was the only area where boys and girls were found in equal numbers. The reason they offer for this is the variety of play opportunities available on such a site. As well as being a softer, more inviting area than tarmacadam or paved yards, natural settings offer prospects required by children for creative and developmental play – various textures and levels, items to be manipulated and spaces to be involved or to stand back and observe. Natural spaces are multifunctional spaces. They do not define the use of the space (such as the sports court) but rather leave room for interpretation. The research project '*Special Places. Special People*' (Titman, 1994) found that a key factor to successful school ground design was the extent to which they offered diversity and could be manipulated by the pupils. School ground design visibly impacts the behavior and wellbeing of the pupils who spend time there (Lucas, 1995) and natural environments have proven to be the spaces that children choose to spend time in and that offer the most benefits to their health and wellbeing.

While the beginning of a new build is the easiest and most financially viable time to plan and design school grounds, existing schools with paved expanses and lack of natural areas and vegetation need to be developed and managed in a sustainable manner. Data from Thompson *et al.* (2008) '*The Childhood Factor*', strongly alludes that both the physical and emotional benefits of access to green space are strongly reflected in childhood experience. The school ground is the space where children connect with the social, cultural and ecological domains of childhood (Malone and Tranter, 2003b) and as such it needs to be developed and managed accordingly. Moreover, as today's children often experience reduced access to green spaces compared to previous generations, the responsibility of schools to provide this space is even more pressing. Major building works provide a significant opportunity to enhance the grounds, particularly with a combined approach to indoor and outdoor design (Foster, 2006). However, for most schools, development of the grounds will be done in isolation from any school building project. Plans for the grounds should be incorporated into the School Development Plan and can be a long term project for the school community. The school grounds need to be mapped and evaluated as the existing topography, habitats and soil type will all influence the design (Foster, 2006). The requirements of the school community also need to be identified and catered for. Green spaces in the community are a vital resource and those such as school grounds are the most important natural environments as they are close to where children live and do not require transport (Dillon and Dickie, 2012). School ground projects that fully involve staff and pupils result in both the most successful and the most sustainable outcomes. Schools have the opportunity to incorporate certain design aspects into the curriculum (eg. making a vegetable garden), thereby involving pupils in truly sustainable environmental and social education. Another aspect of the school community that must be seriously considered is pupil enrolment. Lower playground density accompanied by the presence of vegetation results in higher levels of physical activity (Trost *et al.*, 2010). These are only some of the considerations that schools will have to take into account in the development plan for their grounds as individual schools will have their own unique needs, values and ethos that will need to be reflected in their projects.

Quite a number of countries around the world have responded to the need to 'naturalize' school grounds and harness the social, environmental and educational potential within them. Schools in the UK benefit from significant support through the organization *Learning through Landscapes* (LtL). LtL is an independent, national organization that promotes the extensive development of school grounds (Lucas, 1995) and offers numerous types of supports including training, on-site facilitation and supplier guides. It appears LtL was the first organization of its kind, established in England in 1990. It now operates as *Grounds for*

Learning in Scotland and *LtL Cymru* in Wales. It also inspired the setup of similar programmes in other countries including *Learning Grounds* in Canada, *Skolans Uterum* in Sweden (Malone and Tranter, 2003a) and *Learnscapes* in Australia. The *International School Grounds Alliance* (ISGA), established in 2011, is a global network of organizations that aims to support all schools in developing excellent school grounds (International School Grounds Alliance). Some supports exist in Ireland through various organizations such as Green Schools and The Heritage Council. Bord Bia produced a short teacher worksheet suitable for the senior primary classes on auditing, planning and designing school gardens and grounds (Bord Bia, n.d.). Nonetheless, no organization such as LtL exists in Ireland which means that principals and teachers are quite unsupported in developing and managing the school grounds.

A strategic objective of Ireland's National Biodiversity Plan (2011) is to mainstream biodiversity into the decision making of all sectors, and this includes education. Research has shown us that the level of engagement with the school grounds by children through play and learning is significantly influenced by both the design of the grounds and the policies informing its management and use (Lucas and Dyment, 2010; Titman, 1994; Trost *et al.*, 2010). In both design and management policies of school grounds, the identification, development and protection of natural habitats is paramount. These habitats not only offer the best resources and experiences for environmental education and environmental sustainability principles, but also contribute to national biodiversity objectives. Many primary schools in Ireland are located in rural landscapes and hedgerows often make up part of the perimeter. Hedgerows are important habitats for many birds, mammals and insects and comprise indigenous plant species such as hawthorn, blackthorn and hazel. Protecting our hedgerows is one way of facilitating the conservation of pollinators. Hedgerows also provide a fascinating, natural environment in which biodiversity can be observed and recorded for educational purposes. Treelines can provide similar benefits and again are quite common in rural schools. Schools in urban landscapes may not have the same expanse of green perimeter but will have a certain amount alongside 'built land' habitats such as stone walls and artificial structures. Many of these habitats can be developed and further habitats could be introduced such as flowerbeds, borders, small woodland or scrub areas and even ponds if the space exists. Soil is often a forgotten habitat and is present on every school estate. The soil biota is highly species-rich (Bolger *et al*., in Bullock *et al.*, 2008) and offers huge potential for supporting sustainability principles in the curriculum.

Such habitats promote and protect biodiversity on the school site and enable teachers to present 'real-life' examples to explore the curriculum and to instill a sense of stewardship in pupils through conservation and maintenance activities. Biodiversity needs to be protected from a policy perspective in the design and management of school grounds, for biodiversity's own sake as well as for education and SD.

2.5 Education for Sustainable Development.

Education for sustainable development (ESD) is a relatively young concept and, like 'sustainability', remains elusive and somewhat ambiguous in definition. As a recently emerged global ideology (Cars and West, 2014), there is much discussion of ESD in the literature including discourses on competencies (Wiek *et al.*, 2011), practice (Green and Somerville, 2015) and transdisciplinary approaches (Clark and Button, 2011). ESD is not a subject, but an approach to education that should permeate school life, yet it still lacks cohesion in both theory and practice. A lot of this is due to the fact that ESD can mean different things to different people depending on local contexts (Brunold, 2015) such as values, culture, history and political background. Also, some policy documents are quite conceptual in nature and difficult for teachers to transcribe into practice (Summers and Kruger, 2003). Global in context but local in implementation, an effective ESD policy will aim to create educated and engaged citizens who are capable of thinking about SD locally, nationally and internationally (Brunold, 2015).

2.5.1 ESD: Global to Local Policy.

The origins of 'education for sustainable development' can be traced to the UN Earth Summit that was held in Rio de Janeiro in 1992. Although the roots of ESD can be found in previous educational movements, this was the first time the term ESD was used and catapulted into the global arena. The outcome document of the 1992 Earth Summit was 'Agenda 21' in which Chapter 36 was dedicated to '*Promoting Education, Public Awareness and Training*' (United Nations Conference on Environment and Development, 1992). The first programme area described in this chapter is '*Reorienting education towards sustainable development*' (p.320) and the objectives and activities required to fulfil such an aim are expressed. The vital role that education has to play in addressing environmental and development issues is stressed and guidance is given as to how individual nations may go about establishing ESD on the national agenda. Four key action areas for education in achieving SD are identified – improving the quality of basic education, reorienting existing education programmes to address SD, developing public awareness and understanding, and providing training for all sectors of private and civil society (McGarr, 2010). In 2002, the UN Earth Summit (Rio +10) took place in Johannesburg, South Africa. In December of the same year, the UN General Assembly announced that 2005 to 2014 would be the UN Decade of Education for Sustainable Development (UNDESD). The assembly emphasized education as an indispensable element in the achievement of SD and UNESCO was designated as the lead agency to implement the Decade (www.desd.org). The core goal of the decade was to assimilate the values, practices and principles of SD into all facets of teaching and learning (Brunold, 2015). Global policy frameworks were merged with national policy frameworks to expedite the promotion of ESD (Cars and West, 2014). Australia's approach to the decade was set out in '*Caring for Our Future. The Australian Government Strategy for the UN DESD*' (Department of the Environment and Heritage, 2007). The '*Strategy of Education for Sustainable Development for Sub-Saharan Africa'* was adopted at the meeting of the Association for the Development of Education in Africa at Libreville, Gabon in 2006 (www.desd.org). The UNECE (UN Economic Commission for Europe) adopted their strategy for ESD at Vilnius, Lithuania in 2005. The UNECE Strategy for ESD aimed to encourage countries to integrate ESD at all levels of the education system from primary to tertiary (UNECE, 2005). This became the springboard for individual EU countries to establish their own national frameworks, adapting the principles of ESD to their own environments and cultures. Sweden aligned with the global framework to successfully establish ESD across formal education (Cars and West, 2014). Germany published their National Plan of Action in 2005, with the overarching objective being '*the comprehensive orientation of the education system towards the concept of sustainable development*' (www.desd.org). While the majority of countries retained the term ESD in their policy, some countries, such as Australia, opted for the term Education for Sustainability (EfS).

Agenda 21 advised countries to set up a national advisory group to help mobilize resources and be a focal point for international ties (UNCED, 1992). A steering group, chaired by the DES was set up in Ireland in 2007. A public consultation process followed and a discussion paper was produced but the process was never concluded (Department of Education and Skills, 2013). It was only in 2012 that '*Our Sustainable Future: A Framework for Sustainable Development in Ireland*' (Department of Environment Community and Local Government, 2013) was published followed by '*Education for Sustainability. The National Strategy on Education for Sustainable Development in Ireland. 2014 – 2020*' (Department of Education and Skills, 2014a). This second document provides a framework to support the contribution that the education sector will make towards a more sustainable future. The overall objective of this strategy is

> '*to ensure that education contributes to sustainable development by equipping learners with the relevant knowledge (the 'what'), the key dispositions and skills (the 'how') and the values (the 'why') that will motivate and empower them throughout their lives to become informed, active citizens who take action for a more sustainable future'*. (Department of Education and Skills, 2014a, p. 3).

The national strategy for ESD in Ireland also noted as a priority action area that an ESD advisory group should be established and in 2015 the Inaugural Forum on Education for Sustainable Development took place. The Regional Centre of Expertise on Education for Sustainable Development (RCE-Ireland) was also established as a national network for developing and disseminating ESD. An interim review for 'Education for Sustainability' took place in 2017/2018 (Department of Education and Skills, 2018b) and the findings showed that time pressures, lack of funding and curriculum overload are the main challenges facing schools in the implementation of ESD.

Overall, in Ireland, the work on ESD remains fragmented. Although the National Strategy on ESD has been published, it would appear that it has not manifested in a practical manner at the primary school level by permeating curriculum documentation or teacher guidelines. Furthermore, many initiatives that have been rolled out focus on Development Education and mostly within the context of initial teacher training (ITE) (DICE Project; Eco UNESCO; Ubuntu Network). Much needs to be done before ESD becomes 'routine' practice in Irish primary schools.

2.5.2 Pedagogy.

Education for Sustainable Development is viewed as being proactive and transformational (Department of Education and Skills, 2014a) and requires a movement away from traditional, teacher-led, textbook- centred learning. The vision and ideals of ESD confront the very purpose of schools, including their structures, curriculum and pedagogical practices (Kadji-Beltran *et al.*, 2013). Although teaching and learning has become more child-centred over the past number of decades, a significant shift in how we view teaching, learning and assessment is required if ESD is to become truly central to our education systems.

Teaching and Learning for a Sustainable Future (TLSF) is a teacher education programme developed by UNESCO (www.unesco.org/education/tlsf). It lists eight teaching and learning strategies central to the implementation of ESD - experiential learning, story-telling, values education, enquiry learning, appropriate assessment, future problem solving, learning outside the classroom and community problem solving. This list is not exhaustive and strategies including global learning and place-based learning are among other relevant approaches. A pedagogy that embraces such strategies can empower pupils to become active learners and active participants in both local and global matters. One of the key principles as outlined in '*Education for Sustainability'* is to

> '*use a variety of pedagogical techniques that promote active and participatory learning and the development of key dispositions and skills'* (Department of Education and Skills, 2014a, p. 4).

This requires the teacher to choose the most appropriate strategies to complement the pupils' needs as well as the lesson content to ensure effective teaching and learning. Such strategies also progress the development of skills and values as well as knowledge. Experiential learning requires the pupil and teacher to process the experience, generalize the lessons and apply the findings and outcomes (www.unesco.org/education/tlsf). Enquiry based learning presents a very effective means of developing skills for thinking about sustainability as challenges are presented which require active, open-ended investigations (ibid). Global learning is a critical approach to concerns and experiences rather than the conveyance of factual knowledge (Rauch and Steiner, 2006) and combined with local place-based pedagogy, can help pupils to connect local issues with global phenomenon enhancing their empathy and critical thinking skills. 'Place' underpins the theorisation of sustainability in numerous studies and can provide a meeting point for the three pillars of sustainability (Green and Somerville, 2015). Solutions-based approaches, sometimes viewed as the foundation of ESD, are also important and give opportunity for the traditional curriculum to expand into 'the real world' (Warner and Elser, 2015). What ties all of these educational approaches together is that they are meaningful, provide context to the lesson, create environments where knowledge is co-created between student and teacher (Department of Education and Skills, 2014a) and are cyclical in nature. They also develop students' skills of critical thinking and systems thinking that will be vital to the future problem solvers in society.

ESD should also be interdisciplinary, permeating all aspects of school life. As such, ESD should filter through all curricular subjects and not be viewed as a subject in itself or an 'add-on' for other subjects such as science or SPHE. However, our understanding of sustainability depends on our appreciation and knowledge of science and on our scientific and technological literacy (McFarlane and Ogazon, 2011). Scientific, technological and engineering solutions will have a central role to play in combating and adapting to climate change, the largest sustainability issue facing the planet. Science and technology subjects can be used to explore sustainability issues and develop key competencies of sustainability such as systems thinking and key skills such as problem solving. Yet it is essential that ESD filters through all subjects and the arts have a key role to play in exploring sustainability. It has been argued that scientific literacy has contributed to a mechanistic worldview (McFarlane and Ogazon, 2011) and subjects such as Drama or Music can help pupils to connect with another culture or tradition and develop vital skills such as empathy. UNESCO, through the TLSF programme, recommends storytelling as a powerful teaching strategy as stories have the ability to compel action. Principal themes of sustainability education, such as the impact today's generation will have on future generations, necessitate pedagogical strategies emphasizing vision, imagination and empathy (Madsen, 2013) and subjects outside Science and Technology can provide these opportunities. As well as developing empathy and vision, language and the arts can also be problem-driven and solution-orientated. McNaughton (2010) makes a convincing case for the inclusion of Arts subjects in ESD programmes in Scotland and in a paper on educational drama (McNaughton, 2006), shows how strategies such as democratic teaching and story as a way of learning can cleverly direct pupils towards solution-oriented activities and attain ESD learning outcomes. What is central here is that not only should ESD permeate all subjects, but it should be a tool that can aid cross-curricular integration and facilitate sustainability across the curriculum. In this way, softer skills such as empathy and imagination along with critical thinking, systems thinking and technical skills can be developed through all subjects.

While the literature is quite consistent on what strategies should be used within ESD pedagogy, there is less consistency on what actions constitute 'good' ESD. Many empirical studies on sustainable or 'green' school practices, have found that litter and/or recycling activities are often used as sustainable initiatives (Pirrie *et al.*, 2006). Others focus on efficiency actions such as turning off lights or ensuring equipment is not left in standby mode (www.greenschoolsireland.org; Sustainable Energy Authority of Ireland). While these are worthy actions and show a mindfulness of waste/energy problems in society, they are not going to come anywhere near 'fixing' the problems of environmental degradation (or the subsequent problems of social erosion and economic instability) that the planet currently faces. Webster and Johnson (2009) believe that for ESD to be effective, meaningful and result in actual outcomes that will benefit society, education must tackle the frameworks that currently shape how we see the world. They call the current dominant framework the 'Nature as Unlimited Resource' Framework which they describe as '*a linear, almost mechanical view of the world*' (p15). People who work within this framework see '*use less, waste less and recycle'* as meaningful SD activities (p15). They propose a new framework – the 'Nature as Teacher, Nature as Capital' Framework (p16) which is closely linked to David Orr's (2002) views on ecological design (see section 2.6.1). Within this framework, the linear worldview does not make sense as everything connects in closed-loop cycles. Natural systems inspire industrial design as waste is essentially designed out and only renewable energy is used. This view of ESD is about '*better and better, not less and less'* (Webster and Johnson, 2009, p. 18). As the majority of recycling is down-cycling that eventually ends up in landfill and turning equipment off standby will save only small amounts of energy compared to that wasted in manufacturing for example, Webster and Johnson's critique of current ESD is valuable. The framework offered by Webster and Johnson still focuses on developing the key skills of systems thinking, critical thinking and other discussed above, but does so in a more enlightened context and a more hopeful manner where the focus is not on 'do more with less' but on engaging the imagination in creative design and problem solving.

Schools engaging with ESD must take the time to decide what ESD means to them and their school and discuss these issues with pupils and the wider community. Teachers of ESD can find meaningful foundations for their science and arts based subjects in educational theory such as Dewey's vision of an experimentalist, democratic culture (Tarrant and Thiele, 2016) or Aristotle's Phronesis (Grice and Franck, 2014), giving justification for cross curricular implementation. Overall, ESD has the best chance of being effective in implementation and outcome if it is central to curriculum development and holds defensible authority within and across all subjects.

2.5.3 Obstacles to Effective ESD.

Although ESD has been on the international agenda since the Earth Summit of 1992, numerous challenges have arisen that are impeding its progress. It is important to recognize that the obstacles to effective ESD are significant (Department of Education and Skills, 2014a, p. 37). These challenges are not insurmountable, but will require a focus and dedication by the global community if the ideals of ESD are to be forwarded.

A common hindrance that is cited when any new concept or subject is suggested for introduction in schools is that of curriculum overload. The value of education, in particular early years/primary education, is widely acknowledged and is therefore identified as a key opportunity to advance any important idea or concept in society. Presently, ESD only occupies a small part of overall educational pedagogy across spectrums of knowledge, thought and learning (McFarlane and Ogazon, 2011). More established subjects or concepts that are viewed as valuable to society (such as STEM subjects) appear to be getting precedence. Also, Madsen (2013) found that teachers emphasized the detailed planning of lessons as a factor that impeded their work with ESD. However, if ESD is understood in its true capacity, as an approach to education and not a subject or a topic to be bolted on to another subject, issues of curriculum overload and planning will be alleviated. Using ESD effectively, subjects can be combined in a thematic approach, cutting back on the required planning and associated paperwork and allowing a more effective use of the timetable.

In '*Education for Sustainability'* (Department of Education and Skills, 2014a) a concern was expressed that teachers are not adequately prepared to teach ESD as it often requires a more innovative and multidisciplinary approach. This has been reflected in the literature with teachers expressing a willingness to implement ESD but reporting a lack of skills, knowledge and confidence (Kadji-Beltran *et al.*, 2013; Madsen, 2013). Therefore, a move towards comprehensive ESD in schools will require tailored in-service training and a focus on ESD in pre-service training. Agenda 21 states that

> '*Educational authorities, with the appropriate assistance from community groups or non-governmental organizations, are recommended to assist or set up pre-service and in-service training programmes for all teachers, administrators, and educational planners'* (UNCED, 1992, p. 321).

Kennelly *et al.* (2012) found that student teachers in Australia who encountered ESD during their training valued aspects of this pre-service instruction and that they contributed to their confidence and desire to incorporate ESD into their teaching. But as ESD is a new concept, the majority of teachers have received no training, highlighting the need for continuing professional development (CPD) courses in this area. In Ireland, it is common practice for primary school teachers to complete at least one CPD course during the summer holidays. During the summer of 2016, a search of the three most popular providers of online CPD (INTO, Hibernia and CPD college) returned no courses that explicitly focused on ESD. In 2017, of the 274 courses offered nationwide, 18 had an ESD component such as healthy eating/lifestyles or using the outdoors to support curriculum (Department of Education and Skills, 2018b). The availability of CPD courses are essential to enable teachers to develop their knowledge of sustainability. The development of content knowledge for each of the participants in the Kennelly *et al*. (2012) study was linked with confidence to proceed with ESD. Having 'knowledge' about a topic is very important as it influences what is taught, how it is taught, the calibre of discussion and quality of follow-up activities (Ladwig *et al.*, 2010 in Kennelly *et al.*, 2012). However, knowledge for ESD and related topics is vast and forever increasing. Teachers, owing to their frequent lack of knowledge and skills in sustainability need to be connected with external expertise (Kadji-Beltran *et al.*, 2013). The proposed partnership with B+L will not only present opportunities for teachers to expand their knowledge but also present a genuine case study in environmental sustainability in the locality that can be used as a teaching tool or as lesson content. Teachers in the Green and Somerville (2015) study expressed an ongoing need to find innovative resources and expertise to expand their own as well as their pupils' understanding of sustainability. Links with industry and third level institutions within the community is one solution to connecting to original resources while building local social sustainability.

In many ways, it would appear that we are culturally resistant to sustainability education (McFarlane and Ogazon, 2011) and to the transformational changes required to instill it in schools. Research has shown that work that is being done in ESD often has weak foundations in the existing school structures (Stevenson, 2007) and Shriberg (2002 in Warner and Elser, 2015) maintains that schools are obliged to pursue institutional changes before ESD will infiltrate each discipline. It is extremely difficult to integrate ESD into a system that is characterized by fixed structures such as subjects and curricula (Madsen, 2013) and principals have reported a reluctance to challenge the status quo (Kadji-Beltran *et al.*, 2013). Pre-existing cultural, social, economic or political arrangements, known as practice architectures (Kemmis and Mutton, 2012), can enable or constrain practice. Changing practice requires changing these practice architectures as well as awareness and understanding (ibid). This is no small task as these 'architectures' have often become quite fixed over time and require a real disruption of existing conditions. Gruenewald (2003a) argues that critical pedagogies have the ability to challenge the assumptions and practices that are apparent in conventional education. He recommends a fusion of critical pedagogy with place based education to create a critical pedagogy of place. ESD could also support critical pedagogy as it enables children to question the world around them including the impact of their actions in a local and global dimension.

One component in contemporary education that requires a paradigm shift is assessment. In many countries, teachers and students are beholden to assessment procedures that evaluate 'knowledge' and rank pupils and schools against national and international norms. In this current era of accountability, it is difficult for schools to introduce new methods if their outcomes cannot be effectively assessed. Teachers in Madsen's study (2013) cited testing as an inhibiting factor in ESD. If ESD is about values and skills as well as knowledge, then we need assessment methods that will accurately assess progression in value and skill development. ESD requires transformational change in schools and assessment needs to be part of this change. In order to foster the creative inquiry required by ESD, a major shift away from traditional teaching approaches that favour teacher knowledge and control is required (Green and Somerville, 2015). Less control over the intended outcomes of a lesson leads to more open-ended objectives and a more diverse and differentiated approach to achievement outcomes. As learning outcomes are less predictable and not necessarily measurable, the focus can move from knowledge content to include skills and values, and teacher observation of children at work can take a more central role. Research has been conducted in the area of assessment procedures for ESD. Michalos *et al.* (2010) investigated the development of standardized tests of knowledge, attitudes and behaviours concerning ESD and predicted that there is a long road ahead to develop measures that will be usable in ESD. In the meantime, it will be very important to acknowledge the role of behaviours, attitudes and values in assessment, even if only informal assessment, if we are to facilitate the movement towards ESD as a daily practice.

New strategies and approaches can only be implemented in schools if teachers have the appropriate supports in terms of curriculum and policy. Warner and Elser (2015) found that educators in K- 12 schools in the USA valued ESD strategies but had few tools to support them in designing sustainability programmes. ESD needs to be given a clear curriculum mandate within educational policy that will legitimize its inclusion in school curricula. Aspects of ESD have been present in certain subjects on the Irish Primary School Curriculum (Department of Education and Science, 1999c), namely Science, Geography and Social Personal and Health Education (SPHE). For example, an objective of the Geography curriculum for the infant classes is '*to become aware of, explore and discuss some aspects of natural environments in the immediate locality of the school*' (Department of Education and Science, 1999b, p. 26) and an objective of the SPHE curriculum for third and fourth class is '*to recognize how each person has both an individual and a communal responsibility to the community*' (Department of Education and Science, 1999d, p. 50). As yet, the term ESD has not been used, but the idea has been present although not explicitly identified. At present, a phased review of the primary school curriculum is underway in Ireland, and this represents an opportunity to instill the principles of ESD across the curriculum (Department of Education and Skills, 2014a). However, early documentation on the Language Curriculum (Department of Education and Skills, 2014c) or the Mathematics Curriculum (National Council for Curriculum and Assessment, 2016) does not refer to ESD. Consequently, without explicit reference to ESD it will remain up to individual teachers as to whether they choose content and materials pertinent to ESD in their lessons and attainment of curriculum objectives. Perhaps as subjects such as Science and Geography are brought forward for review, we will see reference to ESD. However, this approach will cause problems as ESD will become attached to certain subjects and viewed as a 'topic' to be addressed rather than an approach to education. The lack of a clear framework can result in uncertainty among educators but this same flexibility has been shown to improve teachers' willingness to integrate ESD in the curricular planning as it allows them to decide for themselves what to include (Madsen, 2013).

The research shows that national policies appear crucial to support and legitimize the work with ESD (Madsen, 2013). However, they need to be somewhat flexible to allow teachers and schools use their own professional judgement as to how to meet the objectives of ESD as it is so culturally and locally attuned. Also, connecting ESD to relevant educational theory, such as Tarrant and Thiele's (2016) historical grounding of ESD in Dewey's work, contributes a sense of rootedness in well-established pedagogy that is understood and supported and adds further justification for promoting ESD in policy and curriculum.

It is still felt that there is insufficient awareness of and commitment to ESD (Cars and West, 2014) and presently, no universal models of ESD exist (Brunold, 2015). Effective CPD is essential in allowing teachers to explore the concept and develop the skills and strategies relevant to its implementation. Also, structural reforms are required to both facilitate and legitimize a move towards ESD. Part of these reforms will include a widening of the school community that will encourage partnerships with stakeholders in the wider community. ESD is what ties all aspects of a sustainable school together – curriculum, management, community– ensuring sustainability is truly holistic.

2.5.4 Sustainable Schools.

The concept of a 'Sustainable School' is an emerging one and many definitions exist in the literature. Sustainable schools embed ESD in their curriculum (Warner and Elser, 2015), manage the school – including energy, water, waste reduction and biodiversity– in a sustainable manner (Kadji-Beltran *et al*., 2013) and ensure active participation by all, including pupils (Katsenou *et al*., 2013; 2015). A sustainable school will embed sustainability principles in curriculum, campus and community and decisions and actions will be mindful of the three pillars of sustainability – environment, economy and society (Warner and Elser, 2015).

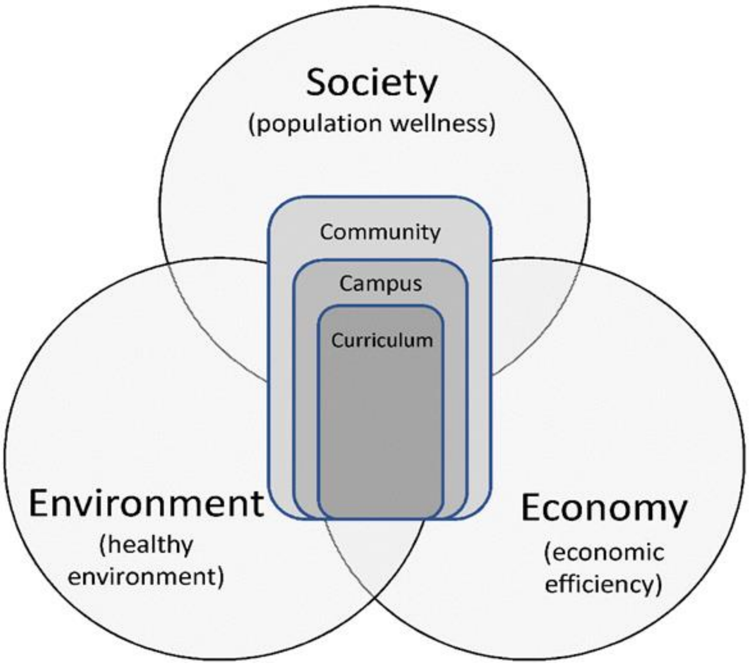

Figure 2.1: Sustainable Education Framework (Warner and Elser, 2015).

Curriculum.

A key agent of change in any school is the principal. As already discussed, fundamental change is required in schools to facilitate the implementation of ESD throughout the curriculum. Furthermore, teachers need to feel supported and justified in implementing ESD in their practice and accordingly will need to see a supportive and progressive principal leading the way. Warner and Elser (2015), when assessing sustainable schools in the USA, found that a school's ability to take a whole-school approach to ESD is based on the culture and organization of the school and it is the principal who plays the leading role in creating this culture of change. They also found that the schools with the most interconnected approaches to sustainability were either newly designed flagship schools or schools with strong leadership. Kadji-Beltran *et al.* (2013) looked specifically at the role of primary school principals in sustainable schools and found that leadership had to play a central role if the challenges of implementing ESD were to be confronted. Of course, implementing a vision of sustainability in any school requires a competent and committed staff (Kadji-Beltran *et al.*, 2013). As a whole school approach to ESD requires shared leadership given the different kinds of knowledge required for its successful implementation (ibid), teachers are required to use their individual expertise and knowledge to progress sustainability education in their school. Research has shown that teachers see sustainability as important and are keen to implement

ESD in schools (Green and Somerville, 2015; Madsen, 2013). Teachers are more likely to be successful in their endeavours if they are supported by school management and feel part of a wider school team. Furthermore, within a sustainable school context, teachers need to take on roles of leadership. Birney *et al.* (2011) argue that no single person can drive a sustainable school – leadership must be distributed and involve a large number of people taking responsibility for the school's direction, including pupils and members of the community.

ESD is relevant to all subjects and all levels, and no child is too young to learn about sustainability. Furthermore, in the spirit of sustainability, children should feel that they are a valued member of the school community and that their democratic voice is heard and listened to. The UN Convention on the Rights of the Child (Unicef, 1989) Article 12 recognizes children as active citizens who have the right to say what they think should happen and have their opinions taken into account in matters affecting them. Too often children are considered as 'future' citizens rather than contemporary, active citizens, which encourages a narrow view of the role of pupils and their democratic voice. A truly sustainable school will involve pupils in planning sustainable upgrades of the building, tracking and monitoring energy and water usage and planning and developing the school grounds. Sustainable schools will also embed this type of work in the curriculum and value the learning experiences that they provide. When students and teachers engage in meaningful projects, such as those based on the school's built and natural environments, pupils actively engage in their own learning. They are encouraged through their own interest and active involvement to develop practices that align with sustainability practices in society at large (Shallcross *et al.*, 2007). One structure that promotes the voice of students is Student Councils. Student councils afford opportunity for student voices to be reflected in their school environment (Department of Education and Skills, 2014a). Almost all secondary schools in Ireland have established student councils compared to only 14% of Primary Schools (ibid). Student councils in primary schools would provide a forum for young pupils to express their views on school environment and school life and could be central to the work of ESD in the school community.

Campus.

A number of authors now believe that sustainable school buildings positively influence sustainable practice in schools (Higgs and McMillan, 2006; Tucker and Izadpanahi, 2017). However, the majority of the literature that focuses on sustainable school buildings, focuses on the design, planning and building of new schools (see Cole, 2015; Izadpanahi and Tucker, 2015; Taylor and Enggass, 2009; Tucker and Izadpanahi, 2017). As the majority of school buildings have not been built with sustainability principles in mind or were built before the availability of sustainable technologies such as PV or LED light fixtures, this work currently targets the minority of school settings. However, each building tells a story. Orr, in his papers Architecture as Pedagogy I (1993) and II (1997) discusses the hidden curriculum of buildings. If we do not engage with the school building, if we do not question what works and how things can be made better, '*we learn passivity towards the built environment'* (1993, p. 226). If buildings are wasteful, use energy inefficiently and have not used locally sourced materials, the story is that understanding ecological processes is irrelevant, energy is cheap and can be squandered and sense of place is unimportant (Orr, 1997). The building speaks of linear systems and lack of connectedness. However, identifying the buildings story, engaging pupils with it, questioning it and seeking improvement will allow schools to integrate ESD across campus while simultaneously questioning current frameworks for thinking as discussed in section 2.5.2. Implementing an EMS will help improve processes, such as waste segregation, as well as identifying areas for improvement, such focusing on reuse rather than recycling. Larger projects, such as installing LEDs or water saving devices, can become goals for the campus and will embed sustainability in the school's development plans. This can all be integrated through curriculum by means of audits, monitoring and project-based work.

Community.

One of the key principles outlined in 'Education for Sustainability' is to '*be interdisciplinary and recognise interdependence and interconnectivities across other sectors'* (Department of Education and Skills, 2014a). This objective goes beyond the cross-curricular nature of ESD, implying that ESD transcends the education sector and should permeate other sectors of community and economy. A whole school approach to creating a sustainable school is vital, but more is required. Partnerships must be developed with the wider school community. This idea of interconnectedness has been defined by Warner and Elser as

> '*the facilitation of the interactions, collaborations and integrations between diverse and relevant disciplines, ideas and education stakeholders in order to teach students that our actions may, and often do, result in unintended consequences'* (2015, p. 2).

Such a definition highlights the array of skills, subjects, individuals and organizations through which ESD must pervade. A sustainable school does not focus on achieving awards, such as the Green Flag (although this may be a part of their endeavours), but rather determines their own path by engaging all relevant stakeholders.

A school is a vital element at the heart of a community (Alexander, 2010). Schools can be models of sustainability in and for the local community and are in a position to initiate community-wide sustainability projects that encompass the three pillars. The community is increasingly being viewed as a resource for learning (Alexander, 2010) and engaging local organisations and businesses will create new learning experiences for both pupils and teachers.

Takano *et al.* (2009) wrote a powerful paper based on their research on place-based education in a rural school in Alaska. Their study revealed the power that a school can have on education in the local community. Pupils often take their newfound knowledge and skills into the home and this can have a ripple effect in communities. Schools can, and often do, run evening courses for adults, again influencing lifelong learning in the local community. Green and Somerville (2015) found that partnerships, which extended into communities and places beyond the school, were an essential part of integrated sustainability programmes. As the knowledge and skill set required to implement effective ESD often go beyond that of staff expertise, schools can create links to professionals in the community. These types of partnerships are at the heart of SD and are reflected in the partnership proposed here with WIT, Bausch and Lomb and the primary school community. Many industry professionals have very specific skill sets, such as those based in engineering, that can broaden and 'make real' ESD project work in the curriculum while also enabling school managers to make effective choices about school development works of the buildings and grounds.

ESD is a practice, something that can only be collectively produced (Kemmis and Mutton, 2012). '*It is this layering of webs of connection between schools, their local places, local community and local organisations that produces an active social ecology of place that underpins sustainability education practice'* (Green and Somerville, 2015, p. 840) .

2.6 EMS as Effective ESD – harnessing school environments as pedagogical tools.

Although an EMS is essentially a management tool, if aligned with curriculum development, it also has the potential to be an innovative tool for teaching and learning. The implementation of an EMS in primary schools, involving pupils and staff alike, is a promising initiative for valuable, everyday ESD. It is experiential and place-based, and involves the development of key skills including monitoring, recording, analyzing and systems thinking. In Ireland, the latest in school design builds on this approach by installing monitors that display real-time energy usage and use sustainable technologies such as PV panels and rainwater harvesting when feasible (Building and Planning Unit, 2012). However, such technologies will only incur maximum benefit if they are utilized within the school's curricular framework. Also, these schools are still designed around the traditional 'industrial' layout with square classrooms and linear corridors and do little to embody broader learning philosophies (Taylor and Enggass, 2009). Understanding the impact of the school's built and natural environment on health, wellbeing, teaching, learning, and environmental and social outcomes will be an important step for teachers and school leaders in pursuing ESD.

2.6.1 Built Environment as Pedagogy.

Lindahl *et al.* (2012) believe that for usability in schools to improve, the parallel processes of pedagogy and FM must be reconnected. As usability depends on both the physical environment and how that environment is used (Blakstad *et al.*, 2010), usability for a sustainable school can be explored through an EMS. An EMS can be used as a management tool and a pedagogical tool, thereby aligning both processes. Blakstad *et al.* (2010) state that buildings are tools that support the activities taking place within them. If a school is engaging in sustainable school practice, the question arises 'how can the building support ESD?' Recently, a small number of authors have begun to explore the possibility of using the built environment for pedagogy. Orr (1993) writes of architecture as pedagogy. Taylor (2009) uses the term '3D textbook' when writing about the architecture of school buildings. Cole (2014) discusses the emergence of the Teaching Green Building. Furthermore, rating systems such as LEED in the USA and BREEAM in the UK give credits for school buildings that address the use of the building as a teaching tool in their design. Much of the research in this area to date focuses on the design of new builds (e.g. Izadpanahi and Tucker, 2015; Kong *et al.*, 2015; Taylor and Enggass, 2009). Admittedly, the design phase is the easiest point of a building's lifecycle to address both sustainability and interactivity, but the majority of schools have not been built with these in mind and must address them during the operation and maintenance phase. In Ireland, for example, most of the 3 250 primary schools have not been built to this latest design, implying that the majority of schools will need to carry out major refurbishments if they are to develop the building and grounds in line with sustainability principles. As these buildings make up the majority of the school building stock, it is important to focus on both sustainable management and ESD in these schools. However, as new buildings alone are insufficient to change pupils' attitudes and behaviour (Alexander, 2010), teachers' understanding of the built environment and their ability to use it effectively is important in all schools. New schools that were built with sustainability and pupil engagement in mind do appear to be at an advantage. Tucker and Izadpanahi (2017) found that pupils attending primary schools that were architecturally designed to engage pupils with the sustainable design features had more pro-environmental behaviours and attitudes. An EMS can facilitate all schools, regardless of design or standard, to begin the journey of viewing the building and grounds as valuable teaching and learning tools while simultaneously identifying areas for improvement or upgrade as part of the broader school development plan.

As the concept of built environment as pedagogy is very young, it is therefore weakly theorized in the extant literature and particularly within ESD. One emerging building type is the Teaching Green School Building (TGB) (Cole, 2014). These buildings teach about sustainability while simultaneously supporting the formal teaching of these issues. Cole (2014) is one of the first attempts to theorize what she terms 'the teaching green building', drawing on principles from museum studies, conservation studies and environmental education. The result is a framework of design patterns for building a school with pedagogical intent. As previously mentioned, many new builds are being sustainably designed with some interactive features to encourage pupil involvement. Cole (2014) identifies four concepts within the design of the TGB; 1) factual information, 2) physical engagement, 3) social interaction and 4) social norms. Factual information can relate to static features and can offer both content and process knowledge, often in the form of signage. Physical engagement involves manipulating features of the built environment or making decisions about resource use in the building. Social interaction involves creating spaces where pupils can meet informally, perhaps for project work or after-school clubs. It also involves designing the layout so as to encourage 'chance' meetings among building users. Social norms involve a building design that encourages sustainable behaviour, making it the norm to recycle and conserve energy and water. Although it could be difficult to address the element 'social interaction' in an older building due to linear corridors with few break-out areas, the other three elements could be addressed to some degree in an existing school building.

Place-based learning has been addressed time and again in the ESD literature (e.g. Green and Somerville, 2015; Gruenewald, 2003b; Silo, 2011; Takano *et al.*, 2009), and the concept of place has become an important tenet of sustainable school practice. Although attention to 'place' has mainly focused on connection to natural environments and outdoor spaces, 'place' is a multi-faceted construct (Cole, 2014) and the physical environment has been somewhat absent from the discourse. It is only recently that the school building has been addressed as a setting for 'place' (Cole, 2014; Kong *et al.*, 2014) and as a pedagogical tool for ESD (Izadpanahi and Tucker, 2015). Orr believes that we learn from buildings and not just in them, that '*architecture is a kind of crystalized pedagogy and that buildings have their own hidden curriculum'* (Orr, 1993, p. 226). Traditionally, a successful school building was one that required little care or interaction from those who used it (Orr, 1993). Orr goes on to argue that these buildings teach apathy, disengagement and '*the irresponsibility invited by never having to know how things work, or what alternatives there might have been'*, that '*it's okay to be oblivious to the most basic aspects of life support*' (1993, p. 226). Today's school buildings must engage pupils and teach sensitivity, connectedness and stewardship. Such engagement with the immediate environment would complement a child's natural sense of wonder and natural desire to explore their surroundings. Although not often discussed within place-based education, the notion of engaging with the school building fits well within the place-based concept. Cole (2014) notes that the school building and grounds are likely the most visible artefacts within the broader system of factors that define 'place' on a school campus. To disregard the built environment from the discourse on 'place', is to disregard a large portion of the educational setting.

Some authors argue that FM cannot be performed without the customer participating in the process (Coenen *et al.*, 2012). Therefore, within a school context, pupil involvement becomes imperative. Barr *et al.* (2011) assert that a school culture that is supportive and engaged in facility operations is vital to a green school's efficiency. The implementation of an EMS with curricular ties can become a tool for engaging pupils with the school's built environment.

Students' participation in the ongoing maintenance of the building will provide experiences in environmental stewardship as well as developing a sense of pride in their school.

The school's built environment can contribute to the school's overall sustainability ethos. It is a large and visible sign to both occupants and the wider community that SD is important and that it is embedded in the core of what a given school is about. Using the built environment is an important part of the overall approach to sustainability in schools and studies have found that it is aligning all aspects – facility and site, organizational culture, and curriculum - that is critical to the success of whole-school sustainability (Barr *et al.*, 2011).

2.6.2 Natural Environment as Pedagogy.

The development and use of the school grounds for pedagogy has received significant attention in the literature for the past two decades, but in practice, many schools still consist mainly of large expanses of tarmacadam. In Ireland, tarmacadam still prevails, but recently there has been some progress made with initiatives such as school gardens. However, school grounds should include outdoor spaces adaptable to many types of activities (Wagner, 2000) many of which should facilitate teaching and learning across all curricular subjects. The grounds should also sustain the hidden curriculum – those messages and ideas that are conveyed to pupils outside of the formal curriculum such as interactions with teachers and the presentation of the school and its grounds. School grounds have the potential to provide safe yet stimulating environments where pupils can learn, explore, play and grow (Foster, 2006). If properly developed, they could enrich the learning experiences of all pupils and bring all aspects of school learning to life.

A school's surroundings are an at-hand, cost-effective resource for taking learning outside. Certain subjects appear to lend themselves more easily to the outdoors. Studies show that when the curriculum is taken outside, it tends to be for physical education or science (Dyment, 2005). Taking science as an example, one would think it almost impossible to teach certain aspects effectively indoors. Plant biology or ecology surely requires learning through fieldwork, but as a practice, even fieldwork is declining rapidly (Scott *et al.*, 2014). Outdoor learning has been proven to have many benefits including the improvement of academic performance (Waite and Waite, 2011) but children still spend most of their day learning in indoor classrooms. Studies have identified a number of barriers which may prevent outdoor learning becoming the norm. In England, the House of Commons Education and Skills

Committee produced a report 'Education outside the Classroom' (2005) which identified five groups of barriers to outdoor learning: 1) risk and bureaucracy, 2) teacher training, 3) schools, 4) cost and 5) centres and operators. While some of these barriers are in reference to taking children to education centres off the school site, others such as risk and teacher training appear regardless of where the outdoor learning is taking place. Dyment (2005) identified teachers' lack of confidence or skills as a major barrier to outdoor learning as did Scott *et al.* (2014). This issue could be quite easily rectified through teacher training programmes. In some countries, training is available through national programmes such as LtL in England, but as already stated, many countries do not have organizations whose sole remit is to develop outdoor learning on school grounds. Even where such organizations do exist, the need for explicit professional development workshops are still cited (Skamp, 2009). In Ireland, of the eighty-nine summer courses offered in July/August 2016 through the three main CPD providers – INTO Learning, Hibernia and CPD College, only one course was focused on this area, 'Learning Outside: Outdoor and Environmental Education'. At Ireland's largest teaching conference, Féilte, in October 2016, one of the fifteen workshops on offer was connected with this area, Áitbheo – Connecting you to your Place, Community and World. So, while the need for training has been identified, these facts clearly highlight the lack of such courses.

Teachers may be willing to teach outside but they are lacking the training opportunities as well as the structural supports within school curriculum planning. In Dyment's study (2005), it was noted that the outdoor environment is less easy to control and learning outcomes are less predictable and not always measurable. In a culture where lesson objectives are expected to be clear and their attainment measurable, this presents a significant problem. School culture is a barrier that interacts with teacher confidence (Scott *et al.*, 2014) to further hinder education outdoors. Whole-school, cross-curricular policies that promote outdoor learning must be developed and be strongly supported by principals and management boards. Without such support, teachers will always lack the confidence to move their classes outdoors. The results of a study by Malone and Tranter (2003b) on investigating school sites for environmental learning and play clearly pointed to the design of the grounds and the school philosophy as the two most important factors affecting the ability of the school to promote children's environmental learning. Skamp (2009) when examining Learnscape use in Australia, stated that Learnscapes need to be integral to the School Environmental

Management Plan and need to encourage alternative teaching approaches and learning styles. A cultural shift to outdoor learning will only occur if it is embedded in both school philosophy and policy and is supported by high quality teacher training courses.

As part of this cultural shift, all subjects will need to be viewed in the context of outdoor classrooms and not only the aforementioned PE and Science. Outdoor learning can support experiential learning and place-based learning, both of which make learning more meaningful for children. The school grounds can be used as a springboard to investigate sustainable issues both locally and globally. The school grounds provide endless opportunities for learning about interconnections (Dyment, 2005) and History, Geography and Science topics are often more meaningful for children when they are embedded in their local environment and these interconnections can really be explored. The natural environment surrounding the school can also provide material, resources and inspiration for other subjects including mathematics, art, drama, literacy and language development. The possibilities are endless if the cultural shift can be enabled.

The hidden curriculum is that which is unintentionally or informally taught or learned in schools. The design and management of the school and its grounds sends messages to the pupils who attend there. These messages include the intentions of school managers in terms of how the grounds are to be used by pupils (Titman, 1994). The appearance of the school and its grounds also communicates the attitude and openness of the school to the local community as well as the school's attitude towards the children. Therefore, the school must think about its ethos and philosophy at the design phase and reflect these meanings through the built and natural environments. Involving pupils in the design and management of the grounds helps students develop a sense of pride, place and ownership (Skamp and Bergmann, 2001). The school grounds can be used as an effective resource for developing skills, awareness and attitudes outside of the formal curriculum. Children, particularly young children, learn about the world around them through play. A natural environment is more conducive to meaningful play and even has advantages over purpose built playgrounds as they stimulate more diverse and creative play (Malone and Tranter, 2003a). Young children use outdoor learning spaces for socializing, pretending, observing and moving (Merewether, 2015). Natural environments provide the multifunctional spaces that can cater for each of these needs. Schools can further enhance these opportunities by providing seating to facilitate socialization (Wagner, 2000) or open green spaces for movement. Outdoor play in such natural environments leads to stronger social skills and increased creative development (Miller *et al*. in Wagner *et al.*, 2010). Utilization of the outdoor environment increases with age (Malone and Tranter, 2003b) and if the development of the school grounds is embedded in the School Development Plan and the school curriculum, it can always adapt to the ever changing needs of the students.

The justification for outdoor learning to enhance both the formal and informal curricula is immense and yet there is a further reason as to why we should instill the concept of the outdoor classroom into the very heart of our education system. Now, more than ever, young people need to be given every opportunity to reconnect with nature. Children's access to nature affords an important aspect of growing up (Malone and Tranter, 2003a). Previous generations had a freedom in childhood to explore and connect with the natural environment away from adult supervision. Today's children experience very few opportunities for safe yet challenging and active play (Foster, 2006). In many cases, school grounds now present a last, moderately secure sanctuary away from traffic and adults (Lucas, 1995). Therefore, school management bodies have an obligation to ensure their outdoor spaces are as conducive to play, learning and social development as possible. The research is in no doubt as to what constitute these types of spaces – natural, green and multifunctional. There is an inherent need in humans to connect with nature and natural spaces. These benefits, while possibly the most important for students, are the most difficult to articulate and quantify. Edward O. Wilson tried to capture this elusive theory in *Biophilia* - that we depend on nature, not only for physical sustenance, but for intellectual, aesthetic and even spiritual fulfillment (Crisci *et al.*, 2014).

> '*The natural world is the refuge of the spirit, remote, static, richer even than human imagination'* (Wilson, 1984, p. 11).

Research has shown that children are drawn to green, natural spaces (Lucas and Dyment, 2010) and this is what schools must provide. The mere action of taking children outside, or the amount of space available will not automatically result in positive experiences (Merewether, 2015). It is the quality of the environment that counts. Natural environments offer an important resource for resting directed attention and providing restorative experiences (Kaplan, 1995). They promote psychological wellbeing, physical health and relief from stress and anxiety (Bullock *et al.*, 2008). Furthermore, the direct impact of outdoor experiences on pupils are often recalled years later (Skamp and Bergmann, 2001) and have an enormous impact on the likelihood of visiting green spaces as an adult (Thompson *et al.*, 2008). These positive, restorative, healthy experiences can be provided for on school grounds with the correct design and management philosophy. Such experiences could even be incorporated into curriculum lessons whereby pupils do the more cognitive, formal aspects of lessons before or after the experiential, outdoor session, thereby allowing children to touch, connect and engage emotionally with the environment giving both freedom and enjoyment to the pupils (Ballantyne and Packer, 2002). The school grounds offer unlimited potential for teaching and learning both formally and informally. They take years to develop and grow and their changing nature is part of what holds students' interest (Wagner, 2000). They offer a safe space where children can reconnect with the natural environment, play, socialise and learn.

For the most part, school grounds are not fulfilling their potential as sites for learning or as sites for biodiversity conservation. A fundamental shift is required in order to recognize that outdoor learning is a legitimate and indeed necessary form of teaching and learning (Dyment, 2005). Such a shift can only occur if backed by policy and excellent training opportunities. Evidence supports the claim that the more young people engage with the natural environment, the more they understand, appreciate and care for it (Dillon and Dickie, 2012). Managing and protecting biodiversity on the school ground supports both the curriculum and biodiversity conservation. Engaging pupils in these processes of designing, managing and conserving offers high quality, experiential, place-based teaching and learning.

2.6.3 Innovative Partnerships for Sustainable Schools.

Many national and international policy documents call for 'innovative partnerships' in the attempt to address SD issues at both the local and global levels. Due to the interdisciplinary nature of sustainability, partnerships are an effective means to bring the required knowledge together from many disciplines to address 'wicked' problems. 'Our Sustainable Future' (Department of Environment Community and Local Government, 2013) states that '*key stakeholders including business, community-based organisations and other civil-society groups must all play their part*' (p16). Agenda 21 speaks of 'global partnerships' in the quest for SD as well as local partnerships to support the various programme areas. Under the programme area ‘Reorienting education towards sustainable development’, countries are encouraged to support the work of universities and other tertiary activities and to create new partnerships with business and other sectors for technology, know-how and knowledge exchange (UNCED, 1992, p. 322). The 2030 Agenda for Sustainable Development calls for ‘*holistic and integrated responses to the many social, economic and environmental challenges we face. This means reaching out beyond traditional boundaries and creating effective, cross-sectoral partnerships’* (UNESCO, 2016). Globally, a significant amount of international declarations have recognized the critical link between environmental sustainability and higher education (Koehn and Uitto, 2013). The Talloires Declaration, for example, was established in 1990 at a conference in Talloires, France and was the first official announcement by universities of a commitment to environmental sustainability in higher education (McFarlane and Ogazon, 2011). At Rio +20, held in Rio de Janeiro, Brazil in 2012, the Higher Education Sustainability Initiative (HESI) was established. It was signed by universities in over forty countries, but only one signatory is an Irish third level institution – the University of Limerick. Regional HEIs are encouraged to closely engage with local communities in coordinating SD activities and creating productive partnerships, thereby strengthening the capacity of a region to self-organize and operate, leading to mutually beneficial outcomes (Karatzoglou, 2013). With regard to the development of sustainable schools, there are professionals within the community who have valuable knowledge that could potentially aid school leaders and teachers in this area.

Alexander *et al.* (2013) believe that professionals working with facilities must understand the users’ behaviour, needs and experiences and manage and systematize the user experience. In the case of principal teachers in Ireland, the job of managing the school facilities largely falls to them and, lacking a background or training in FM, this is a monumental task. To carry it out effectively, they need to receive training and ongoing support. Baharum and Pitt (2009) maintain that with the increasing strictness of environmental directives and the increasing pressure from customers for green products and services, facility managers have no choice but to incorporate sustainability strategies into their practices. Therefore, he believes that improving know-how in sustainability practices is somewhat inevitable. This sentiment is reflected in the growing availability of graduate and postgraduate courses in various aspects of sustainability. In the School of Engineering at WIT, there are now two Bachelor degree courses available in sustainable energy engineering and sustainable civil engineering and a Master's degree in sustainable energy engineering (Technology). Also, many industries are increasingly focused on running their operations and plants in an increasingly sustainable way, benefiting from both the financial gains and also an improved 'green' image. This implies that there is a bank of sustainability knowledge being developed within these companies. Within the school sector, however, there has been limited training in the area of sustainable management of school buildings and virtually no CPD in ESD for the primary school sector.

One industry that is vigorously pursuing a sustainability agenda is the Bausch + Lomb plant in Waterford. The FM team at B+L is dedicated to running the plant sustainably through the introduction of new technologies and the implementation of management systems. There is potential for this procedural knowledge to be adapted and shared with the school sector to aid in the management of school buildings. Also, authors have argued for the need for industrial case studies in relation to other aspects of ESD. For example, Webster and Johnson (2009) in their book *Sense and Sustainability*, discuss the need for industrial case studies for educating about the circular economy. Industrial case studies could be equally as valuable in the area of EMS. These case studies would present information on sustainable technologies and their use and provide an interesting contrast to any technologies used by the school (e.g. How electricity is monitored on a small school site compared to how it is monitored on a large industrial site). Research has shown that opportunities to look at technologies in varied settings aids with the understanding of the concepts behind the technology. Schiller (2012) contends that when specific concepts are taught in different contexts, which demonstrate the breadth of the application, students are more likely to abstract relevant concepts and develop a more holistic understanding. This, he argues, is particularly important to sustainability, which requires a holistic understanding of the interconnectedness between our actions and their consequences.

B+L have strong ties with WIT in a number of research areas and the research presented here provides another platform to further strengthen this partnership. As already stated, HEIs have a crucial role to play in promoting ESD throughout education and the general public. Furthermore, HEIs often have established relationships with both local industries and local schools (e.g. through research and work placement). This puts HEIs in a unique position to help schools engage in sustainable school practice and to harness the 'sustainability' knowledge available in the industrial sector.

2.7 Summary

The defining characteristic of the 21st century organization will be its ability to embed sustainability into every fibre of its operations (Renukappa *et al.*, 2013) and it is critical that the next generation of workers have the required skills, knowledge and attitudes in order for this to happen. As identified in Agenda 21, education and awareness will have the leading role in transforming to a sustainable society but no universal models of ESD exist (Brunold, 2015). The literature has highlighted a number of issues regarding current practice in this area. There is a lack of training in ESD for teachers and it appears that the existing approaches to ESD initiatives are fragmented – championed on the ground by interested teachers and principals. Teachers are interested in sustainability and in incorporating it into their own practice (Green and Somerville, 2015; Madsen, 2013) but lack the supports in terms of training, policy, school structures and resources.

To face the challenges of SD, it is important to nurture a deep understanding of sustainability in students along with a sense of stewardship. One way of doing this is to engage in meaningful activities in the immediate environment where results can be seen and recorded and offer encouragement for further work. The implementation of an EMS in the school setting is one way of creating an educational experience whereby pupils are engaged in meaningful, place-based, experiential learning. However, EMS implementation can be difficult, particularly in regards to the skill set required. The literature has highlighted the lack of expertise on school staff and the lack of training opportunities as a critical barrier in sustainable school management. Focusing on the various areas of concern within an EMS has highlighted further issues. The lack of expertise on staff is particularly pertinent in the area of energy management. In Irish schools, the mandatory reporting of energy consumption has been low and this has been put down to the technical complexity of the procedure (SEAI, 2015). Also, within EMS literature, it has been shown that energy related activities do not improve to the same extent as other areas such as water, waste and school grounds development (Hens *et al.*, 2010, a, b). With regards to water and waste management in Primary Schools, there was very little literature available that addressed sustainability and therefore very little guidance is available to principals when addressing these areas. The area of school ground development has been addressed over a lengthy period, but numerous barriers still exist including lack of teacher confidence in outdoor learning, lack of expertise in developing the grounds and lack of knowledge regarding biodiversity. There is also very limited information on how to transform existing physical school environments into pedagogical tools for EE or ESD (Kong *et al.*, 2014), an area that needs to be addressed in order to support place-based, experiential approaches to ESD.

Another key component of sustainability identified in Agenda 21 is that of partnerships. Community partnerships are an important aspect of ESD. Green and Somerville (2015) found that community partnerships which extended beyond the school were a crucial component of sustainability programmes. Partnerships can be facilitated between industry FM and primary education to enable schools to commit more fully to ESD. The partnership between Bausch and Lomb, Waterford Institute of Technology and local primary schools will help inform a theoretical model of ESD through which EMSs can be effectively implemented while simultaneously helping to alleviate the identified challenges such as lack of expertise in FM and lack of knowledge regarding sustainability issues.

Therefore, the research questions for this project are:

1) How can schools be supported, within an Industry-HEI partnership, to develop and implement an EMS?
2) How can school staff be facilitated in harnessing the built and natural environment of the school for effective ESD pedagogy?

3. Research Design, Methodology and Implementation.

The purpose of this study was to investigate how teachers and school management can be supported in developing and implementing an EMS and in harnessing the built and natural environments of the school for ESD. In order to do this, a multi-phase mixed methods approach was employed. To begin, a preliminary investigation was undertaken in order to ascertain what sustainable actions were currently being used in primary schools in Waterford. Upon analysis of this data, a conceptual model was devised and the second phase of the research focused on exploring the feasibility of this model.

The second phase was designed with a keen focus on the interdisciplinary nature of ESD and the social learning theories that underpin the extended CoPs model. In order to explore the feasibility of this approach, a case study design was utilised to allow participation by all stakeholders and to ensure the transdisciplinary nature of this engagement was maximised. Encapsulated within a pragmatic philosophy, focus was on the social actors, their experience and the practical consequences on the school as a whole. It was hoped that such a design would maximise the learning experience for all involved and create an exemplar for other schools to learn from. As engaging in sustainable school practice is a complex endeavour, the methodology had to have the capacity to deal with multiple actors from different backgrounds, multiple disciplines and ultimately had to have the potential to produce application-oriented knowledge (Gibbons *et al.*, 1994) that would be transferable to other schools. A single-embedded case study design with a transdisciplinary approach created a structure that had the potential to deal with all the complexities posed by this research project.

3.1 The Research Paradigm.

The established set of beliefs and practices that underpin a discipline or field of research is generally referred to as a paradigm. Every paradigm is based on its own ontological and epistemological assumptions (Scotland, 2012) and the research paradigm will influence a researcher's worldview, including their assumptions about the nature of knowledge and reality (Morgan, 2007). As the chosen paradigm influences key decisions throughout the research process, it is highly important that it is articulated clearly thereby reinforcing both the integrity and quality of the research. The following section gives a brief overview of the main research paradigms (section 3.1.1) and concludes with the justification of using the pragmatic paradigm for this research project (section 3.1.2).

3.1.1 Established Paradigms.

The scientific paradigm rose to prominence during the Enlightenment (Scotland, 2012). It developed around the belief that humans were rational beings and the laws of nature could be discovered by measurable, objective means. The term 'positivism' was popularized by Auguste Comte (1880) when he sought to apply the scientific method to the social world. Ontologically, positivism holds a realist stance (Scotland, 2012) which views the world as independent of the researcher. As reality exists independently of the knower, objectivism is the positivist epistemology, whereby the impartial researcher looks to discover absolute knowledge about this objective reality (Scotland, 2012). Therefore, the positivist researcher will create knowledge by reducing phenomena to hypotheses which can then be accepted or rejected by means of gathering data in an impartial and unobtrusive way (Creswell, 2009; Tashakkori and Teddlie, 2010). This data is mostly gathered using quantitative methods.

In contrast to positivism, the constructivist paradigm emerged which viewed the knower and known as interactive and inseparable (Lincoln and Guba, 1985, p. 37). Relativism is the basic ontological presupposition of constructivism, meaning '*entities exist only in the minds of the persons contemplating them*' (Lincoln and Guba, 2013, p. 39). The constructivist epistemology is one of subjectivism (Scotland, 2012). Therefore, knowledge is not 'discovered' but 'created' and exists only in the time/space framework in which it was generated (Lincoln and Guba, 2013, p. 40). As reality is subjective and differs from person to person, the researcher creates knowledge from subjective descriptions of phenomena (Creswell, 2009; Lincoln and Guba, 2013) which are most often qualitative in nature.

Both paradigms have their strengths. The positivist stance is viewed as rigorous and repeatable, and positivists believe in '*the existence of a universal generalisation that can be applied across contexts*' (Wahyuni, 2012) . The constructivist approach is prized for its ability to develop deep, rich data and uncover underlying causes of social issues. Similarly, both paradigms also have their vulnerable aspects. As the positivist approach relies heavily on quantitative data, deeper meaning is often unattainable and the 'why?' behind the data set is not apparent. Also, positivism assumes that an inquiry can be carried out without the influence of a value system (Lincoln and Guba, 2013, p. 87) which results in difficulties when

researching with people in social settings. Conversely, as constructivism focuses on delving deep into the data, wide generalizations are often beyond the scope of this approach.
In recent times, and particularly in relation to researching sustainability issues, it has become evident that both of these established paradigms fall short. Many modern research projects, particularly in the field of sustainability science, require the certainty of scientific facts as well as the assuredness that social values are being taken into account. As William James argued in his lecture '*The Present Dilemma in Philosophy*' in 1907

> '*You want a system that will combine both things, the scientific loyalty to facts and willingness to take account of them, the spirit of adaption and accommodation, in short, but also the old confidence in human values and the resultant spontaneity, whether of the religious or of the romantic type*' (James, 1907, p. 19).

James goes on to argue that pragmatism offers an alternative paradigm for research.

3.1.2 Pragmatism.

Pragmatism is enjoying a revival of late as can be seen in the wide array of papers published in the last number of years (e.g. Morgan, 2014; Onwuegbuzie and Leech, 2005; Ormerod, 2006; Popa *et al.*, 2015). As a pragmatic approach is problem focused and often calls for a mixed-method design (in that the most suitable method is the one that will work best in a given situation), it is very suited to research in the area of sustainability. Pragmatism allows for '*the dark and twilight, the obscure and vague limits of knowledge*' to be explored (Neubert, 2009, p. 165) and a vision of a universe that '*is still in the making*' (James in Neubert, 2001, p. 4). Therefore it compliments a positive and hopeful ESD (see section 2.5.2) whereby the future is still wide open and research and inquiry can feed into a positive potential.

Charles Saunders Peirce (1839-1935) is considered to be the father of Pragmatism. For Peirce, Pragmatism was primarily a philosophy of meaning (Ormerod, 2006). It was William James (1842-1910) who transformed the obscurity of Peirce's ideas into what we now recognise as a philosophy of Pragmatism. His book 'Pragmatism: a new name for some old ways of thinking' (1907) explored issues of metaphysics in the traditional thought model and argued for Pragmatism as '*an attitude of orientation'* (James, 1907, p. 42), '*a method*' (p50) and '*a genetic theory of what is meant by truth'* (p50). 'Truth' for James, is '*what gives us the maximum possible sum of satisfactions'* (p149) but in keeping with pragmatism, is always subject to change. John Dewey (1859-1952) built on and developed the Pragmatism of Peirce and James over a lifetime of research and the production of papers and books over seven decades. From his pragmatic philosophy, he developed a philosophy of education that is based on pupil experience, participation and experimentation (Dewey, 1938). From both a research and education perspective, he highlighted the importance of the scientific method as '*the only authentic means at our command for getting at the significance of our everyday experiences of the world in which we live'* (Dewey, 1938, p. 88).

In many ways, pragmatism breaks down the hierarchies between positivist and constructivist ways of knowing in order to look at what is meaningful from both (Biesta, 2010 in Shannon-Baker, 2016). While positivists argue that there are statements forever true, constructivists argue against objective truth, and typically, Dewey found value in both of these views although he rejected their central claims (Hickman, 2009). Indeed, Dewey wrote '*we tolerate no finalities of meaning parading as ultimate truth or absolute knowledge'* (1989, p. 112). Pragmatism is not committed to any one ontological or epistemological system (Creswell, 2009). Knowledge is recognised as being both constructed and based on the reality of the world we experience (Johnson and Onwuegbuzie, 2004).

Inquiry.

Dewey's philosophy of knowledge relies on his concept of inquiry in which actions, as outcomes of inquiry, serve as the basis of beliefs (Morgan, 2014). 'Truth', which Dewey termed '*warranted assertions'* (Dewey, 1986b, p. 11), is connected with the outcome of successful inquiry. Dewey's philosophy replaces the hierarchical approach of ontology and epistemology with a '*rich theory of inquiry that is broader and more capable than the epistemological project*' (Stoller, 2018). Dewey's theory of inquiry is an explanation of how thought operates in terms of both science and the problem solving encountered in everyday life (Ormerod, 2006). The goal of inquiry is an objective change in the situation which began the inquiry in the first place (Tiles, 1990, p. 154). Embedded in this pragmatic paradigm, the EMS in this case study provided the framework through which inquiry would take place. The principal used the EMS to support inquiry into the building's current functions and performance and simultaneously used it, with the teachers, to structure curricular approaches through which the pupils could engage with and 'inquire' into meaningful sustainability issues.

Truth.

Truth is constructed during experimental inquiry and while carefully designed experiments may produce objective truths, they are only validated at the time of the experiment and may change over time (Hickman, 2009, p. 13). Furthermore, a statement can only be judged to be true or false if it is taken within its wider context – be that social, cultural, economic etc. (Tiles, 1990, p. 109). As Peirce noted, truth is '*the opinion which is fated to be ultimately agreed to by all who investigate*' (Peirce, 1986 in Stikkers, 2009). Therefore, truth can change over time. Pragmatism emphasises the uncertainty and changing nature of our findings (Ormerod, 2006), thereby providing a suitable paradigm for sustainability research, in which futures are uncertain and adaption is key. For Dewey, human learning is largely a socially-constructed phenomenon (Garrison, 1995) and his philosophy significantly supports communities of practice theory. Human inquiry is comparable to scientific inquiry (Johnson and Onwuegbuzie, 2004) – humans naturally question the world around them, seek to manipulate their surroundings on a trial and error basis and learn from their findings. Through this inquiry, hypotheses are continuously tested and revised. They are tested, Dewey tells us, by the consequences they produce when they are acted upon (Dewey, 1938, p. 87). Therefore, to the pragmatist, meaning or truth is determined by its potential consequences. At times, this has been trivially simplified to imply that pragmatism is 'whatever works', but this is certainly not the case. As Reich argues (Reich, 2009, p. 60), '*Pragmatism cannot be reduced to a mere philosophy of utility*'. Dewey links meaning and consequences through inquiry -

> '*Things gain meaning when they are used as means to bring about consequences (or as means to prevent the occurrence of undesired consequences), or as standing for consequences for which we have to discover means. The relation of means-consequence is the centre and heart of all understanding'*. (Dewey, 1986a, p. 233).

This explains how items, or artefacts in CoPs theory, emerge as meaningful through their use. These artefacts or tools gain meaning through social interaction and communication during the process of inquiry.

Experience.

Experience is a key concept in Dewey's philosophy and theory of education. Learning requires continuity within experience and it is most successful when it is in response to a real-life problem (Reich, 2009) highlighting the value of using an EMS for ESD. Indeed, Dewey believed that in order to develop a theory of education, a theory of experience was required. '*Everyday experience is a moving force*' (Dewey, 1938, p. 38) and educators need to harness both the active and reflective aspects of these experiences for meaningful education. As the pragmatic paradigm supports research on sustainable schools, a pragmatic philosophy of education supports ESD. 'Experience' in the pragmatic sense, '*arouses curiosity, strengthens initiative and sets up desires and purposes*' (Dewey, 1938, p. 38) to move one towards deeper and more meaningful future experiences. Therefore meaningful experiences, supported by a sustainably literate classroom teacher, have the potential to create the desire and purpose in pupils (i.e. action competence) to question potential futures based on today's current model of linear development.

A further note on the pragmatic concept of 'experience' is that it is always social (Dewey, 1938, p. 38). Therefore, it complements both the social relationships in the Extended CoPs model and the elements of People and Place in the embedded case study (see section 3.2.3).

A rejection of dualisms.

Another characteristic of pragmatism is pluralism - it disregards dualisms and binary categorisations often associated with the work of Descartes. Pragmatism does not separate thought and action or knowledge and action, but '*brings the process of thought, of knowledge, inside conduct*' (Mead, 1936, p. 352). Dewey believed that experience, for example, involved both body and mind (McDonald, 2003, p. 73) and to experience holistically involved external action together with internal thought processes. Modern pragmatists, such as Rorty (1982), continue to reject dualisms, including theory/fact and fact/value polarities (Garrison, 1995).

A split between theory and practice results in a dualism between knowledge and action (Reich, 2009, p. 62). Pragmatism challenges these dichotomies between understanding and practice and the production and use of knowledge (Popa *et al.*, 2015). The production and use of knowledge are inseparable entities of experience and connect seamlessly with the social nature of knowledge creation that the Extended CoPs model is built on.

Practical outcomes.

Dewey writes that '*in order to discover the meaning of the idea*' we must first '*ask for its consequences*' (Dewey, 1948, 1920, p. 132). Pragmatism is outcome-oriented and focuses on the practical application of knowledge to real-world problems. Dewey argued that '*all principles by themselves are abstract. They become concrete only in the consequences which* *result from their application*' (Dewey, 1938, p. 20). Within pragmatism, there is a strong emphasis on communication and shared meaning-making with a view to creating practical solutions to social problems (Shannon-Baker, 2016). This reflects the communities of practice approach to sustainable school practice developed in Chapter 5. The collaborative approach to problem-solving is central and through this approach participants are enabled to question and jointly reframe their values and understandings (Popa *et al.*, 2015).

Dewey believed that an entity's value should be determined by its impact on everyday life or lived experience (Pugh, 2011). He asks

> '*does it end in conclusions which, when they are referred back to ordinary life experiences and their predicaments, render them more significant, more luminous to us and make our dealings with them more fruitful*?' (Dewey, 1958, p. 7).

Returning to the research questions -

1) *How can schools be supported, within an Industry-HEI partnership, to develop and implement an EMS?*
2) *How can school staff be facilitated in harnessing the built and natural environment of the school for effective ESD pedagogy?*

it is evident that both are written with this element of pragmatism in mind. If an EMS is used to assist FM and to develop a built and natural environment that is supportive of pedagogy, the interaction with this improved environment should create experiences for pupils which will enable them to explore global sustainability issues in meaningful, 'more luminous' ways. Dewey asks

> '*How shall the young become acquainted with the past in such a way that the acquaintance is a potent agent in appreciation of the living present?* (Dewey, 1938, p. 23)

Returning to the work of David Orr (1993) (Section 2.5.4), the building itself is an artefact from the past, presenting to us a history of linear systems that has led to the current sustainability crisis. To interact with such a visual element should render issues, such as climate action, very significant.

Ecology.

This leads to a final characteristic of Deweyan pragmatism. While not a key characteristic as such, it is certainly a pertinent one in view of this research. Dewey was influenced hugely by Darwin's theory of evolution and the first chapter of 'Experience and Nature' (1958) explains his notion of how humans and their experience are both in and of nature, derived from nature in the Darwinian sense of evolved from within it as well as living within it and experiencing within it (McDonald, 2003, p. 59). This again puts forward the pluralistic nature of pragmatism as it dissociates the dualism of man and nature. McDonald (2003) argues that Dewey came very close to articulating an environmental philosophy before the rise of deep ecology, making his philosophy particularly pertinent to sustainability research which looks to make the connections between ecology and society, between built and natural environments. Indeed, experience itself – a key concept within pragmatism, is not removed from nature, but is rather, an event within it (McDonald, 2003, p. 73).

It is argued that today children are losing contact with the natural/physical world (see Section 2.4). Chiasson (2008) when writing about a pragmatic approach to education, argued that this contact needs to be restored as the physical world is the world pupils need to experience '*if they are to viscerally grasp the concept of structure analysis, of parts and wholes – the foundation of art, engineering and the preliminaries of ecological thinking*' (p17). Developing the school building and grounds with a keen focus on ESD pedagogy is a crucial component of sustainable school practice.

Pragmatism acknowledges the presence and importance of the natural and physical world as well as the evolving social world (Johnson and Onwuegbuzie, 2004), allowing importance to be placed on the physical and natural environment in this case study as well as the people.

3.1.3 Communities of Practice and Education for Sustainable Development.

Communities of practice provides the theoretical underpinning for the model developed in Chapter 5. As discussed in chapter 5, CoP theory provides a suitable framework for sustainable school practice (see Section 5.2). As language, meaning and interaction are central elements of pragmatism (Morgan, 2007), pragmatism embraces the use of CoPs theory as a tool for investigating the research questions.

ESD is becoming increasingly recognised for its central importance in education as can be seen from publications such as '*Education for Sustainable Development: a study of opportunities* *and linkages in the primary and post-primary curriculum*' (NCCA, 2018). The Transdisciplinary Case Study approach (see Section 3.2.3) developed by Scholz *et al*. (2006), establishes SD as an important reference point as '*it represents a principle that seems to be widely accepted by most in our society*' (p228). Similarly, the principles of ESD, as outlined in 'Education for Sustainability. The National Strategy on Education for Sustainable Development in Ireland. 2014 – 2020' (Department of Education and Skills, 2014, p. 4), provided the normative reference point for the case study in this research. This was established in agreement with all teaching staff from S.N. an Bhaile Nua when writing the EMS.

Box 2: Key principles
ESD in Ireland will aim to: - balance environmental, social and economic considerations; - promote lifelong learning; - be locally relevant while also linking the local to the national and international; - engage all sectors of the education system, as well as the non-formal education sector; - be interdisciplinary and recognise interdependence and interconnectivities across other sectors; - use a variety of pedagogical techniques that promote active and participatory learning and the development of key dispositions and skills; - emphasise social justice and equity; - focus on values and promote active democratic citizenship and inclusion as a means of empowering the individual and the community. - be an agent for positive change in reorienting societies towards sustainable development.

Table 3.1 *Key Principles of ESD (DES, 2014. p4)*

These principles not only reflected the aims of a suitable ESD, but many also reflected a pragmatic philosophy of education. For example, the aim of education for Dewey is to enable individuals to engage in lifelong learning. This includes an increase of possibilities, the flourishing of diversity and a holistic view on human life (Reich, 2009). Reich argues that this is best done through inquiry and communication, through allowing learners to explore their environments by experimentally inquiring into them and communicating their findings (p63). Dewey felt that the most important attitude one could develop through experience was the desire to continue learning (Dewey, 1938, p. 48). Democracy was another key aspect of Dewey's philosophy of education and the concept of pluralism echoes that of interdisciplinarity and interconnectivity.

By establishing these principles as a normative reference point, it helped to galvanise the collective ethic that was driving this research – a participatory and active education that would enable both staff and pupils develop key skills and competencies for global citizenship, uncertain futures and ultimately, SD.

3.2 The Research Design.

Established within a pragmatic paradigm, this research design utilised the pluralism and emphasis on human experience that this philosophy provides to ensure a holistic yet rigorous exploration of the research questions. A two-phase, mixed-method methodology using a transdisciplinary approach and a case-study method were employed. Each facet of this design complemented the other and facilitated the participation of the various social actors with their different backgrounds and disciplines. It was the coming together of these disciplines and epistemologies that allowed joint problem solving to occur in unique and interesting ways. Figure 3.1 uses Saunder *et al.*'s (2007) research onion framework to give an overview of the research design.

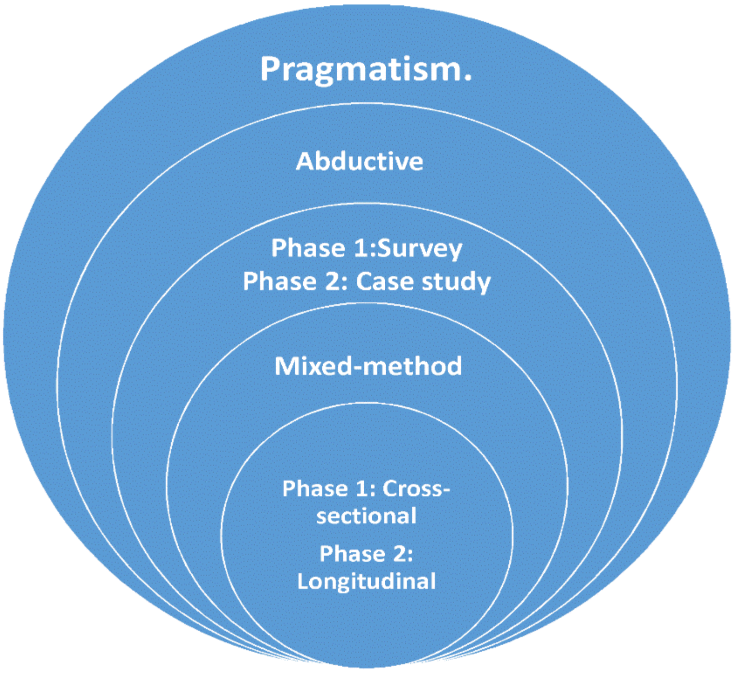

Figure 3.1 Overview of research framework.

3.2.1 Methodology.

Methodology refers to a model of conducting research within the context of a particular paradigm (Wahyuni, 2012) . Pragmatism places primary importance on the research question (Tashakkori and Teddlie, 2003) and the research question then determines the methods used (Onwuegbuzie and Leech, 2005). Within the pragmatic paradigm, a mixed method approach was employed. A mixed method methodology combines the collection, analysis and integration of both quantitative and qualitative data. The first data collection method utilised in the process was a survey questionnaire which combined quantitative data with qualitative data from written responses. The mixed method approach continued into the case study phase and enabled a 'full' picture of the case to be drawn.

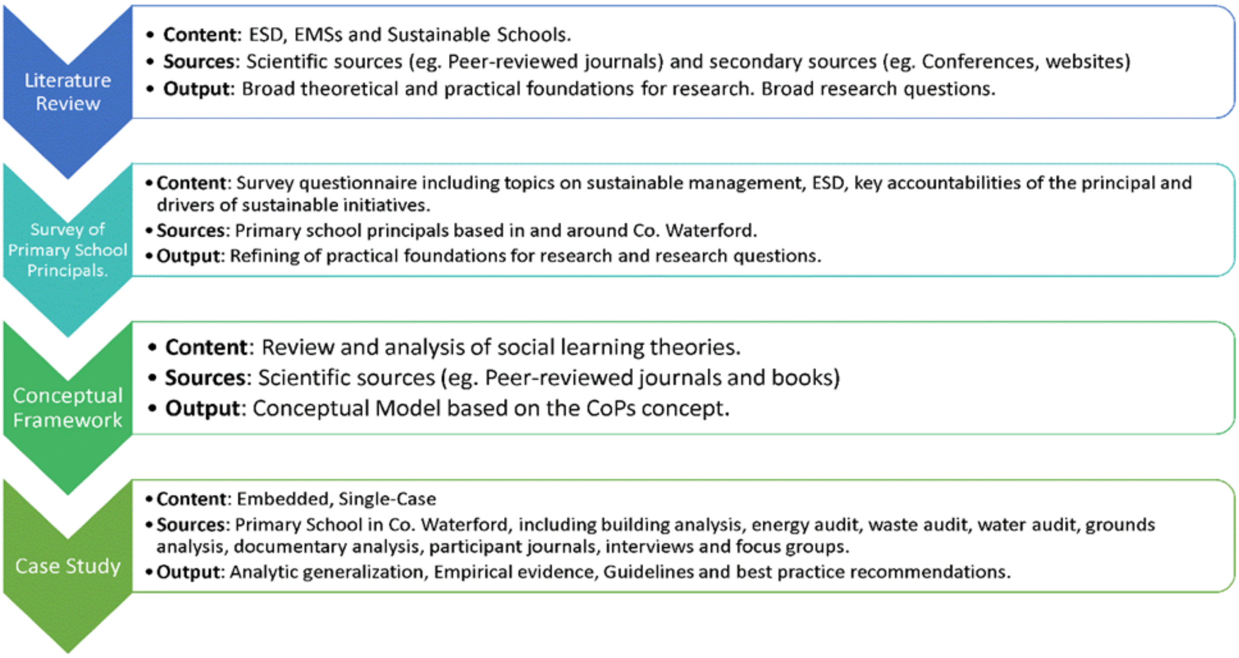

Figure 3.2 Overview of Research Methodology based on Colicchia et al., 2013.

Quantitative research collects data in a numerical or statistical form and examines relationships among variables while qualitative research is a means for exploring and understanding the meaning individual or groups ascribe to social or human problems (Creswell, 2009, p. 4) and often takes the form of words. While there may be an affinity between paradigms and methods (i.e. quantitative methods and positivism and qualitative methods and constructivism) there is no deterministic link (Morgan, 2014). Within a pragmatic paradigm, quantitative and qualitative approaches can be blended to capitalize upon the advantages within each (Shannon-Baker, 2016). Some argue this results in superior research (Johnson and Onwuegbuzie, 2004).

Pragmatists '*use pluralistic approaches to drive knowledge about the problem*' being researched (Creswell, 2009, p. 12). In a mixed-method approach, the approaches can be mixed evenly throughout, one can dominate or one can lead into the other. According to Creswell (2009, p. 14) these approaches can be sequential, concurrent or transformative. According to Creswell's framework, this research is categorised as concurrent transformative as it is driven by a theoretical perspective, i.e. CoPs theory, and the quantitative and qualitative data were collected concurrently (ibid., p215). In phase two, data from the building and grounds audits and the continuous electricity and IEQ monitoring took the form of quantitative data while the participants' journals and the focus groups provided qualitative data. The survey used with the teaching staff at the beginning and end of the case study used both quantitative and qualitative data. Each data set provided a unique perspective on the topic being studied in the embedded design (i.e. place, people and process) and together formed a more complete picture of each aspect. For example, when looking at the built environment as a facet of 'place', IEQ readings were combined with teachers' perceptions on indoor comfort. At times, however, data sets came from the same tradition – for example, qualitative data from focus groups was integrated with qualitative data from the reflective journals and observations to gain an integrated view of cultivating relationships as a 'process' (see section 3.2.3). But keeping with a pragmatic philosophy, the research questions drove the methodology and the approaches were '*mixed in ways that offered the best opportunities for answering*' these *'important research questions'* (Johnson and Onwuegbuzie, 2004, p. 16).

3.2.2 Research Approach.

The traditional way in which knowledge is produced and categorised is by means of disciplines. Disciplinary fields, for example education or engineering, disseminate their 'knowledge' through disciplinary schools in third level institutions or in disciplinary journals within their own academic field. This knowledge is created and evaluated through methods that are approved by the particular field. While disciplinary segregating of knowledge has had many benefits with regards to managing and using knowledge and furthering expertise within defined subject areas, many modern research needs are no longer catered for within single disciplines. This has opened up the research approach of using multiple disciplines to explore and solve problems. This research project, which is embedded in both education and engineering, has needed to cross disciplinary boundaries in order to explore the research questions posed.

Non-disciplinary approaches.

Non-disciplinary methods involve approaching a research question from more than one disciplinary perspective. This can be done in a number of ways and to varying degrees of integration, and accordingly, there are numerous terms used to define these research approaches in the literature; multidisciplinary, crossdisciplinary, pluridisciplinary, interdisciplinary and transdisciplinary (Thompson 1990/1995 in Van den Besselaar and Heimeriks, 2001). Of these, the three main 'non-disciplinary' modes that have emerged most strongly are multidisciplinary, interdisciplinary and transdisciplinary.

Multidisciplinary research involves approaching the same research question from different disciplinary perspectives. While collaboration occurs (Mobjörk, 2010), neither the disciplinary perspectives during the process or the findings are integrated (Van den Besselaar and Heimeriks, 2001). While multidisciplinary approaches juxtapose different disciplinary contributions, interdisciplinary approaches are more coordinated and integrated (Lawrence, 2010). Across the literature, it is generally accepted that integration is what separates multidisciplinary from interdisciplinary. In interdisciplinary research, the research design is jointly created, developing a shared methodological approach (Mobjörk, 2010), with coherent and integrated results (Van den Besselaar and Heimeriks, 2001). Transdisciplinary research not only integrates knowledge, methodologies and findings, but transcends the academic sector and involves non-academic social actors such as private and public sector representatives. As Lawrence (2010, p. 126) notes,

> '*these contributions enable the cross fertilisation of knowledge and experience from diverse groups of people that can promote an enlarged vision of a subject, as well as new explanatory theories'*.

This research project took a transdisciplinary approach, involving actors from WIT, a primary school and the FM team at B+L.

A Transdisciplinary Approach.
Transdisciplinarity is a relatively new approach to research. Similar to pragmatism and the mixed methods approach, transdisciplinary approaches evolved out of the researcher's need to address complex problems. Unsurprisingly, therefore, transdisciplinary approaches are most often found within the designs of sustainability science research (Popa *et al.*, 2015).

The literature has continuously developed over the past few decades, presenting transdisciplinarity as an authentic research approach. While a single, accepted definition of transdisciplinarity does not yet exist, there are many characteristics of this approach that are now widely accepted (Table 3.2).

Characteristic.	**Reference**.
Common theoretical understanding	Gibbons *et al*. (1994) Stokals *et al*. (2003)
Problem-oriented	Jahn *et al*. (2012) Klein, (2008) Mobjork, (2010) Pohl and Hirsch Hadorn (2008) Wickson *et al*. (2006)
Application-oriented	Lawrence (2010) van den Besselaar and Heimericks (2001)
Goal-oriented	Lawrence (2010) Pohl and Hirsch Hadorn (2008)
Involving social actors beyond academia	Hirsch Hadorn (2008) Klein, (2008) Lawrence (2010) Mobjork, (2010) Pohl and Hirsch Hadorn (2008) Wickson et al. (2006)
Future-oriented (including a notion of the common good)	Pohl and Hirsch Hadorn (2007) (2008)
Evolving methods	Mobjork, (2010) Wickson et al. (2006)
Context dependence	Lawrence (2010) Klein, (2004) Mobjork, (2010)
Links theory development with professional practice	Lawrence, (2006) Pohl and Hirsch Hadorn (2008)

Table 3.2 *Characteristics of Transdisciplinary Research*.

As can be seen from the characteristics outlined in Table 3.2, the pragmatic paradigm embraces a transdisciplinary approach. The pragmatic emphasis on shared meanings and joint action (Morgan, 2007), is mirrored in the transdisciplinary approach to research. As transdisciplinarity is method driven and solutions oriented, it is complimented by pragmatism in its action-oriented design. Both approaches harmonise and further bolster the aim to create action-oriented knowledge. Also as pragmatism does not focus on '*first things, principles, categories, supposed necessities*', but rather looks towards '*last things, fruits, consequences and facts*' (James, 1907, p. 42), there is a direct connection with both the goal-oriented and future-oriented aspects of transdisciplinarity. Furthermore, as the fundamental moral value at the centre of pragmatism for Dewey is freedom of inquiry (Dewey, 1925b in Morgan, 2014), this means that individuals and communities should be able to define the issues that matter most to them and pursue these issues in meaningful ways (Morgan, 2014). This sentiment is echoed in the characteristics 'involving social actors beyond academia' and 'context dependence'.

A final aspect of transdisciplinary research that must be addressed is that of reflexivity. Reflexivity is addressed in more detail in section 3.4.5, however, here, it is important to address it within a transdisciplinary context. '*Reflexivity entails a sensitivity to the researcher's cultural, political and social context. As such, 'knowledge' from a reflexive position is always a reflection of a researcher's location in time and social space'* (Bryman, 2004, p. 500). Popa *et al.* (2015) warn that without an explicit reflexive dimension, transdisciplinary research runs the risk of being reduced to formal social consultation. As transdisciplinary research involves actors from different backgrounds and disciplines, it is possible that individuals may hold different or opposing values and opinions. Popa and colleagues (2015) go on to argue for a pragmatic approach to reflexivity in transdisciplinary research as it relates reflexivity to mutual processes of problem solving through shared investigation and social learning that involve both academic and social actors' expertise.

A review of transdisciplinary research by Mobjork (2010) identified three interconnecting dimensions for differentiating non-disciplinary approaches: the degree of integration, the scope of collaboration and the motives behind the research. These dimensions were used to monitor and assess the level of transdisciplinarity in this research.

3.2.3 Multi-phase approach.

This research was divided into two clear phases. Phase one was a preliminary investigation which sought to address the first aim of the research and identify and assess current approaches to sustainability management in primary schools in Co. Waterford. As this was an initial investigation and time was therefore a factor, it was decided that the best means of gathering relevant data was via a questionnaire. Face-to-face questionnaires, while often resulting in better response rates, are very time consuming (Blaxter *et al.*, 2008, p. 179) and therefore unsuitable in this instance. Written questionnaires provide a number of advantages including the ability to cover a large geographical area, their inexpensiveness and often people are more willing to be truthful due to the anonymity they provide (Salkind, 2009, p. 142). A postal survey was chosen (Appendix A) as opposed to an online survey as studies have shown that postal surveys yield higher response rates than internet surveys (Manfreda *et al.*, 2008; Sinclair *et al.*, 2012) and each of the participants in the pilot survey said they were more likely to respond to a survey they received by post.

The second phase of this research focused on one of the respondent schools from phase one, whereby the school engaged in the Extended CoPs model (outlined in Chapter 5). A case study was used for this phase of the research. The demand for a case study arises when there is a desire to understand complex social phenomena (Yin, 2009, p. 4). As the aim of this research was to explore the feasibility of the extended CoPs model by investigating the roles of social actors and the artefacts they use, it provided a suitable design for this inquiry. The exploratory case study was chosen in this instance, as opposed to a descriptive or explanatory case study (Yin, 2009), to allow the process of engaging in the extended CoPs model to be fully investigated. Also, case studies maintain a deep connection to values (Hyett *et al.*, 2014), thereby allowing the principles of ESD to take on a normative reference point for the study.

Single Embedded Case Study Design.

The extended CoPs model as outlined in Chapter 5 provided the framework for the case study. The aim was to explore the feasibility of the model and in order to do so, it was decided to begin with a single test school – i.e. a single-embedded case study (Yin, 2009). This was to allow in depth analysis of '*events, relationships, experiences and processes'* (Denscombe, 2007, p. 35). Such an approach allowed theorization to begin on the various aspects of the CoPs model including the roles adopted by social actors, the artefacts that were used during the process and the emergence of any of these artefacts as boundary objects. Some criticism still exists in using single cases and usually focuses on the inability of the single case to generalise (Eisenhardt, 1989). However, choosing the single case is not based on statistical sampling methods, but rather on theoretical sampling where the goal is to choose cases that are likely to extend emergent theory (Meyer, 2001). Therefore, clear parameters were established for choosing a school that was likely to aid with the development of the Extended CoPs model (see section 3.2.4). Also, some scholars, such as Creswell (1998), believe that the study of more than one case can dilute the overall analysis as introducing more cases is simply introducing more studies of individual cases and the depth of each study becomes less (p63). By investigating a single case in great depth for this research, it was also possible to use a transdisciplinary approach to further theorize the model. Using a number of case study schools would potentially have made the transdisciplinary approach much more difficult, thereby eroding the practising teacher's voice from the inquiry.

Embedded case studies involve a single case that is composed of more than one unit of analysis. Embedding a case is considered a strategy for mastering its complexity (Scholz *et al.*, 2006). Defining the units of analysis is a critical step in case study design (Yin, 2009, p. 52), so the SFM, ESD and CoPs literature were used to select the components of the case. People, place and process were key tenets within FM practice and all three emerged at varying levels in the interview data with FM personnel (see Chapter 6). In the ESD literature, place often underpinned the theorisation of sustainability and provided a focus for the three pillars of sustainability (Green and Somerville, 2015). People are crucial to the holistic approach required for sustainable school practice and processes include both the education and management factors within the EMS. Finally, social learning theory puts people and their relationships at the centre of the learning process while situated learning theory has identified place and situation as important factors. Therefore, the case study components were finalised as *People* and *Place* and were encompassed by the *Processes* they were engaging in as illustrated in figure 3.3.

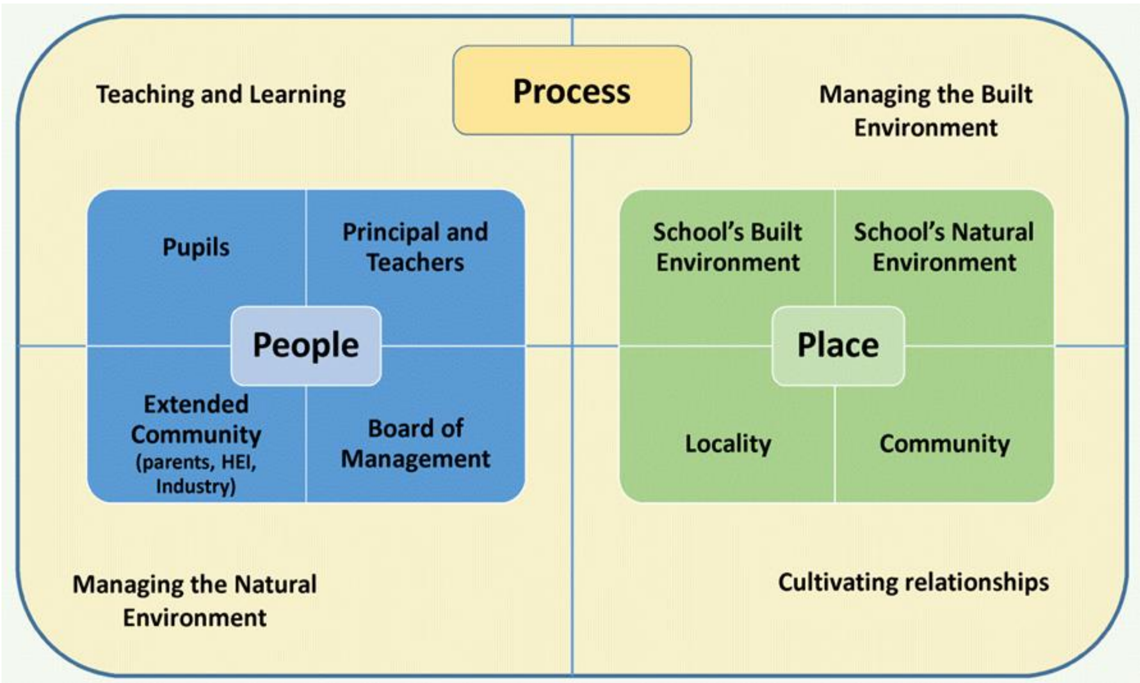

Figure 3.3 Embedded Case Study Components.

A warning that comes with case study research in many research method textbooks is that of bounding the case and establishing the components of the embedded design helped to clarify the 'case'. Similarly, focusing on the Extended CoPs model and continuous reference to the research questions helped to bound the case study and reduce the likelihood of gathering irrelevant or extraneous data.

The case study, as a method, is flexible enough to accommodate participation from all actors and therefore suited the exploration of the CoPs model. Participation then allowed for meaningful learning experiences for all social actors involved.

Transdisciplinarity and the case study approach.

Pragmatism's emphasis on creating knowledge through action draws attention to the possibilities of combining the transdisciplinary approach with case study methodology. Whereas disciplinary knowledge generalizes findings on the basis of standardised conditions, transdisciplinary research aims to validate abstract models in concrete, life-world situations (Pohl and Hadorn, 2008). Therefore, the transdisciplinary aspect of the case study enabled teachers and school leaders to work alongside researchers and FM personnel to integrate sustainable FM and sustainability education.

Transdisciplinary research is a context-specific negotiation of knowledge (Klein, 2004, p. 521). It embraces local environments and indigenous knowledge. Scholz *et al*. (2006) presented the transdisciplinary case study (TCS), based on the three paradigms of the case study, transdisciplinarity and SD, as a means of sustainability learning. Within this framework, Scholz *et al.* (2006) view transdisciplinarity as '*a process of mutual learning and joint problem solving… to solve real-world problems*' (p227). The case study is a crucial element of the TCS as it can connect '*complex, real-world problems with scientific theory building'* (ibid., p228). Scholz *et al*.'s (2006) exploration of the TCS creates a sound framework for combining the case study and transdisciplinary research with sustainability learning.

Combining CoP theory with the case study approach also created a meaningful arena for transdisciplinary learning. The pragmatic philosophy upon which the research is based has the flexibility to accommodate multiple worldviews, thus allowing teachers', researchers' and engineers' approaches and understandings to be utilised in problem solving and knowledge creation. Furthermore, as transdisciplinary approaches have been linked with '*the new* *production of knowledge'* (Van Manen, 2001, p. 850) or Mode 2 knowledge (Gibbons *et al.*, 1994), it presented an interesting pairing with the CoPs approach being explored in this case study, as it complemented that leveraging of multiple expertise within the Extended CoPs model.

Additionally, the case study has also been extensively used for teaching and learning and is closely connected to Dewey's philosophy of education as it recognises that learning is always context dependent and culturally influenced (Scholz *et al.*, 2006). Not only were the participants in this case engaged in learning, but the case study report has the potential to become a learning tool for others. As the sustainable school concept is still at the early stage of both research and practice, single case studies have the potential to build up a store of professional knowledge in a similar way that individual case studies helped to build knowledge in psychology and medicine. These cases become part of the type of context-dependent knowledge that is necessary to allow people to progress towards expertise on a given subject (Flyvbjerg, 2006). Therefore, the case report has the potential to become a learning tool for others wishing to engage in sustainable school practice.

3.2.4 Participants and setting.

A purposive sample of primary school principals and deputy principals was chosen for the survey in phase one. Purposive samples are often used with small, in-depth studies that are based on the gathering of qualitative data and focused on the investigation and interpretations of experiences and perceptions (Matthews and Ross, 2010, p. 167). A purposive sample is a non-probability sample, and it was not a requirement that the results would be generalizable, but rather offer insights that may be transferable.

As one of the aims of the case study for this project was to create a local partnership with primary schools, B+L and WIT, it was envisaged that the schools would be in the greater Waterford area and as such, this became the geographical focus for the questionnaire. Eighty questionnaires were distributed - sixty of these were posted out with a SAE and the remaining 20 were delivered by hand to colleagues, also with a SAE. One response was received from the School of Lifelong Learning and Education.

From the total 81 schools surveyed, a response was received from 46 schools giving a response rate of 56.8%. However, this may not be a truly reflective figure. Out of the principals who were handed questionnaires, a number of them mentioned afterwards that they had given a copy to colleagues in other schools. Potentially, the response rate on the sixty posted questionnaires could be much lower with a snowball effect occurring on the questionnaires that were given to principals by hand.

Furthermore, within the 46 responding schools, only three schools returned two questionnaires completed by both Principal and Deputy Principal. From the remaining 43 schools, 42 questionnaires were completed by the Principal and only one by the Deputy Principal. This resulted in 49 returned questionnaires from 46 schools.

For the case study in phase two, there were three cohorts of participants, each representing the three groups in the Extended CoPs model. Three members of the FM team from B+L participated as representatives of the 'Industry' group. I, as researcher, represented the 'HEI' group. As part of this role, others from WIT were consulted on a regular basis, including my research supervisors and other lecturers from the Department of the Built Environment. And representing actors from the Sustainable Schools CoP were seven participants from a local primary school. The choosing of this school was a critical point in this research.

Following on from the preliminary investigation, it was decided to investigate sustainable management in its entirety – i.e. how it pertains to the building, grounds and curriculum. As there is limited research in this area, particularly in relation to CoPs theory, it was decided to conduct a rigorous, in-depth study with a single school.

As the difficulties and challenges highlighted in the literature appeared to be felt more in schools with teaching principals, it was decided that this was necessary for the case study school. This would then mean that the school would be smaller in size and more likely be located in a rural setting. Critically, the case study school had to be engaged with sustainability at some level – i.e. they were trying to engage with and manage all of these areas. This would enable the identification of difficulties with or gaps in the current system. It was also important that the building itself was constructed pre- 2006. This ensured that the school was not built to the latest GRD standards as these schools are at an advantage when it comes to managing their energy and water in particular. And finally, it was important at this point that the school was located in Co. Waterford so as to engage in a local partnership. Following this case study, if this model was to be rolled out on a larger scale, with WIT as the HEI for example, the geographical location of participating schools would be the entire south east.

The logic of sampling cases for case study research is theoretical sampling (as opposed to statistical sampling), whereby the aim is to identify a case that will be likely to extend the emergent theory (Eisenhardt, 1989). One school that did approach us following the surveys was S.N. an Bhaile Nua, Waterford. This school had four mainstream classes and therefore a teaching principal. The role count for September 2017 was 114 which placed them into the next staffing bracket, meaning they appointed a 5th classroom teacher for September 2018. This school was engaged with green management and had achieved four Green Flags. Also, their school website showed activities such as water auditing. They were a very inclusive school and had made significant alterations to the building to cater for pupils with special needs – both physical and learning. And finally, the reason this school contacted us is that they were having serious difficulty with energy management, which mirrored both the extant literature and the survey findings. Also, when it comes to building typology, this school building had four distinct zones – a 1930s school house with a third classroom added in the 1960s, an extension built in 2008 and a further extension in 2013. This therefore gave some scope for comparison of different classroom typologies and some attributes of this school were likely to be pervasive across schools. Opportunity to learn is of primary importance when choosing a case (Stake, 2000) and following on from the literature findings, the preliminary investigation and the development of the Extended CoPs model, this school provided these opportunities in abundance.

Undoubtedly, focusing entirely on one school has limitations and it is important to acknowledge this. There were aspects of this school that were specific to this site and therefore would affect the approaches to sustainability that were taken. For example, this school had its own well and therefore did not use mains water like the majority of schools. This then impacted on aspects of the water EMS, such as monitoring. Nonetheless, the focus was mainly on the social learning and relationships and 'how' schools could be facilitated and much of the collected data supported the development of the CoPs model. At the outset it was expected that certain aspects of the model may work but others may not, perhaps because of the chosen school or perhaps because of certain nuances within the model. However, it was never intended for the model to be 'tested' based on this single case or indeed for its success or failure to be decided. The objective of the case study was to explore how the model may work and to examine the feasibility of implementing such an approach.

As Stake (2000) stated '*opportunity to learn*' is of primary importance when choosing a case study and it was believed sincerely that engaging the staff of S.N. an Bhaile Nua with the FM team at B+L, brokered by the WIT participant, would create a meaningful, transdisciplinary learning experience which had the potential to further theorise the extended CoPs model.

3.3 Methods of Data Collection.

For phase one, a survey questionnaire was used which enabled a wide cohort of respondents to be reached. A case study was used for the second phase of this project. The case study's unique strength lies in its capacity to deal with a full range of evidence, including documents, artefacts and interviews (Yin, 2009, p. 11), further justifying its use in this research which involved a broad range of data collection methods. A mixed methods approach was employed for this case study with the aim of using a variety of quantitative and qualitative data sources. Good case studies use as many sources as possible (Yin, 2009, p. 101) and this study combined, building performance data, audits (including written reports and photographs), interviews, survey questionnaires, observation and focus groups. Analysis began as soon as data collection began with '*continuous interaction between the theoretical issues being studied and the data being collected'* (Yin, 2009, p. 68). This resulted in an iterative process which enhanced both data collection and analysis.

3.3.1 Phase one; survey questionnaire

First, a Likert scale was used to determine attitudes towards sustainability management of the primary school. There were 21 items on the scale and Cronbach's Alpha, which was determined to be 0.751, was used to assess internal reliability. Six broad themes were used to structure the statements in this section– sustainable management, energy management, waste management, water management, managing the school grounds and ESD. These themes were identified as key areas within the literature review (e.g. Kadji-Beltran et al., 2013) and the statements were informed, in particular, by the investigation on EMS implementation in primary schools in South Africa (Hens et al., 2010a). Following this, ranking questions were used to elicit participants' opinions about their duties in terms of importance and difficulty. The seven categories used were administration, external relationships, human resource management, leadership, policy formation, resource management and teaching and learning as identified in Defining the Role of the Primary Principal in Ireland (Drea and O' Brien, 2003). As drivers for sustainability was a key theme in the literature on industry but not as prevalent in the literature on sustainable schools, the subsequent section sought to identify what drives Primary school principals to engage with sustainability. Next, participants were asked to identify areas that they require support in and how they would like to receive this support. The final section left room for participants to explain any 'green' refurbishments in their School Development Plan (SDP) and also to further comment on any other aspect that arose in the questionnaire. Details such as school size and location were also sought. The questionnaire was piloted with three experienced principals – two primary school principals with over thirty years' experience each and one secondary school principal who had recently completed his Masters in Management in Education. Based on the answers and input of these school leaders, minor additions were made in terms of the wording of some of the sections on the Likert scale and the addition of options on the 'drivers' list.

Two questionnaires accompanied by a cover letter (appendix B) were posted to 60 schools in Co. Waterford and areas along the Waterford border and a further 20 were delivered by hand. It had been hoped to disseminate questionnaires through the MA in Management in Education in the School of Lifelong Learning and Education at WIT but unfortunately only one person fit the required description of primary school principal. The cover letter asked that the Principal and/or the Deputy Principal complete a questionnaire and return it in the SAE. When a completed questionnaire was returned, it was immediately coded with a number and a letter (P for principal and D for deputy principal). For example, the first questionnaire returned was coded 01:P and the final questionnaire returned was coded 46:P. These acted as identifiers for each questionnaire and facilitated the input of data into SPSS.

3.3.2 Survey and audit of building and grounds.

To begin the case study, full audits were carried out in relation to energy, waste, water and biodiversity on the school grounds. Birney *et al.* (2011) advise that when aiming to develop a 'sustainable school' you must first find out what is already happening and recognise this work as part of the sustainable agenda. The aim of these audits was to get a 'snapshot' of how the building was performing and how the building and grounds were being managed. This provided a baseline for the case study, but also identified many positive actions that were already occurring in the school. Each audit was followed up with three walk-through visits

(Lourenço *et al.*, 2014). These visits occurred after 16:30 when all pupils and the majority of teachers had left (the school principal was present during these times) and they allowed the researcher to identify various behaviours that may be positively or negatively effecting energy, waste, water or grounds management. The building was also modelled in Revit and the school grounds were mapped. These models and maps were used during the workshops with staff and were also available as tools for the school staff to use for FM and for pedagogical purposes.

As energy was the most pressing issue and the one school management was most keen to address, this audit took place first, in August 2017. Electricity and oil bills were collected for the previous year and all major energy users were identified. During October 2017, three walk-through visits took place and any lights, small power or other fixtures that were left on were noted. It was also noted whether doors or windows in classrooms were open or closed.

A full survey of the school grounds was conducted in September 2017. The Fossitt Guide (2000) was used to establish current habitats on site and all main plant species were identified and recorded. Again, the grounds were briefly surveyed during the follow up visits to note any changes or additions to the school grounds.

Three waste audits were carried out in late 2017/early 2018. Waste separation was conducted on site and three bins of refuse (recycling, waste and organic matter) were collected every two weeks by a local company. Therefore the audits were conducted on Wednesday evenings prior to the bins being collected on Thursday mornings, giving a full two weeks of waste to be audited. It had been planned to carry out these audits in October, November and December 2017 but as it was important that the audit was carried out following a two week period where there were no school closures, the December audit had to be postponed and it was February before it was possible to audit a full two weeks of waste again. In parallel with these audits, three walk-through visits also occurred and bins throughout the school were checked for waste separation and the grounds were checked for litter.

The water audit was performed in November 2017. As this school has its own water supply there was no historical metering record to view as the school is not billed. A visual check for leaks was conducted during the audit and again in December 2017 and February 2018. During the walkthroughs which occurred in December 2017 and January 2018, it was noted if any taps were dripping or left on.

Full reports, including photographs, were compiled following each audit and walk through. These reports were presented to the school staff during the appropriate workshop and copies of each report were disseminated to teaching staff and management. The presentations provided a springboard for discussion on the school's performance in each area and the possibilities for EMS development including curricular opportunities. Following involvement in the Extended CoP model, the school was re-audited in the four areas during May and June 2019. These audits also consisted of a further three walk-through visits.

3.3.3 Building Performance Monitoring.

During September and October 2017, monitors were installed in the building to record electricity usage, temperature, CO_2 levels and RH levels. At this stage, monitoring had already emerged as a potentially important factor in the researcher's reflective journal following visits to the B+L site.

An Owl Eyes monitor was used to monitor electricity use. These are simple, stand-alone devices that can help the user to understand the building's electricity consumption (Owl.com, 2018). The 'Owl+USB' model was used which has a PC link thereby allowing data to be uploaded, stored and reviewed for the researcher's and school's use (ibid.). The screen displays real-time electricity use in KWh as well as GHG emissions and cost in euro. This data was recorded at one-minute intervals. These monitors have an accuracy of 95%.

Figure 3.4 Owl Eyes Display monitor and the clamp and transmitter.

Data was downloaded weekly from this monitor and analysed in Microsoft Excel on a monthly basis. Bar charts displaying monthly electricity performance were shared with and explained to the school principal and teaching staff and findings were acted upon as soon as possible.

Green Eye Data Loggers were installed in three classrooms in October 2017 also. The first was installed in Classroom 1 (R1) which was the newest classroom built in 2013. The second was installed in Classroom 3 (R3) which was one of the oldest classrooms built in 1937 and the final monitor was placed in Classroom 5 (R5) which was constructed in 2006. The models installed were the TIM12 which continuously monitor CO_2, RH and temperature (CO2meter.com, 2018). The accuracy of these monitors is as follows: Temperature ±0.6˚C, CO_2 levels ±40ppm/±3% and RH levels ±5% (CO2meter.com, 2018). Each of these parameters are displayed on the screen in real-time and were recorded continuously at 5 minute intervals.

Figure 3.5 Green Eye Data Logger

Two loggers had to be withdrawn in January 2018 due to shared use within the college. At the principal's request, the remaining logger was left in R3 where the parameters continued to be monitored. In September 2018, a second logger became available, and again at the principal's request, it was installed in Classroom 4 (R4). This classroom was constructed in 1962 and the principal asked that it be placed here as it had only been used as a general purpose room since the last extension in 2013 but in September 2018 had become the $5^{th}/6^{th}$ classroom and she was interested in the IEQ now that it had full class occupancy.

Data was downloaded from active monitors on a weekly basis and analysed in Microsoft Excel. Bar charts displaying monthly temperature, CO_2 and RH levels for each room were shared with and explained to the principal and teachers.

3.3.4 Workshops with staff.

Five workshops were prepared and delivered to the staff as an introductory phase to the case study. Kennelly *et al.* (2012) found that in engaging pre-service teachers with ESD, it is important to provide opportunities for the teachers to develop a '*practical and coherent conceptualisation of EfS*' that they can bring into their teaching and the main aim of these workshops was to introduce some key concepts and encourage discussion among the staff. Workshops were used effectively in research on FM by Galamba and Nielsen (2016) and on

EMS implementation by Raath *et al.* (2018), and it was expected that they would provide a space for the teachers to become familiar with the ideas of ESD while also allowing myself and the teachers to begin collaboration on this project.

The first workshop was entitled 'ESD and Sustainable Schools' and explored the concepts of sustainability education and sustainable schools. A number of sustainable schools from across the globe that differed in their ethos were looked at to encourage discussion on how sustainability might manifest itself in their practice and their school. The following four workshops were on Energy, Biodiversity and the School Grounds, Waste and Water. There was a balance between addressing the management aspects and the curricular aspects of each of these. Also, the reports from each audit was presented and discussed.

Following each workshop, I recorded observations in my research journal (section 3.3.7). A number of teachers also referred to these workshops in their reflective journals.

3.3.5 Interviews with Facilities Staff.

In December 2017, interviews took place with three members of the B+L staff. A semi-structured format was used. Semi-structured interviews are used to collect data in a range of research designs but are most associated with qualitative social data where the researcher is interested in people's experiences, behaviour and understandings (Matthews and Ross, 2010, p. 221). A small number of broad topics were chosen as stimuli for the interviews, but overall they were unstructured so that any point of interest raised by the interviewee could be explored. These broad topics included;

- interviewees' perceptions of FM,
- how FM can address sustainability issues in an organisation,
- drivers and challenges to sustainability initiatives,
- areas targeted as part of a SFM strategy, and
- implementation of management systems.

Interviewees were also asked for their opinions on how a school might address SFM. Interviews were recorded directly to a laptop and transcribed immediately afterwards. The interviews were then imported into NVivo 11 for analysis. NVivo was a suitable software for this purpose as it enables the researcher to work with the data efficiently and rigorously (Matthews and Ross, 2010, p. 416).

First, each interview was read in its entirety and a word frequency query was conducted on each participant's responses to get a 'feel' for the data. Second, each line of each interview was read and relevant phrases and sections were labelled with codes. This step was conducted a number of times to ensure no codes were missed. Next, codes were grouped together to create broad themes. Each step of this process was recorded in NVivo to ensure rigour and repeatability. Finally, the results of these interviews were presented to the school staff in October 2018 with the aim of informing the development of their new EMS.

3.3.6 Survey Questionnaires.

All of the teaching staff was asked to complete a written questionnaire at the beginning of the case study. This questionnaire was broken into five sections in order to determine the staff's opinions and observations in each area; 1) IEQ, 2) EMS implementation, 3) The Built Environment and Education, 4) The Natural Environment and Education and 5) ESD (appendix C). The questionnaire was piloted with two teachers in another school and following on from their comments, minor changes were made to the wording in sections 1 and 2.

As discussed in the literature review, sustainable management of a building, and in particular energy management, has direct implications for the IEQ of that building (Katafygiotou and Serghides, 2014b). In order to help identify any issues that this building was having, or any direct effects on staff or pupil comfort as observed by the teaching staff, a simple POE was used for section 1 of the survey. Research has shown that both the built and natural school environment can have significant effects on pupil performance (Haverinen-Shaughnessy *et al.*, 2015; Waite and Waite, 2011) and wellbeing (Bullock *et al.*, 2008; Griffiths and Eftekhari, 2008; Thompson *et al.*, 2008) as discussed in Chapter 2, therefore it was important to garner the teachers' feelings and observations about their immediate classroom environment as well as the whole school environment. Following analysis, the findings were discussed with the school staff and areas that required attention or intervention were identified and categorised according to priority, estimated cost and estimated time frame. High priority cases that fell into a low budget range and a time frame that fit within the case study period were targeted for inclusion in this study.

Section 2 of the questionnaire addressed EMS implementation including views on the Green Schools programme as it was administered within this school. The findings from the preliminary survey (discussed in Chapter 4) indicated that the Green Schools programme was generally well accepted by principals who felt it was a valuable initiative and that it was being effectively implemented in their schools. As the Green School programme is the most widely used framework for EMS implementation in Irish primary schools, and this school is involved in the programme and has achieved four Green Flags to date, it was important to analyse the Green School programme as administered in this school, including the teachers' and principal's views on its usability and effectiveness. It was also necessary to identify if teachers were harnessing Green School activities within their own classroom and connecting their own class work with the work of the wider school effort.

Sections 3 and 4 aimed to identify if the built or natural environments were being used as pedagogical tools and if so, for what subjects. The literature had noted that the outdoor environment is often used for PE and/or Science (Dyment, 2005) and the results from the preliminary questionnaire suggested similar usage. It was also important to identify if pupils were already interacting with the building, perhaps in terms of monitoring energy or waste as an aspect of the Green Schools programme.

Section 5 of the questionnaire focused on ESD. The preliminary investigation found that ESD is largely omitted from the School Plan and this was reflected in the wider literature review with authors noting that ESD was often a bottom-up venture with teachers being unsupported in the area of school policy (Stevenson, 2007). It was therefore important to identify if any teachers in this school were trying to implement ESD across their curriculums or what aspects were being addressed within individual subjects.

Six completed questionnaires were collected from the teaching staff in September 2018 and analysed in SPSS. The questionnaires were re-administered in June 2019 and analysed using the same methods. The results were compared and contrasted to identify changes that had occurred over the study.

3.3.7 Observation.

I, as the researcher, kept a field note journal for the duration of the research project (June 2016 – September 2019). Entries in this journal ranged from early, personal entries on coming to grips with the research and the challenges it presented to reflective entries on deciding on paradigms and approaches. As part of this journal, explicit entries were made to record observations following meetings, workshops, focus groups and interviews. Observations can range from formal to casual data collection methods (Yin, 2009, p. 109) and here, the data was more casual in nature. Notes were written as soon as possible following the observation and then reflected upon in relation to other data, the research paradigm and the research questions. Participant observation is a widely used method in flexible designs (Robson, 2007). While I was a participant in the research, these were only the observations of one participant – i.e. the actor from the 'HEI' section of the Extended CoPs model and this had to be taken into account when these observations were being used in analysis. However, the advantage of obtaining observational data is that it provides additional information about the topic being studied (Yin, 2009, p. 110) and can complement the other forms of data collected through the mixed-methods approach.

Pragmatism reminds us that our values and politics are always a part of who we are and how we act (Morgan, 2007) and therefore the journal also became a source for reflexivity (see section 3.4.5).

3.3.8 Reflective Journals.

For the duration of the case study period in which the school staff were actively involved in designing and implementing the EMS (September 2018 – June 2019), five of the participating teachers also kept a journal. This was a reflective journal based on their own thoughts, ideas and opinions about how the research was progressing, their involvement in it and how their own practice was being effected. The number or length of entries was not prescribed for participants, but rather the school staff were encouraged to make entries following a workshop or classroom activity they had carried out. Reflection is an integral part of the teaching profession, both at ITE (Clarke, 2004; Uline *et al.*, 2004) and during professional practice (Quinn *et al.*, 2010). Indeed, encouraging reflection and dialogue enables learning to take place (Merriam, 2008). Using the journal formalized the teachers' reflection and enabled them to systematically work through the process of engaging with these new pedagogies and informing their own practice. In order to understands 'what works' in the classroom, reflection is a very useful tool (Uline *et al.*, 2004) and as these teachers were trying new approaches and engaging their pupils in new ways with the school environment, the journals aided the teachers' critical reflection as to why certain approaches were successful or not.

Each participant's journal was collected during the case study to facilitate ongoing analysis and collected for full analysis at the end of June 2019. These journals were analysed using

NVivo whereby codes were established and then combined to identify broader themes that emerged within this data. Memos were also made in NVivo to identify all major decisions during the process and the reasons behind such decisions. These journals provided qualitative evidence of the teachers' personal journeys and experiences during the process and the emerging themes helped to formulate the topics for the focus group.

3.3.9 Focus Group.

During this research, a focus group took place with the school staff in February 2019 and six of the participating teachers were available to take part. Although most of the teachers were keeping a journal throughout the case study, using a focus group created the opportunity to observe group dynamics and the extent to which views were shared across the group (Robson, 2007, p. 284). I facilitated the focus group and was accompanied by another researcher who took on the role of non-participant observer.

A powerpoint presentation was used to aid the interview. I began by thanking everyone for being there and I informed the participants of the structure that the session would take. As an introduction, I showed the teachers an image of the Extended CoPs model again and reminded them of what we were trying to achieve. Then I recapped on the findings from the FM interviews.

The first section of the focus group focused on the first research question and participants were asked 'What have been the benefits/difficulties, as you see it, of having access to this FM knowledge?' The second section of the interview focused on the second research question and participants were asked 'Have there been aspects so far that have helped you to use 1) the school's natural environment and 2) the school's built environment?' For the final section, I asked the teachers what were the benefits and challenges of the model so far, i.e. what aspects would they like to maintain and what aspects needed development in order to further support them in their work.

Immediately after the focus group, myself and non-participant observer returned to the college, compared notes, discussed observations and wrote up an account of the focus group. This was then emailed to the participating teachers who read over the notes and confirmed their accuracy. All of the participating teachers approved of the written account and did not wish to make any changes or additions to the data. These notes were entered into NVivo and coded to identify the emerging themes.

A case study approach embraces a wide range of data collection methods in order to support deep description and rich analysis of the case. Table 3.3 details the output of each method as well as the research question targeted.

Data Collection Tool	Participant	Number	Output	Research questions targeted.
Survey questionnaire	Principals and Deputy principals in Waterford and surrounding areas	49	Overview of current practice in local schools including challenges encountered	1
Survey and audit of building	S.N. an Bhaile Nua School building	1	Baseline data for identification of changes. Written reports on energy, waste and water management Revit model	2
Survey and audit of grounds	S.N. an Bhaile Nua School grounds	1	Baseline data for identification of changes Written report on biodiversity Map of habitats on site Identification table of plant life on site	2
Building performance monitoring	S.N. an Bhaile Nua School building	1	Graphs of electricity use Graphs if IEQ performance Monthly performance data shared with principal and teachers	1 2
Workshops	Teachers	7	CPD for teachers in ESD Sharing of ideas among teachers	1 2
Semi-structured interviews	FM personnel	3	Transcribed interviews Identification of key components of SFM approach	1
Pre -survey questionnaire	Teachers	6	Identification of current attitudes and approaches of participating teachers	1 2
Post-survey questionnaire	Teachers	5	Identification of attitudes and approaches of participating teachers following engagement with the model	1 2
Observation	Teachers	7	Reflections on research process Reflexivity Observations from workshops/meetings	1 2
Reflective journals	Teachers	7	Reflections on designing and implementing an EMS Reflections on engaging an ESD approach	1 2

			Personal reflections on engaging with sustainability in and out of school	
Focus group	Teachers	6	Discussion on benefits and challenges of an SFM approach Discussion on using built and natural environments for pedagogy	1 2

Table 3.3 Overview of research methods

3.4 Establishing Trustworthiness.

Establishing trustworthiness in relation to a research project is of utmost importance. Lincoln and Guba (1985) state that historically, researchers have posed four questions in order to establish trustworthiness;

- '*Truth value'*: How can one establish confidence in the 'truth' of the findings of a particular inquiry for the subjects with which and the context in which the inquiry was carried out?
- *Applicability*: How can one determine the extent to which the findings of a particular inquiry have applicability in other contexts or with other subjects?
- *Consistency*: How can one determine whether the findings of an inquiry would be repeated if the inquiry were replicated with the same (or similar) subjects in the same (or similar) context?
- *Neutrality*: How can one establish the degree to which the findings of an inquiry are determined by the subjects and conditions of the inquiry and not by the biases, motivations, interests, or perspectives of the inquirer?
  (ibid., p 290).

Within the positivist paradigm, these four questions emerge as internal validity, external validity, reliability and objectivity respectively while within the constructivist school of thought they are addressed through credibility, transferability, dependability and confirmability (Lincoln and Guba, 1985, pp. 301-319). While the pragmatic approach relies strongly on the scientific method (as discussed above in Section 3.1.2), it also has strong ties with constructivism and in particular, social constructivism (Neubert, 2001). Therefore both approaches to each of the above questions were taken into account when establishing the trustworthiness of this research.

Although the case study is now widely accepted as a distinctive form of empirical inquiry (Stake, 2000; Yin, 2009), there remains some disquiet regarding its lack of rigour. But the case study approach has the potential to connect complex, real-world problems with theory building (Scholz *et al.*, 2006) if executed systematically and rigorously. Throughout this project, from conception to data gathering and analysis to interpreting the findings, considered thought was given to validity, reliability and objectivity. Although the research is presented in a somewhat linear fashion, in practice, it was an iterative process and particularly during the case study phase, the underlying theories were constantly revisited. Yin (2009, p. 68) states that in case study research continuous interaction must occur between the theoretical issues being studied and the data being collected. Such an approach ensured that the research stayed focused on the extended CoPs model and its underlying theories.

3.4.1 Internal Validity/Credibility.

According to Lincoln and Guba (1985), the first question that must be addressed is 'How can one establish confidence in the "truth" of the findings of a particular inquiry for the subjects with which and the context in which the inquiry was carried out?' As already discussed (Section 3.1.2), "truth" in pragmatism is the outcome of successful inquiry. Therefore, a determining factor in establishing the credibility of this research was a measure of the practical outcomes on the school as a whole. To facilitate this, baseline data was measured prior to the case study phase – audits in each area of energy, waste, water and BD on the grounds and the teachers' attitudes and approaches to ESD, and this was measured again at the end of the case study. The focus then became ensuring the validity of this collected data.

Triangulation of data ensures both internal validity and credibility. One of the advantages of a case study methodology is that numerous data sources are available to the researcher and in this project a range of data sources were utilised to improve the internal validity of the research (as discussed in Section 3.3).

Prolonged engagement and observation are verification strategies that are cited with regards to credibility of qualitative data (Creswell, 1998). Taking the time to build relationships with participants improves trust, improves the researcher's understanding of the culture in which the participants work and allows all participants to review the data to check for distortions. I first met the principal of this school in November 2016 and began to regularly visit the school from September 2017 onwards to carry out audits and check monitors. During this time, the teachers got to know the researcher and professional relationships were well established by the time the case study phase began in September 2018. Throughout the case study phase then, the participant teachers would review written observations and reflections made by the researcher and offer advice and critique which bolstered internal validity. Lincoln and Guba (1985, p. 374) argue that 'member checks' such as these are essential, not only to verify factual and interpretative accuracy but also to provide evidence of credibility.

Peer-review and debriefing also strengthened the validity of the results. Along with publishing and presenting research findings, the data and observations were continually checked by research supervisors. Peer review, such as this, provides an external check of the research process (Creswell, 1998) thereby strengthening the validity of the findings.

3.4.2 External validity/Transferability.

The aim of the case study is not scientific generalization but rather analytic generalization that will '*expand and generalize'* theory (Yin, 2009, p. 15). The value of the single case study is that it provides the time to ensure rich description and acute detail on each of the embedded units. What becomes useful and interesting then, is a full and thorough knowledge of the particular (Stake, 1978). The extended CoPs model, developed in Chapter 5, provided the template to examine the empirical results of this case study (Yin, 2009, p. 38).

Within Pragmatism, theories are viewed as being both contextual and generalizable and pragmatists use transferability to consider the implications of their research (Shannon-Baker, 2016), i.e. what are the practical outcomes of doing this for the readers of this research? The case study approach itself helps with the implications of this question as it is aligned with 'naturalistic generalization' – the generalization arrived at '*by recognizing the similarities of objects and issues in and out of context and by sensing the natural covariations of happenings'* (Stake, 1978, p. 6). To facilitate naturalistic generalization, deep description was used in the case report to help the reader to develop vicarious experience (Creswell, 1998, p. 186). Case studies build on readers' tacit knowledge (Lincoln and Guba, 1985, p. 359) and the thick description further enabled this to occur.

3.4.3 Reliability/Dependability.

According to Yin (2009, p. 79), having a case study protocol significantly increases the reliability of a case study. The protocol for this case study was written early in the study and saved in a case study database (a folder containing all information on the case, including procedures, timelines, etc.). It provided a 'roadmap' of the journey through the case study. However, case study researchers must integrate real-world events with the needs of data collection (Yin, 2009) and in this research, the original timeline was altered on numerous occasions due to unforeseen circumstances at the school. Nonetheless, each alteration was recorded and a final overview of the research 'journey' is recorded in the case study database.

Having such a tightly monitored database system meant that all critical points in the research, including when and why key decisions were made, were recorded and available for anyone interested in the reliability of the research or in repeating the research in another setting. As an external check, the lead research-supervisor also checked the database, adding to the dependability of the work.

3.4.4 Objectivity/Confirmability.

Pragmatism endorses a balance between subjectivity and objectivity throughout the inquiry (Shannon-Baker, 2016). The search for an ultimate truth or complete objectivity are not considered useful endeavours by the pragmatist (James, 1907), rather objectivity relates to the agreement that occurs through communication between social actors in their communities (Giacobbi Jr *et al.*, 2005).

Each researcher brings their own beliefs, attitudes and prior experiences to each inquiry and this must be identified and catered for in order to safeguard the findings from bias. Explaining the researcher's bias from the beginning is necessary so that readers understand the researcher's stand point (Merriam 1988 in Creswell, 1998). One way to safeguard the research from such bias is for the researcher to explicitly recognise their beliefs, attitudes, etc. and to consciously try to set them aside during data analysis (Meyer, 2001). The use of a reflective journal allowed me to reflect on my biases and how they may have impacted upon data collection and/or interpretation. Furthermore, including the entries from this journal in the NVivo analysis enabled emerging themes to be identified which could then be compared to the themes from other sources to identify any discrepancies or potential conflicts.

Reflexivity is '*an awareness of the ways in which the researcher as an individual with a particular social identity and background has an impact on the research process'* (Robson, 2007, p. 172). Reflexivity was particularly significant to this research due to the transdisciplinary approach that was employed. Pragmatism facilitated a reflexive approach as it recognises the role of values and views knowledge production as a social process whereby 'truth' and 'credibility' are defined within the community of inquiry (Popa *et al.*, 2015).

Therefore, as part of the process, values and opinions were openly discussed during the workshops and focus groups and this kept the issue of reflexivity for the researcher to the fore. Furthermore, establishing the normative reference point (as outlined in section 3.1.3) at the beginning of the case study ensured that values were given a high priority from the start.

3.4.5 Ethical Considerations.

Ethics is a fundamental pillar of all research (Blaxter *et al.*, 2008; Robson, 2007) and this research was developed with ethics as a central value. Within a pragmatic paradigm, the CoPs framework, case study methodology and transdisciplinary approach all dove-tailed to create a flexible design that would cater for the needs, values and opinions of all participants.

Ethical Approval.

The questionnaires for the school principals were anonymous although some participants signed the questionnaire before returning it. From an ethical point of view, it is important to provide participants with sufficient background information about the research (Denscombe, 2007, p. 159). Therefore the questionnaire was accompanied by a cover letter describing the research, the aim of the questionnaire, that it was being conducted through WIT and that it was funded by B+L. Contact details were also provided with the invitation to contact us should the school require any further information or any advice regarding sustainable management of schools (appendix B). These surveys were carried out early in the research and at that time, the School of Engineering had no ethics committee. As the full ethics application was not submitted until later in the project, details of these surveys, including methods of analysis, were included and the Ethics board agreed that the surveys had been conducted in an ethical manner.

Prior to the case study phase, participants were given a participant information sheet and consent form. Participants were informed orally and in writing that following the completion of the consent forms, they could withdraw from the research at any time with no reason or reprisal. All participants signed and returned the consent forms and remained with the research for the duration of the project. The confidentiality of all the participants was fully respected throughout the research. All participant teachers were given codes that were used on their reflective journals and initial and final surveys. These codes corresponded to pseudonyms that were used in all written documents, including published papers and the final dissertation. Furthermore, prior to publishing any work, participants were given the opportunity to read the material to ensure their data was being used and interpreted in a fair and unbiased manner. No research was undertaken with participants until after ethical approval was received. As ethical approval was not required to conduct audits of the building or grounds when the pupils were not present, some of these audits began in August/September 2017. The first energy audit was conducted when approval was under review as it involved spending a number of hours in the school to identify all energy users and it was decided to conduct this physical audit when pupils were not in school. As the research was approved pending minor amendments in September 2017, some initial walkthrough observations occurred in October as these were not the focus of the amendments. The amendments included the need to submit a publication agreement between myself and my supervisors and the need to submit for further approval should I create an online platform for engagement with participants. This idea to create an online platform did not materialise due to time constraints and the work required to do so.

Ethical approval was sought from the Ethics Committee at Waterford Institute of Technology in June 2017. Following a meeting with the committee in September 2017, the project was approved with minor amendments. These amendments were made promptly and full approval was received in October 2017 (appendix D).

Reporting back to the school.

The transdisciplinary approach was a key strand of this research design and as such, the participants were encouraged to actively participate from the outset. In particular, the teacher participants were informed of their key role in the development of the EMS for their school as they were the ones who knew the school, the pupils and the community and were best placed to ensure that the needs of the whole school community were being catered for.

As part of this transdisciplinary approach, all data and findings were regularly reported back to the school. Each of the initial audits (energy, waste, water and BD on the grounds) was written up and the reports forwarded immediately to the principal. The findings of each audit were then discussed at the appropriate workshop. The continuous monitoring – electricity, CO_2, temperature and RH, was graphed at the end of each month and given to the staff. When issues arose (such as a peak in CO_2 levels) or when patterns were identified (such as high baseload at the weekends), these were discussed with the principal immediately. This meant that a number of problems were rectified before the implementation of the EMS.

3.5 Summary.

This chapter has described the research design behind this project and has identified how each component – the CoPs model, the transdisciplinary approach and the case study method – was developed, so that they reinforced one another as well as combining to support the overall research design. For case studies, theory design as part of the design phase is essential (Yin, 2009, p. 35) and the development of the communities of practice framework in the previous chapter directed the data collection phase and ensured continued focus on the research questions. The transdisciplinary approach then enabled participation from all actors involved and complimented the leveraging of multiple expertise within the model.

As engaging in sustainable school practice is a complex, multi-layered venture, the research design had to have the capacity to deal with actors from different backgrounds, multiple disciplines and the potential to produce application-oriented knowledge (Gibbons *et al.*, 1994) that could be transferable to other school sites. Encapsulated within a pragmatic philosophy, it is argued here that the layering of CoPs, the case study and the transdisciplinary approach, has the potential to do this. In a modern, globalized society where education needs to be more future-oriented, this model allows teachers to move beyond the boundaries of their school and harness the learning opportunities available in their wider community.

4. Preliminary Investigation.

As highlighted in the literature review, sustainable management of primary schools is a wide and complex issue. While some aspects of sustainable management of primary schools have received quite notable attention, such as energy management, other areas, like water management or waste management, have received less consideration. Given the expansive and varied nature of sustainability education and sustainable management of primary schools, it was decided to carry out a preliminary investigation of the current situation in Primary Schools in Co. Waterford and surrounding areas by means of a questionnaire. The aim was to quantify the current situation with regards to sustainability in schools in the South East while simultaneously identifying any potential obstacles to the implementation of sustainable management strategies.

4.1 Results.

In Ireland, a principalship position can be either teaching or administrative. The position is normally based on pupil enrolment number, with the current figures standing at 177 as the cut off point for an administrative principal. Generally, if a school has less than 177 pupils, the principal has to take up full teaching duties along with their administrative role as principal. There are a number of circumstances where the pupil enrolment number is lower for an administrative principal position - for example, the enrolment figure is 114 if the school operates as a specialist autism unit (Department of Education and Skills, 2017). The responses for this survey (n=49) were from 25 administrative principals, 20 teaching principals and four deputy principals. As it is estimated that around two-thirds of Irish primary school principals are teaching principals, we can see that this sample is not representative of the wider primary principal population. Due to the huge demands on teaching principals' time, it is not surprising that fewer teaching principals filled out and returned the questionnaire. Pupil enrolment figures also determine the number of class teachers in a school. For example, based on the staffing schedule 2016/17, pupil enrolment must reach 85 to become a four teacher school. Figure 4.1 shows school size for this sample based on teacher number.

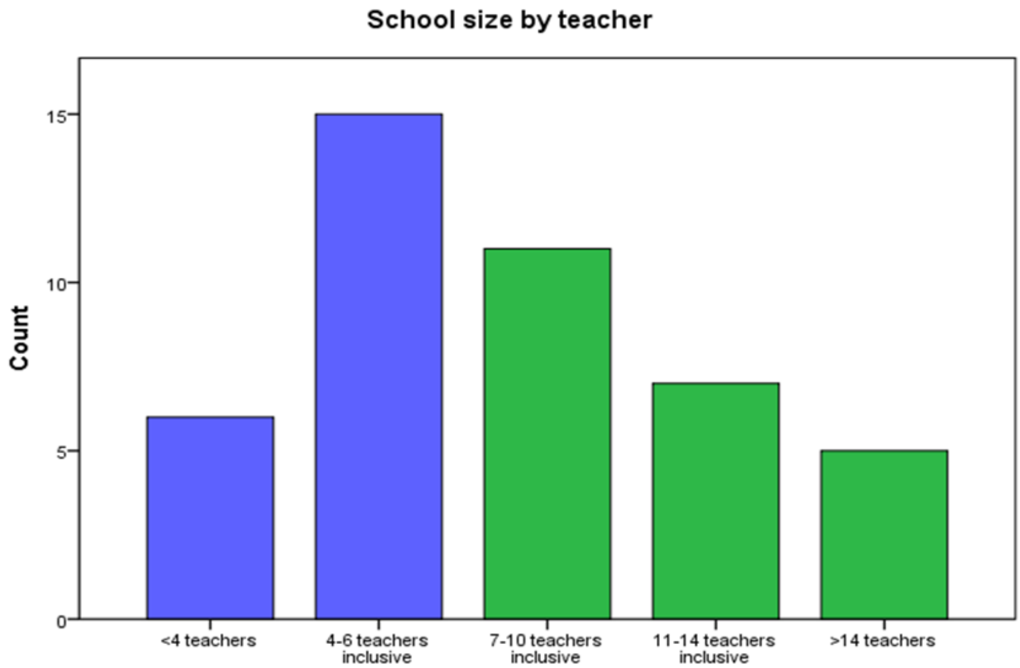

Figure 4.1 School size based on teacher number.

4.1.1 Principles and Deputy Principals' perspectives on Sustainability Management.

The aim of the 21 items on the Likert scale was to determine attitudes towards sustainability management in Primary schools and also some specific actions that are being taken and they covered areas that were identified as important in the literature review. To facilitate the analysis of these results, they have been graphed according to theme. One respondent (a teaching principal), did not fill out large sections of the questionnaire citing 'the ever increasing demands on teaching principals' as his reason. This issue of time in relation to teaching principals is a recurring theme that arises throughout these results.

The first three items on the scale looked at issues of sustainability management in general. 68.8% of respondents (n=48) either strongly agreed or agreed that sustainable management of the school building and grounds is an area of high priority for the school. However, 45.8% either disagreed or strongly disagreed that sustainable refurbishments are included in the School Development Plan and a further 14.6% did not know. With regards to the statement 'sustainable management of the school building and grounds receives regular attention by the Board of Management', 51.1% either disagreed or strongly disagreed and 4.3% did not know.

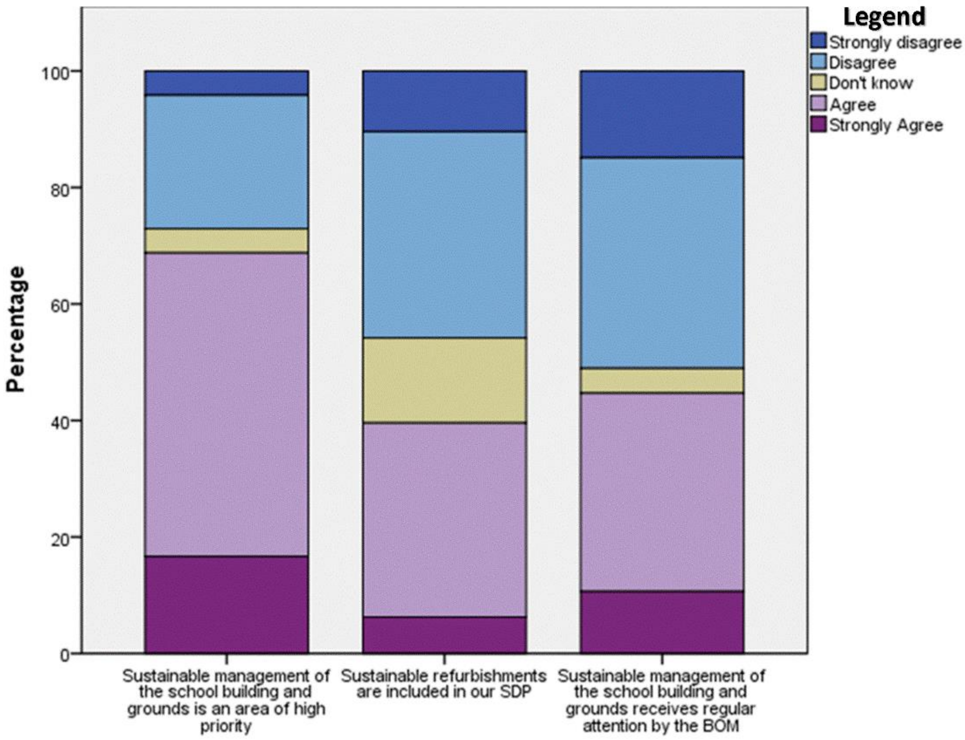

Figure 4.2 Principal/Deputy Principal perspectives on sustainability management.

The next four statements were on the theme of energy management, an area that received much attention in the extant literature but also an area in which there were many challenges highlighted (Lourenço *et al.*, 2014; Sekki *et al.*, 2015). 40% of respondents agreed or strongly agreed that they were confident in managing the energy demands of the school building but 21.3% checked the 'don't know' box for this statement. 66% of respondents agreed or strongly agreed that electricity usage is monitored using the electricity bills but only 21.3% agreed or strongly agreed that the meter was read monthly. Only eight respondents agreed that their school has an energy policy.

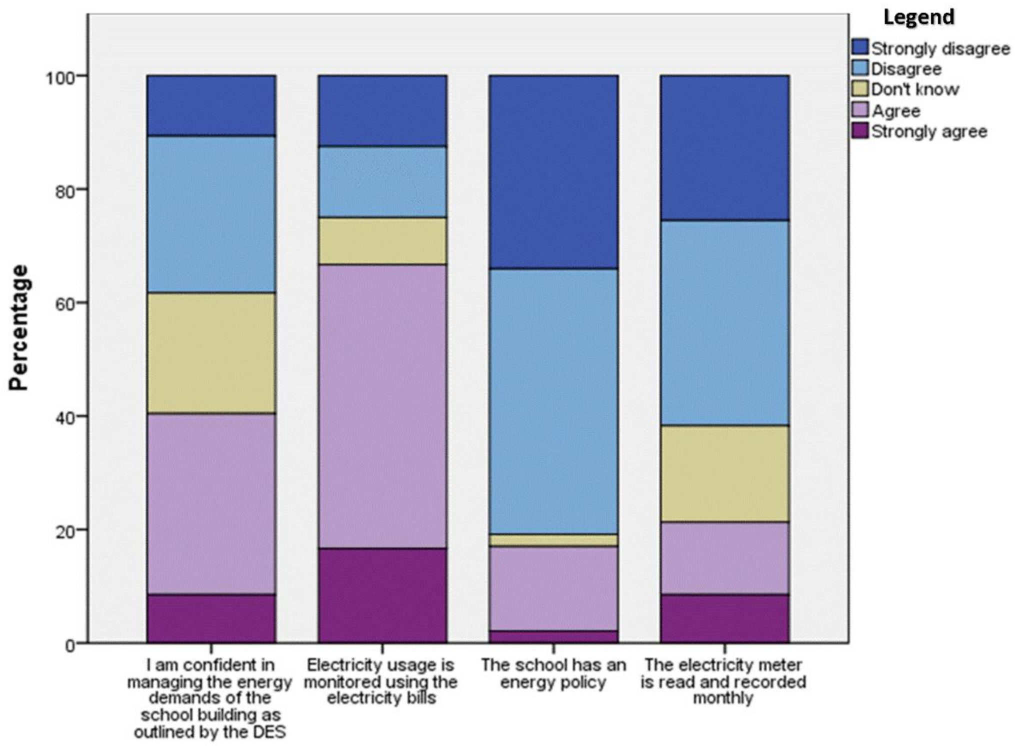

Figure 4.3 Principal/Deputy principal perspectives on energy management.

The next four statements were in relation to sustainable waste management. Principals conveyed a high level of confidence in this area with 72.9% either agreeing or strongly agreeing that they were confident in managing the school's waste effectively. No respondent disagreed or strongly disagreed with the statement 'waste generated by the school is sorted into the appropriate bins' emphasizing high perceived levels of waste separation in schools. However, the results were divided with regards to organic waste, with just over 50% agreeing that composting activities occur on the school premises. Only 19% of respondents agreed and two strongly agreed that GPP is taken into consideration in the purchase of new equipment, an action that may not be perceived as being related to waste management.

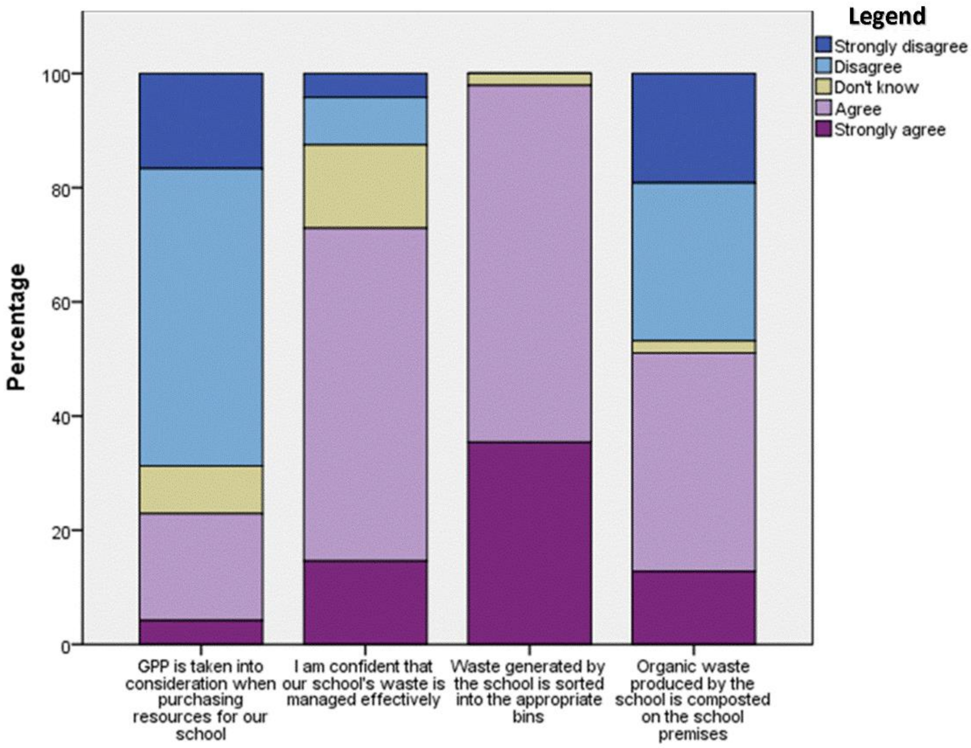

Figure 4.4 Principal/Deputy principal perspectives on waste management.

There were three statements based around the theme of water management as shown in figure 4.5. Confidence in water management was similar to that of energy management with 44.7% agreeing or strongly agreeing that they were confident that their school's water was managed effectively. 64% per cent agreed or strongly agreed that the taps are checked regularly for leaks while 14.9% stated that they did not know, implying that perhaps care staff may check as part of their duties. 47% of respondents do not have a water meter on site but of the remaining 53%, 7 agreed or strongly agreed that it is read and recorded monthly.

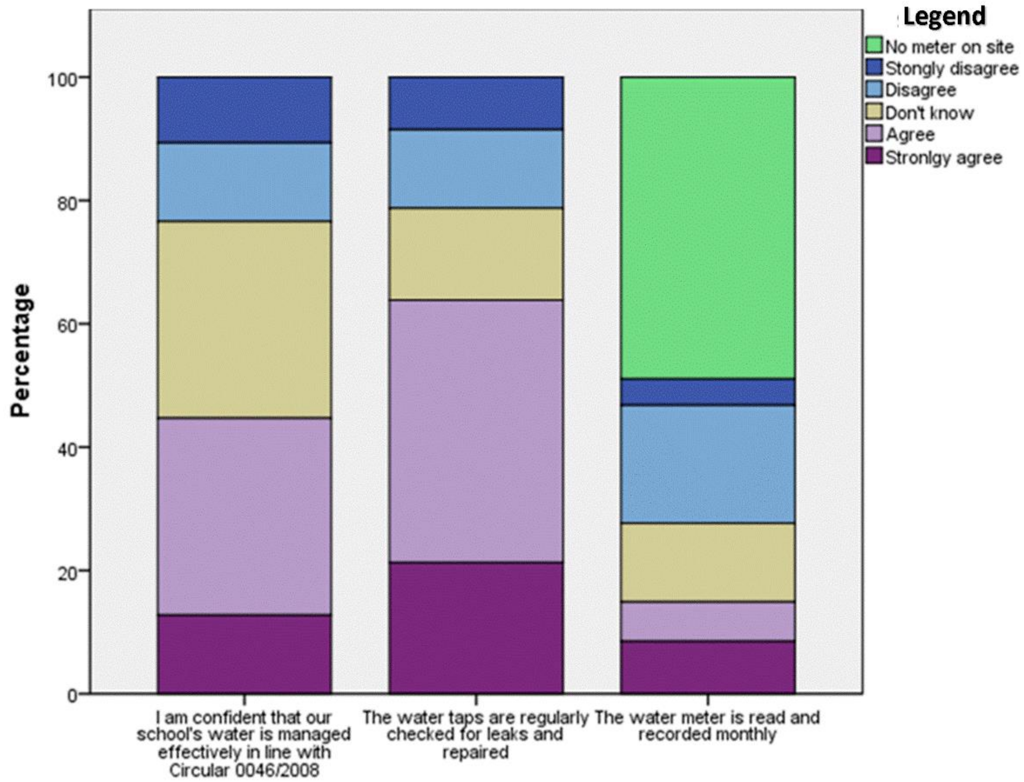

Figure 4.5 Principal/Deputy principal perspectives on water management.

Principals displayed high levels of confidence in grounds management, as shown in figure 4.6, with 66% agreeing or strongly agreeing that they are confident they manage the school grounds effectively. However, 57.4% disagree or strongly disagree that there are areas for attracting pollinators on site while a further 8.5% do not know. 23% said they did not know if the majority of plants/trees on site are indigenous with just over 8% disagreeing with this statement. These are interesting responses as a significant 74.5% either agree or strongly agree with the statement ‘the school grounds are conducive to outdoor learning’.

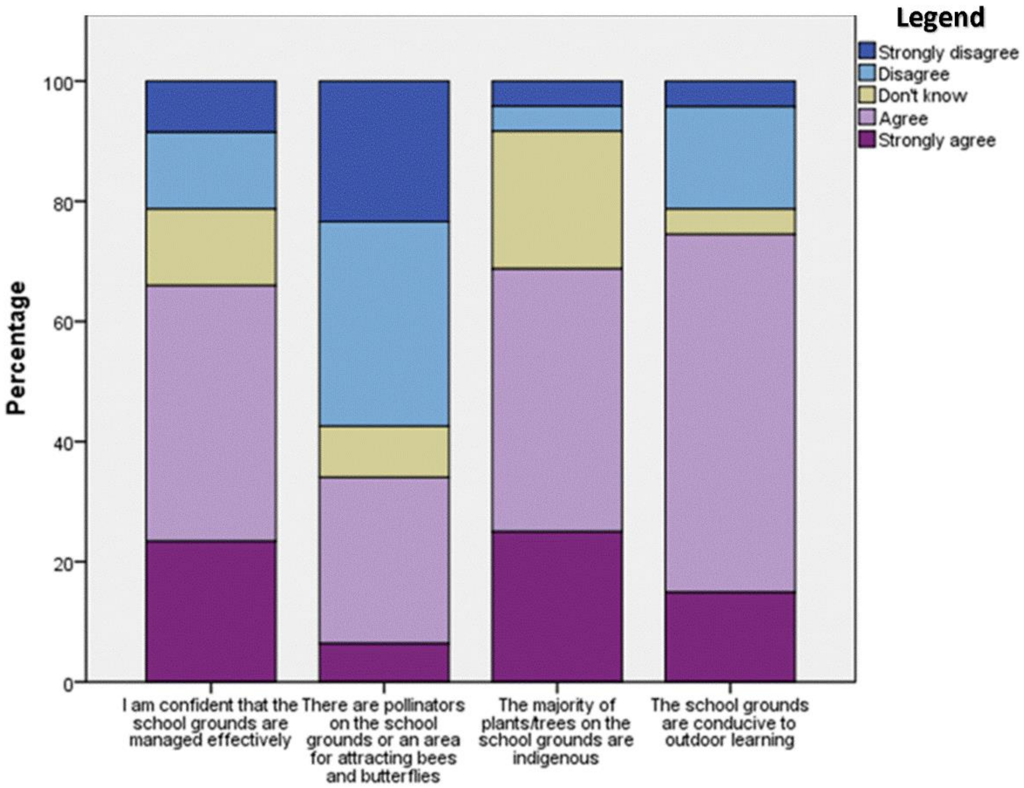

Figure 4.6 Principal/Deputy principal perspectives on managing the school grounds

The final three statements were based around the theme of education, as shown in figure 4.7, with two of the statements referring to the Green Schools' Programme as it is an example of an educational EMS that is run in many primary schools in Ireland (www.greenschoolsireland.org). All respondents' schools participated in the Green Flag programme and overall, it is perceived very positively. Only one person strongly disagreed and eight disagreed with the statement 'the Green School Programme is a valuable initiative in our school' while three strongly disagreed and seven disagreed that the programme is implemented effectively in their school. Quite a surprising response was received for the statement on ESD with 76.6% either strongly disagreeing or disagreeing that ESD is referred to in the School Plan and a further 15% not knowing.

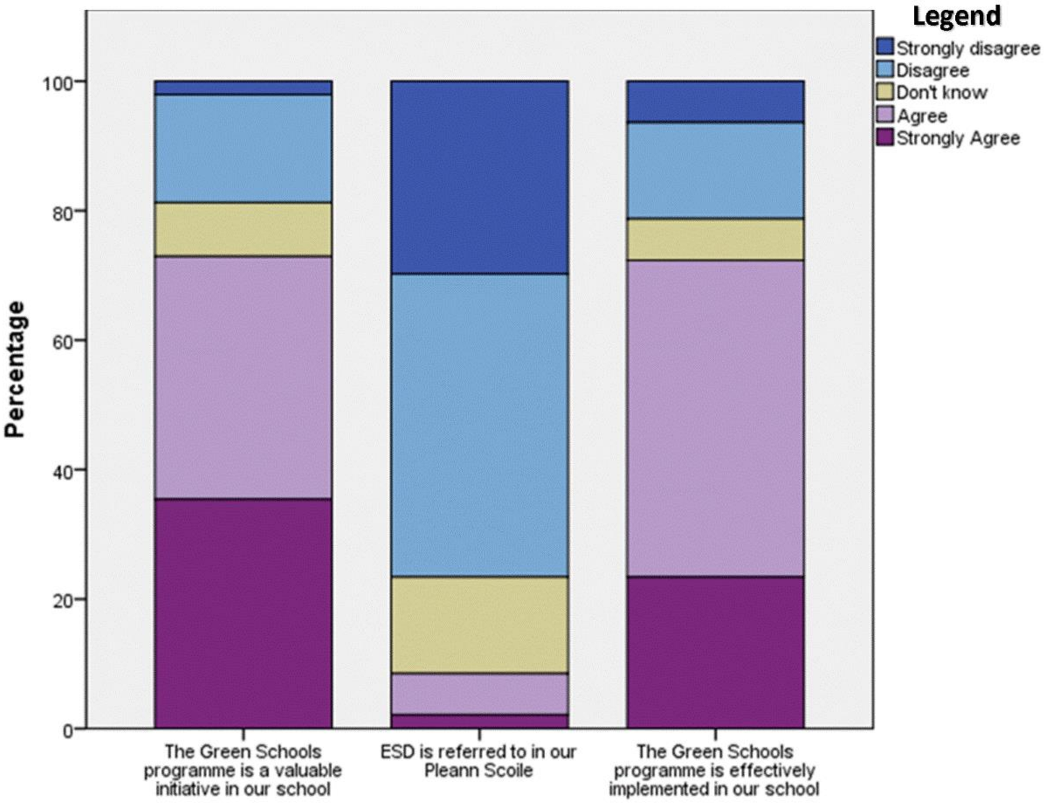

Figure 4.7 Principal/Deputy principal perspectives on Green Schools and ESD.

4.1.2 Key accountabilities of the primary school principal.

The document 'Defining the Role of the Primary Principal in Ireland' (Drea and O' Brien, 2003) sets out seven key accountabilities of the primary school principal - administration, external relationships, human resource management, leadership, policy formation, resource management and teaching and learning. It is important to understand how school leaders relate to each of these duties, which they view as most important and which they find most difficult so that they can be supported in each of these areas within a sustainable schools framework. Figure 4.8 provides an overview of how these school leaders viewed each of these key duties in terms of importance, while figure 4.9 shows how they were viewed in terms of difficulty.

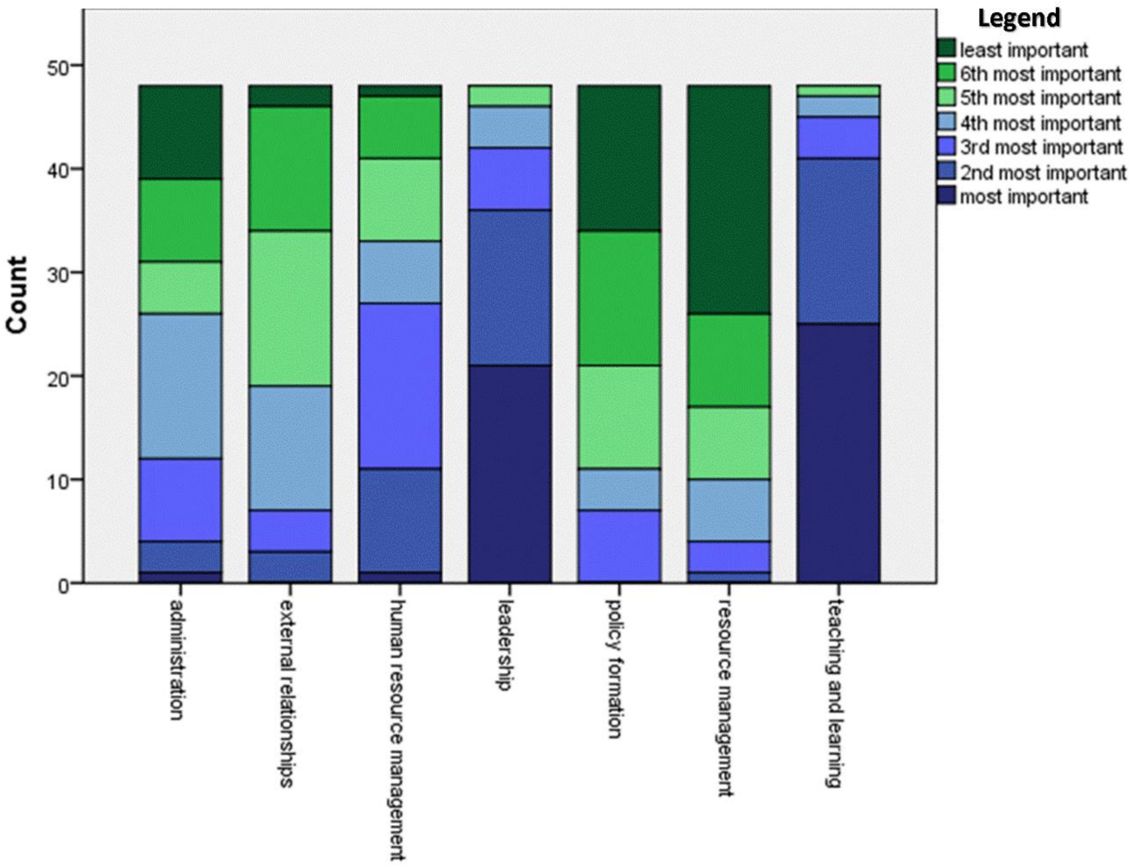

Figure 4.8 Key Accountabilities of the Primary Principal as ranked by importance.

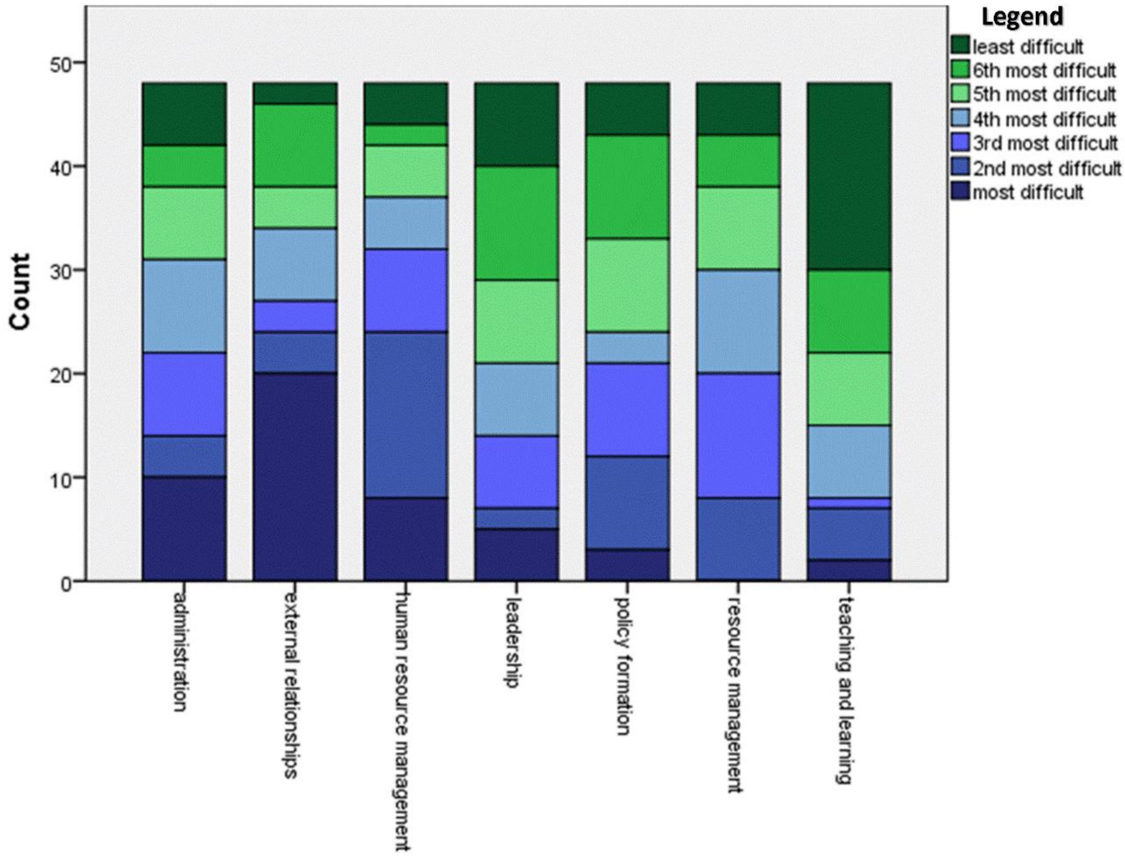

Figure 4.9 Key Accountabilities of the Primary Principal as ranked by difficulty.

Teaching and Learning, closely followed by *Leadership* were clearly the top two duties in terms of importance. 45 respondents (n=48) ranked *Teaching and Learning* as one of their top three most important duties while 87.6% ranked *Leadership* in their top three. Teaching principals were slightly more inclined to rank *Teaching and Learning* higher while administrative principals were slightly more inclined to rank *Leadership* higher. Nobody ranked either *Teaching and Learning* or *Leadership* as their least important or second least important duty. *Leadership* was viewed as more difficult than *Teaching and Learning* but both of these duties were the least difficult of the seven duties as perceived by these respondents.

The least important duty as ranked on this survey was *Resource Management*. This is not to say that school leaders do not view this as important, but just not as important as their other duties. Almost 80% of respondents ranked *Resource Management* as one of their bottom three duties in terms of importance, with 45.8% ranking it as their least important of the listed duties. Only 8% placed *Resource Management* in their top three. This is in contrast to views on difficulty whereby 41.7% placed *Resource Management* in their top three choices.

Administrative principals were more likely to view Resource Management as difficult with 13 of the 25 respondents ranking it in their top three in comparison with only 6 of the 20 teaching principals.

The most difficult duties as perceived by these respondents are the two relating to interpersonal associations. Slightly less than 67% placed *Human Resource Management* in the top three duties according to difficulty while 56.3% ranked *External Relationships* in the top three. However, the structure of these figures is interesting with 16.7% ranking *Human Resource Management* as their most difficulty duty while 41.7% ranked *External Relationships* as the most difficult. The similarity in perceived difficulty between these two duties is not reflected in perceived importance. Fifty-six per cent ranked *Human Resource Management* in their top three most important duties compared to only 14.6% for *External Relationships*. In fact, 60.4% placed *External Relationships* in their bottom three duties in relation to importance.

The remaining duties, *Administration* and *Policy Formation*, were both viewed as quite difficult with almost 46% placing *Administration* and 43% ranking *Policy Formation* in the top three. A number of respondents mentioned time as a barrier in relation to these areas and therefore it is not surprising that more teaching principals ranked these areas as more difficult. With regards to importance, *Administration* and *Policy Formation* were viewed respectively as the fifth and sixth most important duty out of the seven listed.

4.1.3 Drivers of sustainability initiatives.

Seven drivers were listed on the questionnaire, inferred from themes in the literature review – Environmental, Expertise on Staff or BOM, Financial, School Image, Regulations and Legislation and Teaching and Learning Opportunities. As finance was identified as a crucial driver in the industry literature and often identified as a barrier in the school literature, it was decided to separate this into two drivers –grants available and money saving- to help determine if certain aspects of finance were more important than others. Principals did not have to rank all seven options but rather identify the options that were drivers for their school and rank them in order if they chose more than one. There was an option to fill in any other drivers as respondents saw fit, but this was not used on any of the questionnaires.

The key drivers, as clearly identified by the respondents of this questionnaire, were financial – see figure 4.10. 25% ranked grants as their number one driver while 64.6% had grants as one of their top three drivers. Only 10.2% of respondents did not rank grants as a driver at all. Similarly, 23% stated that saving money was their most persuasive driver with 62.5% ranking saving money as one of their top three drivers. Twenty-nine per cent ranked both financial drivers as their first and second choice.

Following financial incentives, teaching and learning opportunities was the next most influential driver. 75% of respondents had teaching and learning opportunities as a driver at some level with 20.4% stating it was their top driver and 45.8% placing it in their top three drivers. The remaining four options were each identified as drivers by over 60% of respondents, but they were not ranked as highly as financial or teaching and learning. Only one person put image as their top driver while two ranked environmental as number one. Thirty-three per cent ranked Regulations and Legislation in their top three drivers while 31.3% ranked Expertise on Staff or BOM in their top three. Interestingly, 28.6% did not rank Regulations and Legislation as a driver at all.

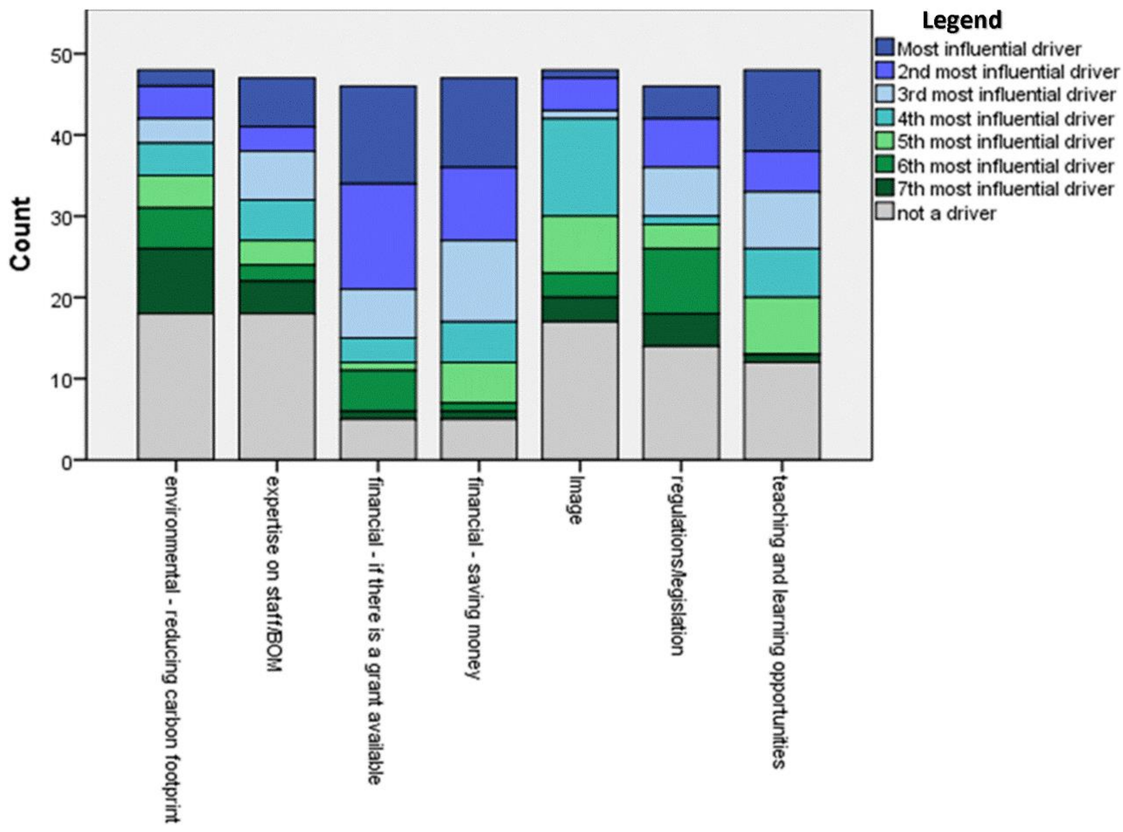

Figure 4.10 Drivers of sustainable management of primary schools.

4.1.4 Areas requiring support.

The next section asked school leaders if they would like support in any of the following areas – energy management, waste management, water management, building upgrades, managing the grounds and implementing ESD in the curriculum. They were also asked if they would like this support in the form of written guidelines, policy or to outsource to a specialist agency.

Energy management was the area requiring most support with building upgrades following closely behind. In both of these areas, support was sought mainly through outsourcing with 54% stating they would like to outsource energy management and 69% stating they would like to outsource the upgrading of the building. Surprisingly, the next area where support was most sought was in implementing ESD in the curriculum. This support was sought mainly in the form of written guidelines (36.7%) or policy (26.5%). Just over 50% of respondents said they would like support with grounds management and water management while the area with the smallest request for support was that of waste management, reflecting the high levels of confidence in this area.

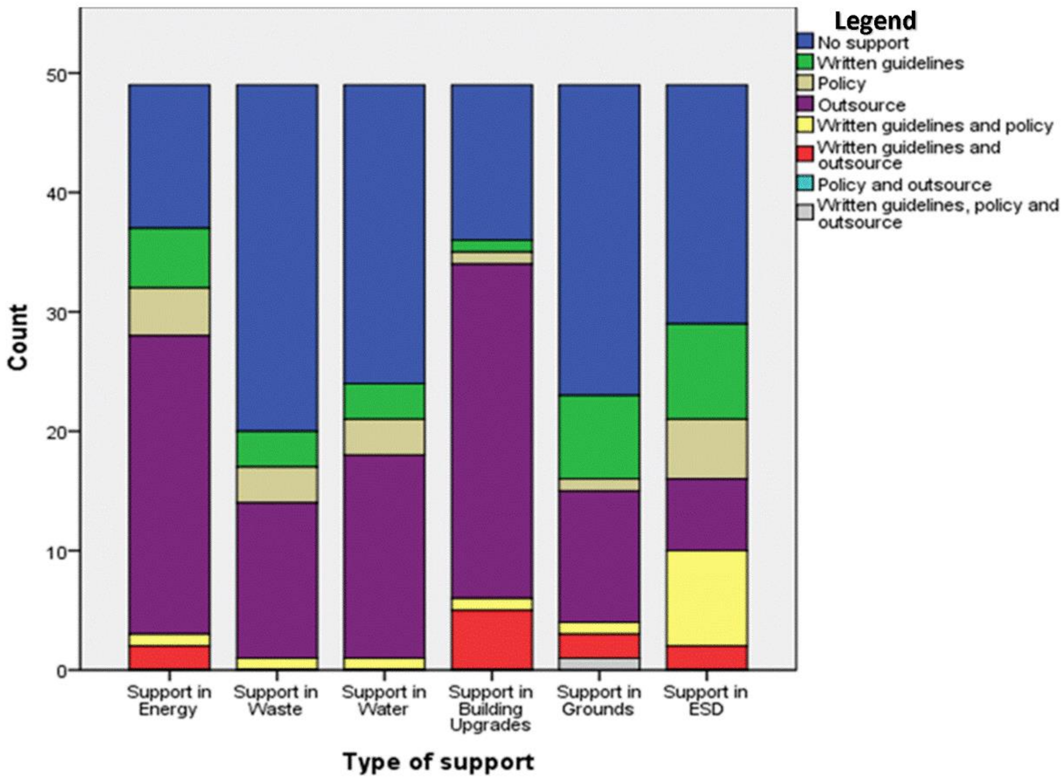

Figure 4.11 Types of support required for sustainable management of primary schools.

4.1.5 Additional information.

The survey concluded with an open ended question, an option to fill in any 'green' refurbishments that are in the school's Development Plan and a space for the school's BER. Also, many respondents wrote notes in the margins alongside other questions throughout the questionnaires revealing further insights into sustainable management in primary schools.

Sixteen respondents filled in answers to the question Do you have any other comments/relevant information on this area? The main issues raised in this section are barriers and difficulties encountered in FM and references to building upgrades previously carried out. Ten respondents made specific reference to time barriers, three referring explicitly to the work overload of teaching principals. Three respondents mentioned financial barriers and four referred to staff shortages as significant difficulties in this area. Seven references were made to building upgrades previously carried out in the school and three references were made to problems ensuing from these upgrades.

Seventeen respondents filled out the section *Brief explanation of any sustainable or 'green' refurbishments in your School Development Plan*. Six principals stated that Green Flag activities were referred to in the SDP. Four respondents identified upgrades that had been carried out in the past while seven referred to works that they hoped to carry out in the future. Of the four that wrote about past works, two mentioned the Summer Works Scheme, funding available to carry out minor works over the summer holidays. One respondent mentioned finance and lack of knowledge as barriers to carrying out future upgrades.

On the 49 returned questionnaires, only six respondents filled in their BER. Fifteen respondents wrote a question mark or 'I don't know' in the box. One was an incorrect rating and the remaining 27 were left blank. Of the six that were filled in, two were B1, two were B2 and the remaining two were B3 and C1.

4.2 Discussion.

The aim of this questionnaire was to survey school leaders' attitudes and behaviours in relation to sustainable management of the Primary school. The focus was on Principals and Deputy Principals as they are strategically placed and are in a position to foster change and reorient the school vision. Principals in particular have been identified as having a crucial role to play in directing the school toward sustainable practice and ESD (Bottery *et al.*, 2012; Kadji-Beltran *et al.*, 2013; Zachariou *et al.*, 2013). Furthermore, many studies identified that critical reformation of a schools fundamental structures is required if the school is to be reoriented towards ESD (Gruenewald, 2003a; Stevenson, 2007). While it is acknowledged that shared leadership and a whole school approach is the way forward, Principals and Deputy Principals were targeted here due to their role in, and therefore their knowledge of, broad management issues, including facilities management.

4.2.1 EMS implementation.

The Green School programme provides the structure for EMS implementation in schools in Ireland and each school in this survey participated in this programme. As the focus in this project is on FM, the theme of 'travel' was not covered in the survey. Overall, sustainable management was viewed as very important but this did not always translate into action. 33% of respondents agreed or strongly agreed that sustainable management is an area of high priority but in contrast, only 19 stated that sustainable or 'green' refurbishments are in the SDP and 21 stated that such matters receive regular attention at board meetings. This belief that sustainability is important and requires attention in schools and the contrasting difficulty in implementing sustainability actions has been reflected in previous research. National College research (in Birney *et al*., 2011) identified a disparity between schools' perception of the importance of sustainability and what they were actually doing. This highlights the need to identify the barriers that are hindering schools from engaging with sustainability.

The SDP is a keystone document for schools as it is a '*statement of the educational philosophy of the school, its aims and how it proposes to achieve them'* (Department of Education and Science, 1999a, p. 8). The Irish policy document 'Education for Sustainability' (Department of Education and Skills, 2014a) recommended that all schools should reflect SD in their school plans from 2016. In this survey, the main references to sustainability in the SDP were in the form of Green School activities and specific building upgrades that schools intended to carry out. Hens *et al.* (2010b) identified that successful EMS implementation begins with the implementation of managerial instruments. The SDP is crucial in identifying priority areas for management and development and therefore if schools are to take sustainability seriously, actions and policies need to be reflected in this document. Birney *et al.* (2011) found that 'leading sustainable schools' (ie. schools that had embedded sustainability into all aspects of school life) included sustainable practices in their school improvement plan which added formality and legitimacy to their sustainability agenda giving a strategic focus to their efforts.

Teachers also require this legitimacy in ESD implementation and lack of a clear framework can lead to uncertainty (Madsen, 2013). A clear vision and mandate must be laid out for all sustainability work to allow leaders and teachers strategically incorporate ESD into all aspects of school life.

Energy.

Of the four areas surveyed, confidence was lowest in the area of energy management and this was the area where most principals sought support. Energy management could be viewed as technically more difficult than other EMS areas. Lourenço *et al.* (2014) found that school managers did not have concrete information about the schools' energy consumption patterns and were not knowledgeable about related issues such as CO_2 levels and indoor comfort. Indeed, the health of the indoor environment is highly important in schools and intrinsically linked to energy management. Katafygiotou and Serghides (2014b), in a study of secondary school buildings, found a relation between poor indoor quality and the low energy efficiency of building. Other research has shown that there can be more difficulty with energy as opposed to other aspects of an EMS. Kadji-Beltran *et al.* (2013), when looking at sustainable schools, found less than half of participants monitored water or energy consumption while 'keeping schools tidy' was the most prevalent sustainable practice. Hens *et al.* (2010b) found that integrating environmental aspects into school management positively correlated with the schools performance in waste and water but not with energy. This perceived difficulty with energy management could be alleviated if principals had professional relationships with experts in this area. The proposed partnership in this study will promote such relationships.

There was also a discrepancy between confidence in energy management and 'what was being done' (Birney *et al.*, 2011) with 40% stating that they were confident in managing the energy demands of the school but only 17% stating they had an energy policy and 21% agreeing that they read and record the meter regularly. Energy policies are important documents to aid communicating energy protocol and practices (AlFaris *et al.*, 2016) and organizations that have energy policies outperform those without (Lane *et al.*, 2014). This survey would suggest that the importance of an energy policy has been overlooked in Irish primary schools. As electricity usage has been shown to be on the rise in schools (Lourenço *et al.*, 2014), energy management remains a pressing issue and will be addressed as an aspect of this project. A substantial body of literature exists on this topic, but much needs to be done to offset the many challenges.

Water.

Confidence in water management was not much higher than that of energy management with only 44% saying they agreed or strongly agreed that they were confident the school's water was managed effectively. Although the confidence levels are similar to energy management, less principals said they required support in water management (54%) in comparison to energy management (79%). Also, 31% stated 'don't know' which is the highest level of uncertainty demonstrated across the four areas in relation to confidence. This is interesting as it possibly suggests that principals are acknowledging that they do not know what exactly effective water management entails. This could be related to aspects of hygiene and ensuring adequate, safe water supply. One principal commented as follows,

> *'Water management is very problematic because of importance of toilets and hygiene. Not prepared to skimp on this.'* (19:P)

Here there is a perceived conflict between sustainable water management and hygiene and sanitation issues. Presumably, this principal views 'using less water' as sustainable management which then causes a problem as it raises hygiene issues. Much of the extant literature on water management in schools covers issues of sanitation and access to drinking water. Both of these are critical aspects of water management but have yet to be looked at within a sustainable approach. Understanding water management as a holistic approach, covering conservation, adequate supply, sanitation, etc. will need to be addressed if school managers are to be confident in managing this area.

In the spaces provided for 'any other comments' on the questionnaires, seven schools referred to water conservation measures carried out on the school premises such as the instillation of 'water hippos' (bags that displace water in the toilet cistern) or upgrading plumbing systems. Out of these seven, four wrote about problems that arose following these upgrades. Three principals specifically mentioned the 'hippo bags' and that they caused '*major difficulties*' and had to be removed. Another deputy principal referred to push buttons that were installed on toilets to conserve water but *'proved pricey and ineffective'*. The same respondent also said that sensors installed on urinals *'also caused problems'*. Although the sample here is somewhat small (n=46), it still draws attention to current problems in practice with regards to sustainable management in schools – who made the decision to install these devices and on who's advice? How were they paid for? Was there a guarantee and who is responsible for ensuring their efficiency and value for money? There was a Water Conservation Scheme in 2010 to *'enhance water conservation in existing school buildings by carrying out specific works'* (Department of Education and Skills, 2014b, p. 22). In this presentation to the Joint Oireachtas Committee on Education and Social Protection, the department stated that '*these measures improved water conservation and reduced costs in use for schools'* (p22). How this improvement and cost reduction was calculated is not stated and if the above four examples were financed under this scheme, questions are certainly raised as to its effectiveness and value.

Sustainable water management in schools is almost an unaddressed issue in the literature and as there are many difficulties for school leaders in relation to this topic, it will be addressed within this project.

Waste.

Confidence was at its highest in the area of waste management and the least amount of support was sought in this area. Waste management has been a focus in Ireland for a number of decades with the first key national document 'Changing our Ways' published in 1998 and many anti-litter campaigns run in schools during the 1980s and 90s. An overwhelming 98% of respondents agreed or strongly agreed that waste generated by the school is sorted into the correct bins. Waste separation is an inexpensive and direct approach to applying principles crucial to SD (Samuelsson and Kaga, 2008). As waste is the first theme of the Green Flag programme it is one of the first actions taken by schools on their Green School journey. However, empirical evidence is limited in this area, with the only research in Ireland dated at 2001 (O'Mahony and Fitzgerald, 2001). While this research showed a significant waste to landfill reduction (discussed in section 2.4.2), there is no published data since that date and so it is uncertain as to whether these high reduction levels have since decreased as has been shown in relation to other sustainability initiatives (eg. Lewis 2013 discussed in section 2.2.3). Green School co-ordinators collect data when visiting schools and assessing them for the flag, but following emails to Green Schools Ireland, we have been unsuccessful in receiving further information in regard to this data as no response was received.

How principals view waste management and their beliefs on what it entails would provide more insights into this area. For example, if waste management is viewed primarily as waste separation and recycling, then the high confidence levels can be accounted for. However, if waste management is viewed as a broader management of all physical resources from cradle to grave, then we once again have disparity in principals' confidence and what they are actually doing in practice. If we look at the waste hierarchy, we see that recycling is preceded by re-use and prevention. Prevention and minimisation must be to the fore of waste policy (Department of the Environment Community and Local Government, 2012) and this must be reflected in schools' waste practices, both for waste management itself and for examples set by the school for its pupils and wider community. One example of reuse that schools could undertake as an active example of ESD is composting. In this survey, just over half of respondents agreed that they compost on site. A crosstabulation of *confidence in waste management* with *composting on site* (Table 4.1) shows interesting contrasts in this data. Twenty of the thirty-four respondents who agreed or strongly agreed that they are confident in waste management do not compost at their schools. Notably, five of the six respondents who disagreed or strongly disagreed with the statement on confidence in waste management do compost on the school site. This shows significant discrepancies between a school's confidence in their waste management strategy and actual waste management actions.

I am confident that our school's waste is managed effectively * Organic waste produced by the school is composted on the school premises Crosstabulation

		Organic waste produced by the school is composted on the school premises					
		Strongly disagree	Disagree	Don't know	Agree	Strongly agree	Total
I am confident that our school's waste is managed effectively	Strongly disagree	0	0	0	2	0	2
	Disagree	0	1	0	3	0	4
	Don't know	1	0	1	4	1	7
	Agree	6	9	0	8	4	27
	Strongly agree	2	3	0	1	1	7
Total		9	13	1	18	6	47

*Table 4.1 I am confident that our school's waste is managed effectively * Organic waste produced by the school is composted on the school premises Crosstabulation*

However, 50% engaging in composting activities would appear high in comparison to research carried out elsewhere. It was found that only 18.9% of schools in a Turkish study composted their organic waste (Kayihan and Tonuk, 2012). This issue of managing organic waste was identified as an area needing immediate attention in A Resource Opportunity (Department of the Environment Community and Local Government, 2012) and the use of the 'brown bin' (bin collection for organic waste) has been on the increase around the country. However, using such a service results in missing meaningful ESD opportunities in schools. Two principals referred specifically to composting activities in their comments on the questionnaires. One stated that their school engaged in composting when they were working on the Green Flag for waste but have since stopped. The other, who ticked 'strongly disagree' with regards to composting on the school site, wrote

> '*Not enough effective monitoring (during the summer months?). Needs various materials – brown, green layers to add to pile, aerated and moisture added. Lots of effort needed to monitor effectively'.* (46:P)

This principal has knowledge about composting, but other barriers have come into play such as time and manpower.

Another area that principals may not have linked to waste management is GPP. Only 23% of respondents indicated that GPP is taken into account when purchasing school resources. GPP is considered a core strand in driving sustainability and resource efficiency (EPA, 2014) and needs to be considered in any waste management strategy. Considering new purchases as part of waste management is a systems approach to sustainability, connecting various factors together as part of the greater 'whole'. Systems thinking has been identified as a key skill that must be developed in sustainability leaders (Shriberg and MacDonald, 2010), and this survey has identified a number of potential areas that are not being connected by principals in terms of sustainability management.

Although there are a number of investigations into waste practices in schools, and principals in this survey have indicated high confidence levels in waste management, it appears that there is a disconnect between various aspects of waste management and the overall approach. There is scope to enable school leaders to address the higher levels of the waste management hierarchy and to view waste as a resource and not something to be 'thrown away'.

School Grounds.

Principals alluded to high levels of confidence in grounds management with 65% of respondents stating that they agreed or strongly agreed that the school grounds are managed effectively and only 52% saying they require more support in this area. Once again there is some discrepancy in how confidence levels and perception of the grounds as sites for learning compare with the actions of creating areas for biodiversity such as plants for pollinators and planting indigenous trees and shrubs. And while confidence levels appear high, it must be noted that over a fifth of respondents indicating that they are not confident in how the grounds are managed is not insignificant.

73% of respondents agreed or strongly agreed that the school grounds are conducive to outdoor learning. Although 69% agreed that the majority of plant life on site was native, only 33% stated that they had an area for attracting pollinators and 50% agreed that they composted on site. This raises the question of how school leaders interpret outdoor learning. Studies have shown outdoor education tends to be focused on physical education or science (Dyment, 2005). If principals' equate outdoor learning with PE, for example, then the above agreement with school grounds being conducive to outdoor learning makes sense. However, if outdoor education is understood in a broader sense, as both place and content for cross-curricular learning, then once again we see a discrepancy between beliefs and actions.

School grounds should include spaces adaptable to many types of activities (Wagner, 2000) and while it is very important to have spaces suitable for physical activity, it is also important to have spaces that will adapt to taking other subjects outdoors, enable the development of other skills and allow children to enjoy the natural environment. Experiential learning in the outdoors is a central part of ESD (Hill, 2013) and school grounds need to be suited to this kind of education. Without activities such as composting or planting pollinator-friendly plants, meaningful possibilities for ESD are missed including physical engagement with the natural environment and opportunities for skills development such as observation, recording, predicting and questioning. Biodiversity conservation is also a critical element of SD (Bullock *et al.*, 2008) and as such, should be addressed through a school's ESD programme. School grounds can provide a means of protecting biodiversity through education, awareness and habitat generation and protection.

While confidence appears relatively high in sustainable grounds management and there is an abundance of literature on this area over the last few decades, it will remain in this project as part of the EMS. In particular, the area of biodiversity will be focused on as it is such a critical issue of SD and therefore an important tenet of ESD.

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The four areas of energy, water, waste and school grounds were identified in the literature as key aspects of an EMS and each provide a meaningful avenue for experiential, place based ESD. Further investigation into each area via this survey showed that sustainable management of each area is viewed as important but that this is not necessarily reflected in practice. Furthermore, as resource management was listed as least important of the seven key accountabilities of the principle, but as quite a difficult aspect to their duties, there is a clear need to support school leaders in this area.

4.2.2 Education for Sustainable Development.

Education for Sustainable Development is still in an emergent phase, and it was felt that as a concept, it has yet to find a foothold in Irish primary schools. Although the Green Schools programme is prolific in Ireland, it appears focused on immediate environmental issues and disconnected from a broader interpretation of ESD. Generally, the Green Schools programme was viewed favourably by the respondents but approximately 20% did not view it is as a valuable initiative or feel it was being implemented effectively in their school. Throughout the surveys, ten schools made reference to the Green Schools programme in their written comments. Some view it very positively –

> '*We are working towards our 7th Green Flag – Global Citizenship and Energy. The Green Flag initiative has kept 'sustainability' issues to the forefront for staff and pupils over the past decade – a great scheme*.' (02:P)

In this instance we have a school that has progressed significantly through the programme (most schools in this survey referred only to the first three or four flags). These later flags are more embedded in ESD and have a global as well as a local focus. For a school to be working towards their 7th flag, it suggests a dedicated staff or at least a single member of staff who is championing the cause. Others referred to the programme positively, but with more of a focus on it's potential.

> '*Green schools' initiative has certainly made schools more green 'savy'. However, the time and work entailed is quite significant – although curriculum links can be made it needs a dedicated team/teacher to continue to drive the various initiatives…'* (30:P)

> *'Green schools has the potential to be an effective tool in schools but it is very difficult to implement fully and monitor due to staff shortages (B-posts) and time.'* (46:P)

Once again, there is reference to the barriers of time and staffing. Following the down-turn in the economy in Ireland in 2007, numerous cost-cutting measures were placed on schools. One was the moratorium on new B-posts – posts of responsibility whereby teachers took on a position of middle management and held responsibility for certain curricular, pastoral and managerial areas. Therefore, if a staff member with a B-post took leave or retired, they were not replaced. As very often more senior members of staff held these positions, retirements seriously affected the middle management structures of schools. While a number of respondents made specific reference to staffing barriers, two specifically mentioned the issue of B-posts as an example of staff shortages.

Another issue that arose was that of continuation of each theme. Flags are achieved on a two-year basis and each is focused on one theme. However, two principals alluded to the fact that while a flag may have been achieved, it does not necessarily mean the work is continuing.

> '*Green schools has definitely highlighted 'green management' but I find we have great focus when we're working on a flag but the good habits are lost the following year. The flag becomes a symbol of what <u>was</u> done. It is too time consuming to concentrate on more than one area at any given time.'* (17:P)

This echoes the return to 'siloed' thinking that Lewis (2013) discusses with regards to the AuSSI programme in Australia whereby whole system thinking was encouraged through participation in the programme but student understanding shifted back to a siloed approach after three years and teachers' perceptions of sustainability reflected similar shifts. As well-known sustainability leader David Dixon puts it

> *'… it is easy to have tokenism… you can have a Green Flag school but it may not be a particularly sustainable school'* (as cited in Bottery *et al.*, 2012, p. 233).

Given the significance of EE and ESD, the effectiveness of eco schools programmes is of great importance (Pauw and Petegem, 2013). The Green School programme is undoubtedly an important initiative in Irish primary schools and this is reflected in the number of times it is referenced in the School Development Plan, but the examples above highlight the need for investigation into the actual impact and influence of the Green Schools programme in Ireland.

A high number of schools -76.6%, did not have ESD referred to in the school plan. This is interesting for a number of reasons. Firstly, all schools were participating in the Green Flag initiative and many principals mentioned Green Flag activities when referring to 'green' upgrades in the SDP. However, schools did not make a similar link with regards to ESD. This would intimate that schools view the Green Flag programme as a management tool but not an avenue for exploring ESD. Kanyimba *et al.* (2014) found in a literature review regarding EMSs in schools, that they were used as management tools. Connecting this managerial aspect to curricular ESD therefore, needs to be facilitated and is an area that requires attention. Another interpretation of this low result for ESD in the School Plan could be principals' limited understanding of the term Education for Sustainable Development. As previously mentioned, it is a relatively young concept and therefore possibly not fully understood by practitioners. It is likely that many ESD activities are documented in the school plan but ESD as a specific construct is not addressed.

Another surprising finding in relation to ESD was the number of principals who stated that they would like further support in the area and in particular the number that would like to outsource that support. Thirty respondents said they would like more support in ESD which is more than that requested in the areas of waste, water or grounds management. Furthermore, eight said they would like to outsource this area. While this is very low in comparison with the other areas, it is still surprising that this many principals would like to outsource something that should be so central to the curriculum. Again, this could be a lack of understanding or misinterpretation of the term. Or it could be that principals view ESD as another 'fad' or another initiative that is being placed on schools to roll out. Birney *et al.* (2011) in their study on sustainable schools in the UK, noted that many of the school leaders reported feeling overwhelmed by the volume of government initiatives that they were expected to implement. Or as a principal in this survey put it – *'Curriculum overload!! (Apologies Mother Earth)'* (24:P).

If principals can be facilitated to understand and embed ESD as an approach to school management and curriculum, then it will have a much higher chance of success. As these respondents view sustainability as important and rank *Teaching and Learning* as a key driver of sustainability initiatives, their attitudes towards ESD do not make sense. There is a disconnection between ESD and sustainable management and this will be explored as part of this research.

4.2.3 Drivers and barriers.

The key drivers for undertaking sustainability initiatives in a school as identified by this survey were financial. Finance was a key driver in the industry literature and lack of finance was often cited as a barrier in the education literature (Hens *et al.,* 2010a; Kanyimba *et al.,* 2014). The availability of grants was a top driver but this was not always looked upon favourably.

> *'We have taken on upgrades that were supported by grants in the past, like the 'hippo bags' for water saving but they caused us huge problems and had to be removed'.* (09:P)

Government support, in the form of grants, is very important and shows commitment by government to push the sustainability agenda and reduce CO_2 emissions and related carbon footprint. But perhaps how these grants are administered needs more consideration. The Summer Works Scheme (SWS), referred to by three of the schools in this survey, is a form of devolved funding to schools to undertake minor works during the summer holidays. As the BOM and principal have to identify the works to be carried out and oversee the project, questions arise as to the expertise or qualifications required to oversee such building upgrades. As one principal wrote –

> '*Principals are expected to have the time, energy and expertise to manage infrastructural improvements- an impossible task, which also tends to 'gobble up' summer holidays. My worry is that it distracts me from my core duties which to me are leading, teaching and learning and human resource management'*. (28:P)

Saving money was another key driver for primary school leaders in this survey.

> *'As a teaching principal, the demands on my time are huge. Anything to do with saving energy needs to have a financial benefit for me to implement something that usually demands more paperwork'.* (29:P)

For schools, who are often on restricted budgets, this is an understandable outcome and has been reflected in literature. Lane *et al.* (2014) identified saving money as a main reason for engaging in energy saving initiatives in three school districts in Wisconsin and Lourenço *et al.* (2014) also identified economic factors as the greatest driver in addressing increased energy consumption in Portuguese schools. Therefore, to encourage school leaders to engage in sustainability initiatives, financial incentives are advantageous.

Following finance, *teaching and learning opportunities* was the next most influential driver. This is an interesting driver as presumably it is unique to this sector. Thirty-six respondents ranked *teaching and learning opportunities* as a driver with ten of these stating it was their top driver. Using the school building and grounds as a teaching tool is an effective means of harnessing strategies for ESD such as systems thinking and experiential learning (see section 2.1.2) and has been potentially identified by some school leaders as *teaching and learning opportunities* was viewed so strongly as a driver. This is an interesting contrast to the responses on ESD whereby it is not referred to in key school documents and a number of principals would like to outsource its implementation. This indicates a lack of connection between educational opportunities in the environment and ESD as a curricular component and is indicative of the lack of CPD in this area as highlighted in the literature review.

Public awareness is an issue that was identified in the literature as in need of immediate action, particularly in the area of biodiversity. Other sectors, such as industry, have opportunities to show case their sustainability initiatives in order to improve public awareness but the driver for such advertising is usually to improve a company's image. *School image* was not noted as a significant driver in this study. However, it has been shown to have some impact in the wider context as often schools choose to engage in very 'visible' signs of sustainability such as improving the school grounds and reducing litter (Kadji-Beltran *et al.*, 2013; Pirrie *et al.*, 2006). Similarly, *environmental* drivers were not ranked highly by this survey. Eighteen respondents did not rank this as a driver, and of the thirty who did rank it, the other drivers were more influential. In the industry literature, the environmental attitudes of managers were found to impact the success of the EMS (Martín-Peña *et al.*, 2014) but this has not been explored in the education literature. Indeed, the only reference to environment as a driver found in this literature review was in a study by Kaza *et al.* (2015) on developing sustainability leadership in third level professional faculty whereby only one participant pointed directly to environmental concern as motivation. Lack of environmental concern among school staff could be an issue when it is an aim of ESD and EE to develop environmental awareness and values. The impact of teachers' environmental attitudes on these objectives also requires further investigation.

Another driver investigated in this survey was *Regulations and Legislation*, and it resulted in a mixed response with 16 respondents placing it in their top three drivers and 14 respondents saying it is not a driver. In the industry literature, *Regulations and Legislation* also received mixed views. Renukappa *et al.* (2013) found government regulation and legislation to play a key role in both environmental and social sustainability in the UK industrial sector but Colicchia *et al.* (2013) found that while it was an important driver, it is simultaneously viewed as a barrier as heterogeneity in and among countries makes adopting environmental initiatives difficult. Principals' additional comments on this survey also intimated that legislation and regulations can be viewed as a barrier rather than a driver,

> *'It is very frustrating and disheartening trying to implement sustainability without proper government support and the obstacles of overwhelming legislative and regulatory bureaucracy'*. (07:D)

The final driver listed on this questionnaire was *Expertise on Staff or BOM.* This received a response very similar to *Regulations and Legislation* with 15 placing it in their top three drivers and 18 not ranking it as a driver. This need to tap into external expertise to support sustainability was identified in the literature, but harnessing internal expertise at both staff and board level is also important. Less than half of respondents agreed that sustainability issues get regular attention at BOM meetings on the Likert scale (section 4.1.1) and therefore it is not surprising that many do not look in this direction for expertise. Some principals referred to this issue directly,

> *'I don't have the knowledge on staff or board to manage the building correctly'* (09:P)

while others referred to further challenges that impede the boards' work, '*The BOM is well aware of the benefits of insulation, new windows, lighting, heating, etc. but our funding does not cover day-to-day expenses so funding is a big issue.'* (07:P)

'Staff and Board members are stretched time wise as it is, so sustainability management tends to be an aspiration.' (10:D)

A key theme in the industry literature was that of drivers, but this has not been explored in relation to the education sector. Drivers that were identified in the education literature were incidental and not the focus of a research question. Barriers were often referred to in the education literature, particularly in discussions on challenging aspects of both EMS and ESD. While school leaders were not asked about barriers to sustainability management in this questionnaire, a number were identified through the written comments on returned surveys. Time was cited most often as a barrier in this survey, followed by a lack of knowledge, finance and staffing issues. Time was cited as a barrier to EMS implementation in both the industry literature (Martín-Peña *et al.*, 2014) and the education literature (Kanyimba *et al.*, 2014). Although not asked about barriers in this survey, thirteen principals cited time as a barrier in their extra comments. Principals commented on having to work through the holidays as well as increased work during term-time.

'*Insulation upgrade carried out – Principal worked through holidays and increased workload during term time*.' (19:P)

'*Principals are expected to have the time, energy and expertise to manage infrastructural improvements – an impossible task, which also tends to 'gobble up' summer holidays'*. (28:P)

Time was also viewed as a barrier to implementing the Green Schools programme.

'*… The flag becomes a symbol of what <u>was</u> done. It is too time consuming to concentrate on more than one area at any given time*.' (17:P)

'*Green schools' initiative has certainly made schools more green 'savy'. However, the time and work entailed is quite significant*…' (30:P)

The issue of staff shortages was very much connected to the time barrier, including the lack of B-posts.

'*Green schools has the potential to be an effective tool in schools but it is very difficult to implement fully and monitor due to staff shortages (B-posts) and time*'. (46:P)

'*Time is a huge factor in trying to manage sustainability of school energy and environmental management systems. The reduction in the number of post-holders in our school has made it extremely difficult to commit a teacher to cover the Green Flag initiative*.' (37:P)

And a significant issue in relation to time and staff barriers was the position of the teaching principal.

'*Teaching principals simply cannot manage doing both roles effectively*'. (08:P).

'*There is a huge workload of duties on the teaching principal. Each year the workload is being increased at a huge rate with new procedures and initiatives* …' (26:P)

As both roles are 'class teaching' and 'administrative duties of the principal', then it can be assumed that many principals will prioritise their duty to their classroom pupils. It is clear from this survey that sustainable management of the building and grounds is particularly difficult for the teaching principal.

A lack of knowledge or expertise and finance were the other two barriers as identified in this survey. Hens *et al.* (2010a) in their research into EMS in primary schools in South Africa found that cost-intensive projects were less successful than more inexpensive activities. In this survey, numerous references were made to building upgrades and other measures that include high, up-front costs. These included water conservation measures such as push taps and urinal sensors (01:P, 09:P, 19:P, 25:P, 28:P), window replacement (07:P, 11:P, 25:P) and insulation (09:P, 19:P, 25:P, 28:P). However, some of these measures were unsuccessful as previously discussed in relation to the 'hippo bags'. Many respondents mentioned upgrades or initiatives that they would like to undertake but cannot due to lack of finance.

'*We plan to insulate the building as soon as funding allows*'. (07:P)

'*At a huge expense to our school, we recently replaced the majority of our school windows, necessitating our BOM availing of a huge loan to undertake same. Our 1964 building would greatly benefit from modern insulation and an electrical and plumbing upgrade should finances be made available*…' (07:D)

> '*Lack of funding and resources in primary schools means that schools are prioritising 'surviving'! Constant fundraising by parents to manage day-to-day running costs means we do not have the resources to make huge changes re 'green' refurbishments…*' (27:D)

The lack of knowledge or expertise was cited as a barrier in the extra comments but was also highlighted in answers such as filling in the BER or the high level of '*don't know'* responses on the Likert scale when specific regulations were referred to (for example, confidence in water management). Kanyimba *et al.* (2014) also identified a lack of skills as a barrier to EMS implementation in South African primary schools, while others identified lack of knowledge as a barrier to ESD (Madsen, 2013).

Identifying and understanding the drivers and barriers to sustainability initiatives in schools will assist in the development of the partnership model and in identifying the best ways to proceed with both EMS and ESD in the case study phase.

4.2.4 Leadership roles in the primary school.

The importance of leadership.

The role of the principal has been studied in depth including its effect on whole school behaviour (De Nobile *et al.*, 2016), student achievement (Kythreotis *et al.*, 2010; Pashiardis *et al.*, 2011; Robinson *et al.*, 2008), classroom practice (Leithwood and Jantzi, 2006) and teacher efficacy (Ross and Gray, 2006). Leadership is a vital ingredient for sustainability work (Burns, 2016) and there is now a new wave of literature investigating sustainability leadership across sectors and the role of the principal in sustainable schools. Key attributes of sustainability leaders include empowerment (Burns, 2016; Carr, 2016; Pepper, 2014), systems thinking (Burns, 2016; Shriberg and MacDonald, 2010), effective communication (Shriberg and MacDonald, 2010) and the ability to establish a shared vision (Kadji-Beltran *et al.*, 2013). In other words, a very specialist skill set is required to be an effective leader for sustainability. This survey identified a lack of knowledge as a significant barrier to sustainability management and as the literature documented a lack of CPD for principals in this area, herein lies a significant gap. Principals in this survey revealed their interest in sustainability issues and there is now a crucial need to support them in managing this area effectively. The key attributes listed above were not easily identifiable in the returned surveys. Indeed, it can be inferred from responses that many principals struggle with these skills. Empowering staff and the wider community to engage in a shared vision of sustainability requires the ability to communicate effectively with strong interpersonal abilities. In this survey, both *human resource management* and *external relationships* were cited as being among the most difficult of a principal's duties while many principals stated difficulties in getting staff to commit to the Green Schools programme. Another key skill, systems thinking, also appears to be underdeveloped as there were many discrepancies noted in answers including a disconnect between Green Schools and ESD, between GPP and waste management, between suitability of school grounds for learning and actions taken in grounds development and confidence in waste management and the rate of composting. A siloed approach to management is not in keeping with sustainability and is ineffective in a modern age when now more than ever, interconnectedness is crucial. Industry has had to adapt to these changes in order to remain competitive in a global economy and B+L is an example of a company who approaches FM from a systems thinking perspective. Systems thinking is a skill and can be taught and will be targeted as part of the partnership approach developed in this research. The principal's role in developing sustainable schools as learning organizations and growing systems is fundamental (Zachariou *et al.*, 2013) and this survey highlights the support required in undertaking such work. Higher education can and should play a significant role in developing sustainability leaders (Burns, 2016) and it is hoped that an outcome of this research will be feedback into CPD courses provided in the School of Education for school leaders.

Shared Leadership.

Leadership for sustainability is a shared leadership. Pepper (2014) investigated sustainability leadership in eight schools participating in AuSSI in Western Australia and found that while only three of the participants were school principals, all held the belief that the responsibility for leading sustainability must be shared among colleagues and the community. This is in contrast to a number of respondents in this survey whereby lack of paid management positions, such as B-posts, was cited as a difficulty in running the Green Schools programme. Undoubtedly teachers and school staff are stretched in implementing the national curriculum alongside many other initiatives, but managing a school sustainably should be viewed as an effective means of school management- both curriculum and administration. This survey identified a number of difficulties facing school leaders in their attempt to sustainably manage schools, including issues of time, lack of finance, staffing issues and lack of expertise. A number of these difficulties could be alleviated through a shared leadership approach.

Results from this survey suggest that teaching principals feel the aforementioned difficulties more acutely. Teaching principals were less likely to agree with the statement *'Sustainable management of the school building and grounds is an area of high priority*' with 52% of teaching principals either agreeing or strongly agreeing with this statement as opposed to 80% of administrative principals. Schools with administrative principals were much more likely to compost organic waste (80% of administrative principals vs. 44.5% of teaching principals) although teaching principals were more likely to agree with the statement '*The school grounds are conducive to outdoor learning*' (89.5% of teaching principals vs. 58% of administrative principals) possibly due to the more urban environment of larger schools. In the overall comments, thirteen respondents referred to time as a barrier – six administrative principals, six teaching principals and one deputy principal. Of the six administrative principals, three connected the time difficulty with a lack of staff and of the six teaching principals, four related the time difficulty with the role of teaching as a principal. Time as a barrier was often related to staffing issues, viewed from the perspective of the principal. It is unfortunate that so few deputy principals responded to the survey as this is a high leadership position in a school and it would be interesting to note what areas of management they are taking responsibility for. It would also be insightful to understand the low response rate from this cohort. If principals distributed the questionnaire to their deputies and the deputy principals chose not to respond, this could be due to lack of time, lack of knowledge or indifference. However, if principals chose not to give a questionnaire to their deputies, this could be because of the principal's perception of lack of involvement in this area by the deputy principal. It could also be due to the principal's awareness of the time restraints and workload on the deputy principal. Unfortunately, we cannot determine the level of involvement of deputy principals in this area of sustainability management.

A further area requiring exploration in this concept of shared leadership is the role of the BOM. Lane *et al.* (2014) when investigating energy management in Wisconsin schools found that administrative support, especially from the school board, was one of the strongest facilitating factors. A first step in harnessing this support from the board is to inform them of ongoing work in this area, but only 51% of respondents agreed or strongly agreed that sustainable management received regular attention at BOM meetings. Potentially, there may be relevant knowledge or expertise among board members and although not ranked very highly, 30 respondents did rank '*expertise on staff/BOM*' as a driver of sustainability initiatives at some level, indicating that this is being realised to some extent.

Developing relationships.

External relationships was identified as a key accountability of the principal by Drea and O' Brien (2003) and has been noted as a significant challenge for school leaders in both the wider literature and this survey. Cultivating and maintaining external relationships within the wider community is a core facet of a sustainable school and requires skill, time and understanding. Pirrie *et al.* (2006) identified involving the wider community as the most challenging area for Eco Schools in Scotland and this has been reflected in this survey. A significant 20 respondents placed *external relationships* as their most difficult duty. These relationships could range from parents to community groups but are all essential for an effective sustainable school. As teachers have expressed the need to connect to external expertise to support ESD and community partnerships have been shown to support schools in pursuing sustainability (Green and Somerville, 2015), principals must be supported in developing the skills required to cultivate such relationships. Furthermore, *human resource management* was cited as being just as difficult by respondents of this survey. A whole school approach to sustainability (as discussed in section 2.1.3) demands shared leadership (Kadji-Beltran *et al.*, 2013). Sustainable school leadership should be an empowering process whereby all teachers become leaders, either within their own classrooms or in roles within the wider school community. Principals themselves need to be empowered to be change agents within their school community and engaging with both principals from other schools and academic and industrial professionals who are interested in sustainability will help create a space whereby principals can develop confidence as sustainability leaders.

4.3 Summary.

The aim of this questionnaire was to analyse current trends and issues in sustainability in primary schools in and around Co. Waterford. The following are the main findings from the survey;

- Confidence in managing the energy and water demands of schools is much lower than confidence in managing the school's waste or the school grounds.
- The highest levels of confidence were expressed in the area of waste management at a significant 72.9%.

- The highest level of uncertainty in regards to confidence was noted in water management with 31.9% ticking 'don't know'.
- An energy policy is generally overlooked as an aspect of energy management.
- Only 7.5% of respondents acknowledged having ESD referred to in the School Plan.
- Approximately 73% of respondents agree or strongly agree that the Green Schools Programme is a valuable initiative in their school and that it is being implemented effectively.
- *Leadership* and *Teaching and Learning* were identified as being the most important of the seven key accountabilities of the principal.
- *Human Resource Management* and *External Relationships* were identified as being the most difficult of the seven key accountabilities of the principal.
- *Finance*, followed by *Teaching and Learning* were identified as the key drivers for implementing sustainability initiatives in primary schools.
- *Time* was noted as a significant barrier to implementing sustainability initiatives.

These key findings help to develop a 'big picture' of the current state of sustainability in primary schools in and around Co. Waterford, but upon deeper scrutiny of the data, many discrepancies were noted. Table 4.2 identifies the main disparities highlighted in the data.

Finding A	**Finding B**	**Disparity**
• 70% agreed or strongly agreed that sustainability management is important.	• 40% say that sustainable refurbishments are in the SDP. • 45% say that sustainability issues receive regular attention at BOM meetings.	• School leaders are identifying sustainable management of building and grounds as important, but significantly fewer are taking action such as raising issues at board level.
• 40% expressed confidence that they were managing the energy demands of their school effectively and in line with Department guidelines.	• 21% read and record the meter monthly. • 17% have an energy policy • 12% know the BER rating of their school.	• Although confidence in energy management is quite low at 40%, significantly less take specific action on energy management (such as reading the meter or implementing an energy policy) or comply with guidelines such as displaying the BER certificate in the school.
• 73% stated they were confident in managing the waste produced by the school.	• 23% say GPP is taken into consideration for new purchases.	• While confidence in waste management is very strong compared to other areas, it appears to be linked to the sorting of waste materials (i.e.

	• 51% compost organic matter produced by the school on site.	recycling) rather than the higher levels of the waste hierarchy.
• 75% agreed or strongly agreed that the school grounds are conducive to learning.	• 51% compost on site. • 69% agree or strongly agree that the majority of trees/plants on site are indigenous. • 34% agree or strongly agree that there are areas for attracting pollinators on site.	• A significant number of principals believe that the grounds are conducive to outdoor learning, but the question is raised as to what subjects came to mind as this question was answered. With significantly less composting or planting pollinator friendly plants, effective outdoor learning opportunities are being missed.
• 72% agreed or strongly agreed that the Green School programme was being effectively implemented in their school.	• 17% have an energy policy. • 21% read and record the electricity meter monthly. • 7 out of the 24 schools that have water meters read and record them monthly. • 51% compost on site. • 34% have pollinator friendly plants on site.	• While the majority of respondents believe the Green School programme is being effectively implemented in their school, many of the required actions of the various flags of the programme are not being carried out – or at least not on a continuous basis. A small number of respondents mentioned carrying out actions when they were working towards a specific flag but discontinuing the action when the flag was achieved.

Table 4.2 Disparities identified in survey questionnaires.

While the data set is relatively small, the sampling was purposive and there are trends highlighted that could be transferable to other counties in Ireland. For example, a high cohort of respondents indicated that managing external relationships is one of their most difficult duties and this has also been reflected in the wider literature. Therefore, it is likely that a purposive sample of principals and deputy principals from another county in Ireland would reveal similar results. However, the geographical focus for this research is Co. Waterford and the analysis of these questionnaires gives a strong overview of sustainability in primary schools in this area. Furthermore, following the distribution of the questionnaires, a number of schools made contact with queries or seeking advice and one school in particular was keen to establish a connection and become part of the next phase of research. This in itself was been a positive outcome of this phase of the study.

The next phase of the study sought to implement the proposed partnership model with WIT, B+L and the participating primary schools. Within each of the four areas of the EMS identified in the literature – energy, water, waste and school grounds – challenging areas or areas of difficulty were identified in this survey and were focused on within the partnership model. Furthermore, as both internal and external relationships had been identified as an area of difficulty within leadership, these areas needed to be focused on and facilitated within the model. As key drivers for sustainability in schools were also identified, along with barriers such as time, it was possible to anticipate how these would come into play and plan accordingly.

The next stage of this work looked at the conceptual framework within which the evaluative case study would take place.

5. Conceptual Framework.

Following the literature review and preliminary survey of primary school principals, a conceptual framework was devised that could potentially cater for the challenges highlighted and address the needs of primary schools in the field of sustainable management. Although the preliminary investigation targeted school leaders, it was decided that the next phase would involve all school teaching-staff. As sustainability leadership is distributed leadership and sustainable school practice would require input from a wider cohort of staff, it was decided that working with teachers and principals would be a suitable starting point and would also address the lack of CPD in this area as identified in the literature review.

In an attempt to address key challenges identified in both the literature review and the preliminary survey, such as lack of time, staffing barriers, financial barriers and lack of knowledge and expertise, it was important to create a framework within which principals and teachers could be supported and facilitated in their own practice. Therefore, workplace learning was an ideal starting point to cater for these issues and became the basis for the conceptual framework that was then developed.

5.1 Pragmatism.

The pragmatic paradigm, as discussed in Chapter 3, views knowledge building as active, experimental and social in nature (Peters, 1977 in Popa *et al.*, 2015). The model developed in this chapter focuses on teachers and principals actively engaging with their own practice within their school community. By focusing on teachers and principals, the EMS and ESD can be aligned, as management and pedagogy are dealt with simultaneously through workshops and EMS development and implementation. Furthermore, pragmatism emphasizes the importance of the socio-cultural in knowledge development and therefore aligns nicely with SD which is often locally attuned.

Another feature of pragmatic learning is that it involves '*learning through experience*' and '*acquaintance with a changing world*' (Dewey, 1938, pp. 19-20). Both of these concepts are highly relevant for ESD and EMS development. The model proposed in this chapter allows teachers and school leaders to engage directly with their own school environment to develop the relevant and necessary skills for EMS implementation while simultaneously creating the space for critical thinking to question the current narrative around issues such as recycling, and to consider and discuss alternatives.

A pragmatic approach, similar to a constructive approach, emphasizes a social component in the construction of knowledge. As ESD relies heavily on wider community connections, and as developing external relationships was identified as one of the most difficult duties of the principal, a framework that embraces these social elements will bring these types of relationships to the centre of the process. Indeed, for the past number of years, many constructivist theorists have been looking at pragmatism, and in particular the work of Dewey (e.g. Neubert, 2001; Reich, 2009). Within this constructivist perspective, meaning negotiation, knowledge appropriation and concept development are dependent, to some degree, on access to a more expert or knowledgeable 'other' (Smith, 2003). The conceptual model that follows allows for knowledge transfer across boundaries. This creates a pathway to the expertise that has been identified in both the literature and preliminary investigation as being lacking on school staff. By supporting school staff in their ESD/EMS endeavours through a HEI/industry partnership within a social learning framework, many of the challenges identified thus far can be alleviated to some degree (e.g. lack of time and expertise). Also, a social learning framework supports the exploration of issues such as shared leadership, developing relationships, CPD and community (as highlighted in Chapter 3).

5.1.1 Social Learning Theory.

Social Learning Theory focuses on the importance of the social context in which learning takes place. It is often viewed as the theory that married behavioural and cognitive approaches to learning in that it emphasizes observation and modelling as key components in learning as well as our ability to abstract, symbolize and anticipate outcomes (Gibson, 2004). Albert Bandura is the academic most associated with social learning theory. Bandura outlined a social learning theory with particular focus on '*the important roles played by vicarious, symbolic and self-regulatory processes*' (Bandura, 1971, p. 2). He developed this over the coming years and changed the term to social cognitive theory to reflect the cognitive nature of observational learning (Bandura, 1986, p. 3). In this social learning system, new patterns of behaviour can be acquired through either direct experience or by experiencing the behaviour of others (Bandura, 1971). As social beings within a social setting, teachers in schools learn from each other in their daily interactions.

Much social learning occurs on the basis of casual or studied observation of exemplary models (Bandura, 1971, p. 10). Consequently, ensuring access to these models becomes a point of importance. Individual teachers developing excellence in their practice will influence all members of the teaching staff and in particular the early, formative years of newly qualified teachers who may join a staff. In areas, such as EMS implementation, where expertise is lacking on the teaching staff, connecting with these exemplary models is more difficult and HEI's have the potential to facilitate these connections. The conceptual model (presented in section 5.3.3) aims to address this issue. Social learning theory focuses on the effect of social interaction on the learner's cognition. Social interaction exposes the learner to the opinions and experiences of others, thereby influencing their prior beliefs and understandings and facilitating their learning (Goel *et al.*, 2010). Due to the interdisciplinary nature of ESD, it will be beneficial to expose teachers to competencies outside of the education sector in order to influence their prior thinking on the subject and develop their capacities and confidence in engaging with ESD.

In his later work, Bandura focused on the concept of self-efficacy – the '*judgement of one's capability to accomplish a certain level of performance*' (Bandura, 1986, p. 391). Teachers' efficacy beliefs are crucial to enhancing student learning by influencing the effort teachers put into teaching, their readiness to embrace new teaching strategies and their capacity to persevere in the face of challenges (Bandura, 1997; Takahashi, 2011) all of which are pertinent to ESD. While teacher self-efficacy will vary in ESD depending on factors such as school ethos and CPD received, it is probable that it will generally be low in relation to EMS implementation as this is not an area teachers are trained in. This was highlighted in the preliminary investigation discussed in Chapter 4 whereby principals' confidence in energy management and water management in particular was low. Our perceptions of self-efficacy – how competent we believe we are likely to be in a given situation – influence the effectiveness of our interactions with our environment and with others (Lefrançois 1999 in Gibson, 2004). Therefore, it is important to work with teachers in order to improve self-efficacy in ESD and EMS implementation improving their interactions with both their environment and their colleagues and pupils.

Social learning theory is particularly relevant to this project as it takes into account the learning, the individuals and the environment in which they are operating (Gibson, 2004). 'Environment' not only refers to the very central elements of built and natural environments in this project, but also the wider socio-cultural context in which these teachers work.

Therefore, issues of national policy along with local community issues can be catered for within the framework.

5.1.2 Situated Learning Theory.

Dewey used the term ‘situation’ to encompass all that is involved in a transaction between a learner and their environment (Tiles, 1990, p. 64). Situated learning theory (SLT) is a social theory of learning that was developed by Lave and Wenger (1991) based on the works of Dewey, Vygotsky and others. Social learning theory posits that learning emerges from the interactions between individuals in a group (Bandura, 1986). In SLT, meaning is negotiated through practice in social situations and ‘learning’ is becoming a member of a given community, understanding its language and tools, and engaging in meaningful activity. These activities take place in authentic environments and cognitive processes have to be understood as embedded in and functions of these specific environments (Thornton Moore, 2004). Research has shown that for the brain to make meaningful connections, learning needs to be tied to physical, embodied experience (Merriam, 2008). There is a duality here in the context of this research – not only is it important for work place learning to be embedded situationally; context, culture and environment, but teachers’ understanding of the impact of the immediate built and natural environment on student learning in ESD must also be encompassed.

The ‘situatedness’ of SLT should be considered as more than the contextualisation of learning (Altomonte *et al.*, 2016). Situated learning centres on involvement in groups or communities that enable learners to engage with and eventually contribute to the generation of knowledge relevant to them (Cámara de la Fuente and Comas-Quinn, 2016). It is this focus on knowledge production rather than passive knowledge transmission that has the ability to engage ESD in schools as a social process of change. New approaches, tools and resources need to be developed for ESD, and engaging in the production of these artefacts reflects meaningful, situated practice and meaningful, experiential ESD.

In situated learning, what is learned is profoundly connected to the conditions in which it is learned (Brown and Duguid, 1991). From a pedagogical viewpoint this compliments a place-based approach to ESD as proposed in this study (harnessing the school built and natural environment). However, this connectedness to the learning situation has meant that issues of transfer have been cited as a challenge for SLT (Clancey, 1995; Bereiter 1997 in Jenlick, 2013). Transfer involves using aspects of what one has learned in alternative situations or contexts. It involves doing something that one has not been taught explicitly to do (Greeno, 2006). A claim of SLT is that knowledge does not transfer between contexts (Lave, 1988) but other research would suggest that transfer does occur but is dependent on a number of criteria. Anderson *et al.* (1996) argue that there are situations when transfer can occur depending on a number of factors - the similarity of the contexts or the material originally learned, the degree of practice in the original context, the number of symbolic components shared between the contexts and where attention is directed during learning or at transfer. Greeno (2006) argues that transfer requires conceptual agency on the learner's part, i.e. '*treating the concepts, methods and information of the domain as resources that can be adapted, evaluated, questioned and modified*' (p538). Therefore, learning opportunities need to be more than just learning new information or using a new piece of equipment. Learners must be enabled to develop a participatory identity with strong conceptual agency so that they can they have the confidence to go beyond what they have been taught (Greeno, 2006). By embedding this framework in both social and situated learning theories, teachers can develop their identity as learners within their domain, negotiate meaning as a social practice and develop conceptual agency through authentic learning experiences with experts from other fields. Communities of practice are part of a broader conceptual framework for understanding learning in its social dimensions (Wenger, 2010a) and embrace both social and situated learning theories.

5.2 Communities of Practice.

The concept of a Community of Practice (CoP) was born of the work on situated learning by Lave and Wenger (1991) and is a good place to start exploring a social discipline of learning (Wenger, 2010a). Originally, this concept focused on existing professional communities (Buysse *et al.*, 2003), but the concept has been evolving ever since. CoPs can vary in both name (e.g. learning community) and style in different organisations, but they share a basic structure consisting of a domain, a community and a practice (Wenger *et al.*, 2002). The domain is the shared understanding of the particular interest, the community creates the social fabric of learning and sense of belonging and the practice is the body of knowledge – experiences, stories, documents, ideas, tools, etc. – that the community develops, shares and maintains (Hizar Md Khuzaimah and Hassan, 2012; Wenger *et al.*, 2002). Today, CoPs are used to explain learning and knowledge creation across a number of organisational settings (Amin and Roberts, 2008) and numerous definitions exist in the literature. Generally, CoPs are '*self-organized groups of practitioners*' (Snyder and Wenger, 2010), who are '*informally bound together by shared expertise and passion for a joint enterprise*' (Wenger and Snyder, 2000) and '*learn to improve their practice by regular interaction*' (Borzillo *et al.*, 2011). It is likely that CoPs will continue to evolve as new challenges arise in our globalizing economy and communities and organizations adapt to engage with these challenges. Issues of sustainability are one such global challenge.

Today, CoPs are widespread in education (Wenger, 2010b), from teachers working together to improve education in their own school, to local principals meeting regularly to discuss effective management. But the framework of CoPs is particularly suited to principals and teachers who wish to engage in sustainable schools practice. Firstly, the extant literature on ESD has shown that it is often disconnected and championed by individual teachers and a CoP would create a knowledge space for these professionals to share knowledge and best practice (Borzillo *et al.*, 2011; Hizar Md Khuzaimah and Hassan, 2012). As there are numerous challenges facing ESD implementation, teachers are more likely to persevere if they are connecting with like-minded, supportive peers. Second, while participation in a CoP is usually voluntary, it can be encouraged by management (Dubé *et al.*, 2006) and this gives principals, who are interested in sustainable schools, an avenue to encourage participation by connecting with other, interested schools. Third, due to the ambiguous nature of sustainability, CoPs would allow teachers to engage with this concept in a professional, but informal setting. Research has shown that teachers experiencing a personal shift toward sustainability appears to be important (Kennelly *et al.*, 2012). CoPs create the space for meaning to be negotiated and practices to be developed (Lave and Wenger, 1991) and it is this type of social learning space that will allow teachers to develop their own conceptualisation of sustainability (Kennelly *et al.*, 2012) on a personal level, while simultaneously developing ESD materials, which has been shown to play an important role in fostering teachers' commitment toward sustainability (O' Brien 2010 in Mitchell *et al.*, 2014). Learning within CoPs has been portrayed as a social formation of a person alongside knowledge acquisition (Pyrko *et al.*, 2017), and so will enable teachers to engage with the concept of sustainability at a personal level and consider lifestyle choices and personal viewpoints within the wider social setting. Within such a pragmatic setting, knowledge and knower are not separated and learning is about becoming a certain person (Wenger, 2010a) – in this case a person who is developing an awareness and literacy with regards to sustainability. Fourth, research is now suggesting that teachers co-construct their efficacy beliefs (section 5.1.1) in shared practices and teacher engagement in social contexts may shape their efficacy beliefs (Takahashi, 2011). Finally, as CoPs are more recently being used as models of CPD for teachers (Hou, 2015), they are an ideal forum to engage teachers in developing their own practice in ESD. CoPs have created the platform for the next generation of new cultural forms and discourses (Niesz, 2010) and it is these types of learning spaces that are needed to embrace the disruptive pedagogies and institutional change required to start on the path to sustainable schools. Teachers' personal commitment and teaching purposes have been highlighted as important factors for ESD in a number of works (Stagell *et al.*, 2014) and educators need a forum in which they can reflect on their own practice and discuss their ESD experiences among peers. This does not mean that pupils are excluded from participating in sustainable schools practice, but rather that when problems/issues have been identified within the school community, the teaching staff have a forum in which to discuss, reflect and develop their own skills in order to facilitate and support pupils.

Principals and teachers engaging in CoPs to pursue sustainable schools offer many advantages, but, admittedly, it can only be a starting point. The transdisciplinary nature of sustainability will require more. Green and Somerville (2015) found that teachers needed to connect with expertise beyond school staff to engage in effective ESD. Lack of skills on staff has been cited as a barrier to effectively implementing EMS (Kanyimba *et al.*, 2014), and the skills deficit has also been cited as a difficulty in energy management (SEAI, 2015) and waste management (Ward *et al.*, 2014). In a study by Kadji-Beltran *et al.* (2013), principals reported lack of confidence in the administrative skills required for sustainable schools. As teachers and principals have received little CPD in ESD and have not been trained in FM, these are significant challenges. However, the benefit of a CoP approach is that it can be evolutionary (Snyder and Wenger, 2010). The knowledge and skills required to engage in sustainable school practice will require crossing the 'boundaries' of the CoP. Boundaries connect CoPs and offer new learning opportunities (Wenger, 2000). It is by crossing these boundaries that school staff will learn new skills and competences required for sustainable schools.

5.3 A partnership approach for sustainable schools.

Sustainable development requires movement beyond traditional boundaries and the creation of effective, cross-sectoral partnerships (UNESCO, 2016). Widespread, societal change is required to tackle issues of sustainability and education has been identified as crucial in this change. Therefore, it is of global interest to promote and develop sustainable schools. With the wide repertoire of skills and knowledge required to address both sustainability in general and the development of sustainable schools, innovative and effective partnerships are required. CoPs are suitable spaces for the development and sharing of knowledge and practices across divisions (Borzillo *et al.*, 2011) and partnerships are critical in enabling this knowledge translation (Cheek *et al.*, 2009). Although originally used to describe the sharing of knowledge within a profession, CoPs are continuously evolving and take many forms in the extant literature. They can be homogenous (composed of people from the same discipline) or heterogeneous (composed of people from different backgrounds). Wenger *et al.* (2002) argue that it is often easier to begin as a homogenous community and it is similarly argued here - CoPs consisting of principals and teachers, working together to develop sustainable schools, need to be established before the decision is made to connect with other disciplines. In this way, educators can explore the concept of ESD with peers, who are facing similar classroom challenges, and develop their collegial practice before extending the boundaries.

5.3.1 HEI and Industry.

Universities and third level institutions have an important role to play in the pursuit of SD (ULSF, 1990; UNCED, 1992). In particular, regional HEIs are expected to work closely with local communities in creating productive partnerships (Karatzoglou, 2013). There are a number of examples in the current literature, whereby HEIs worked with schools on ESD- or EMS-based projects. As discussed in Chapter 2, EMS were developed and employed in primary schools in South Africa with the assistance of universities (Hens *et al.*, 2010a). The role of the university was very influential in this instance and the authors cite the importance of universities taking the lead in this research area. Sewilam *et al.* (2014), investigated the introduction of ESD into Egyptian schools and found the school-university partnerships to be fundamental to the project's success. Outside ESD partnerships, HEIs often have many other links to community organizations. Schools of Education at third level institutions often create partnerships with local schools, for initial teacher training and work placement, and for research projects at Masters and Doctoral level. Similarly, Schools of Science and Engineering create links with industry for both undergraduate work placements and postgraduate research programmes. HEIs can enter into communities with a view to integrating research and practice and co-constructing knowledge (Buysse *et al.*, 2003). Cheek *et al.* (2009) studied a community of research and practice (CRP) involving a university and a care centre in Australia. It proved to be a very successful community and due to the co-construction and co-ownership of the research, practitioners were more likely to take on board the findings and work them into their own practice. It is argued here that within the CoP framework, there is scope to develop the CRP concept and introduce other communities of interested professionals, who can enable the transfer of knowledge and skills that are pertinent to sustainability. In the case of sustainable schools practice, facility professionals from industry are one such community.

There has been a significant movement towards the sustainable approach in industry over the past decades. Many industries implement an EMS to manage their environmental impact and are motivated to do so due to the significant benefits they provide (Tung *et al.*, 2014). Through such environmental management, industry experts have developed procedural knowledge that could potentially be transferred to other sectors. Extending the boundaries of CoPs in sustainable schools and SFM, has the potential to engage professionals on both sides in new discourse on ESD. Teachers' exposure to professionals engaged in 'real' sustainability initiatives will give both content and new insights to ESD implementation in the classroom. School managers' introduction to such processes will aid with the development of specific skills that are required for EMS implementation. Explicit knowledge can be articulated or written down, and social discussion within a CoP is an effective arena for transferring such knowledge and adding to the 'practice' (experiences, stories, documents, ideas, tools, etc.) of the CoP. Moreover, as much of this knowledge will be in tacit form – unstructured and developed through experience, CoPs will provide a suitable space to engage with such knowledge transfer. Tacit knowledge is much more difficult to communicate to others, as it is highly personal and difficult to formalize (Nonaka and Takeuchi, 1995). A central benefit to learning in context is that learners can pick up situated meanings tacitly (Jenlick, 2013). Tacit knowledge can only be revealed through social interaction (Nonaka and Takeuchi, 1995) and therefore CoPs are particularly pertinent in this instance.

A wider aspect of ESD is that of public awareness and understanding (UNCED, 1992) and as people spend a significant amount of time in the workplace, it makes it a useful location for informal and non-formal education (UNESCO, 2016). At this boundary site, there is significant potential for education professionals to enable this informal learning in the industry workforce, using their professional skills as learning specialists and their knowledge of learning processes. Boundaries can be places of unusual learning, where perspectives meet and new possibilities arise (Wenger, 2000), and it is within these spaces that the transdisciplinary nature of sustainability can really be explored.

5.3.2 Boundaries.

Boundaries are complex places where knowledge domains clash and social actors navigate knowledge beyond their own discipline. Engaging in an EMS from an ESD perspective requires teachers to engage with the building and grounds at a pedagogical level, which is problematic if the teacher lacks content knowledge on how features of the building operate or how the built and natural environments interact. Boundary interactions reflect these experiences of being exposed to a foreign competence (Wenger, 2000). Boundaries can take different forms and Carlile (2002) developed three levels of boundaries, reflecting increasing complexity – syntactic, semantic and pragmatic. He also discusses knowledge as common or domain-specific and the three properties of boundary knowledge as difference, dependence and novelty (Carlile, 2004). Difference can refer to the amount or type of knowledge, dependence is the extent to which actors from each CoP must take each other into account, and novelty refers to how unique the circumstances are. At a syntactic boundary, knowledge is transferred from one CoP to another. As novelty increases, a semantic boundary is encountered through which knowledge must be translated, meaning the perspective of one CoP needs to be made comprehensible to the other (Abraham *et al.*, 2015). If novelty increases further, a pragmatic boundary is encountered, through which knowledge must be transformed. Carlile's framework highlights the complexity of boundaries and the spaces between, but also the scope for innovation and new knowledge creation. Table 5.1 suggests examples of situations that may be encountered at each boundary as novelty increases. Only through application and observation of the framework will the true possibilities become known.

Boundary Type.	Knowledge movement	Example	Knowledge Type
Syntactic	Transfer	Showing how to analyse an electricity bill. Demonstrating an energy audit.	Common knowledge.
Semantic	Translate	Explaining/modelling interdependencies in building systems.	Common knowledge and domain-specific knowledge.
Pragmatic	Transform	Developing interactive elements within the built environment for pedagogical purposes.	Domain- specific knowledge (ie. Pedagogical knowledge vs. knowledge of the built environment – school staff and industry staff need to develop a common language to share this knowledge).

Increasing novelty.

Table 5.1 Knowledge transfer at each boundary type (based on the work of Carlile 2002, 2004)

5.3.3 Conceptual Model.

Transferring knowledge, whether explicit or tacit, is a tricky and challenging endeavour. HEIs, due to their unique position and role as educators, have the capacity to undertake the more complicated roles within a CoP. Knowledge brokers connect across boundaries and introduce new practices into a CoP (Ishiyama, 2016). Brokers can co-ordinate members' knowledge requests (Borzillo *et al.*, 2011) and as HEIs usually have pre-established connections to both schools and industry, they are in a position to facilitate the brokering of knowledge across boundaries. Brokers can translate, co-ordinate and align perspectives through multi-membership or other ties to multiple CoPs (Kuhn, 2002). But brokering knowledge is delicate and often brokers do not fully belong (Wenger, 2000). Dangers include being viewed as an intruder, being rejected by one's home community (Kuhn, 2002) or being side-lined in both communities. As people who take on these roles may become marginalised within the CoP, it is suggested here that this role is taken up by the HEI as a facilitator of the movement across boundaries. Wenger (2000) states that brokers require '*enough legitimacy to be listened to and enough distance to bring something new*' and HEIs will have professionals with expertise in each of the areas and therefore the capability to effectively carry out this role. Furthermore, as educators they will be able to identify the boundary type being encountered and thus aid the transfer, translation or transformation of knowledge.

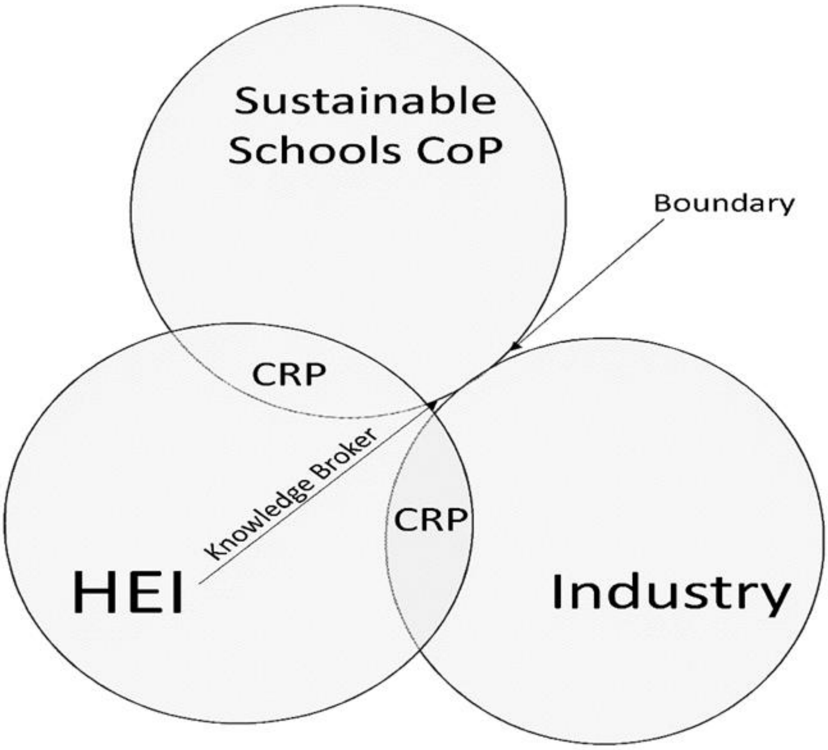

Figure 5.1 Extended Communities of Practice for Sustainable Schools.

In this model, school staff will be supported within a HEI-Industry partnership to engage in EMS implementation – both the sustainable management of school facilities and understanding the built and natural environment of the school and to how harness it for meaningful ESD. Teachers and school leaders will engage in skills and knowledge development through social interaction with both HEI and industry professionals. There may also be possibilities for FM personnel to visit the school to facilitate pupil projects or for pupils to visit an industrial site to compare sustainable technologies in a contrasting setting. This may also result in more unintended outcomes, such as being influenced by how engineers work, and incorporating these approaches into lesson activities. School staff will benefit from teacher training and CPD from both the Schools of Education and Engineering. This in turn will forge links between these two Schools, overcoming a challenge that has been identified in sustainability in higher education, that of siloed approaches and lack of integration between departments (Kaza *et al.*, 2015). HEIs will also gain valuable insight for research and the opportunity to observe and analyse their recommendations put into practice. The industry group will benefit from social impact in the local community. Corporate social responsibility (CSR) is a key factor in global competitiveness for industry and companies with better CSR performance have been shown to face lower capital constraints (Cheng *et al.*, 2014) and attract higher quality employees (Greening and Turban, 2000). Engaging with local schools to forward both environmental and educational outcomes will benefit a company's 'green' and 'social responsibility' image. It is understood that some of these links are already established. For instance, Waterford Institute of Technology has strong, established links with Bausch and Lomb, a high volume medical device manufacturing facility with a plant in Waterford. To give one example - students undertake work placement at the plant and this results in feedback loops that benefit content on engineering courses at undergraduate and postgraduate level. Figure 5.2 outlines the possible knowledge flows that may materialise from such a model, however the full benefits will only become apparent on observation and analysis of the model in practice.

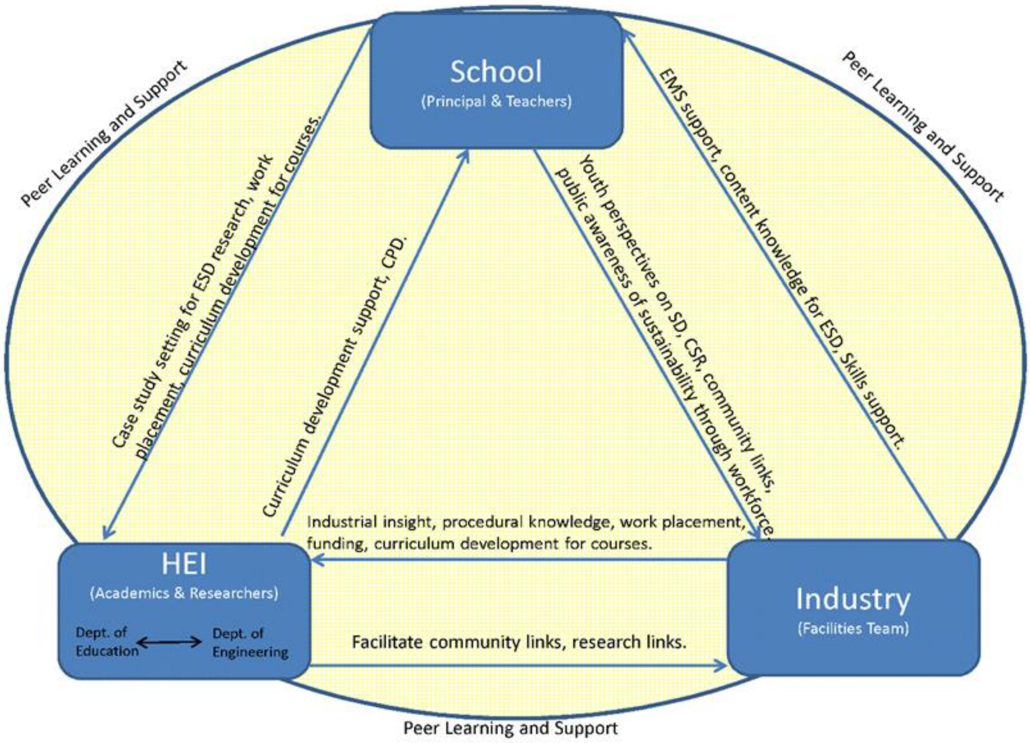

Figure 5.2 Potential knowledge flows in a School-HEI-Industry partnership.

While the practical implications of the usability of this model will only become apparent upon empirical testing, it is envisaged that this model could be usable in a number of settings. The model has been designed so as to be able to cater for the various interpretations of school EMS as identified in the literature. For example, a management team that wants to focus on improved energy management will want to develop different skills to a teaching staff who wants to focus on energy as a learning topic resulting from consultation with pupils and other stakeholders. An EMS has the potential to develop action competence if pupils are involved in the analysis of the building and grounds, the identification of the target areas and the discussion/creation of potential solutions, testing these solutions and analysing their impact, but teachers need to develop the required competences in order to facilitate such participation. Furthermore, participation may be interpreted differently in different cultures. For example, Schnack (2008) speaks of his Nepalese students having contrasting views of participation to his own, and teachers' skills and knowledge can be developed within this model regardless of how participation is perceived within the broader school culture. Another possible factor influencing engagement in the extended CoP may be the length of time a school has been partaking in sustainable school practice. For a school that is just starting out, the EMS as a management tool may be an initial entry point into the model whereby staff can increase their understanding about sustainability issues in the built environment or managing building services. However, as sustainable school practice develops and an ESD approach is taken, teachers' confidence may develop and they may find themselves ready to engage in open-ended projects. Such schools may even encourage pupils to enter into the CoP.

It takes time to develop collaborative cultures and this model allows teachers and principals to build competence and confidence in developing these school cultures. The CoP theory itself is a theory that has developed over time and it is hoped that the testing of this model in a school setting will enhance the theory and usability of the model.

5.4 Summary.

Progress towards more sustainable societies requires a population that is aware of the goals of sustainability and has the knowledge and skills to contribute towards these goals (Brunold, 2015). Schools, HEIs and industry all have a role to play in making this happen and will all benefit from the outcomes. This chapter discusses the significant role that CoPs has to play in addressing sustainability issues across sectors, and the conceptual model presented here on addressing the concept of sustainable schools is one such application. The work of sustainable schools is viewed as a practice, and extending CoPs creates a model for informed practice. The community of practice is a very important aspect of the model as it creates a space for knowledge development, research, professional development and the sharing of knowledge and experience. However, they need to be extended through community partnerships that will allow school staff to harness the expertise and skills they require to ambitiously work on the practice of sustainable schools. Over time, this should result in longer term benefits for both HEI and industry, as undergraduate students and graduates will be more likely to have a sustainable outlook and have higher levels of sustainability literacy.

Any conceptual work that aims to integrate perspectives from different disciplines results in some issues being simplified, while others are stressed (Carlile, 2004), and the model presented here is not without exception. The current emphasis in this model resides on the knowledge flows into the school CoP, therefore focusing more on the educational rather than the industrial aspects. The following chapters describe various aspects of exploring the model.

6. Investigating Facilities Management Knowledge.

The extant literature on facilities management (Section 2.1) has shown two interesting trends – one towards sustainable FM (SFM) and the other away from a solely technical perspective to one that encompasses social phenomena. In many ways these two trends are interconnected as FM now aims to deliver a more holistic service which encompasses the three pillars of sustainability. EMS are tools that can support an organization in becoming more sustainable and are utilised throughout industry and schools. EMS implementation in schools has encountered numerous challenges as highlighted in both the literature review and the survey questionnaire in Chapter 4. Also, the aim of the EMS can vary from school to school from a narrow focus on reducing bills and CO_2 emissions to a broader methodology for engaging pupils in action-competence oriented ESD. As EMS have been employed for longer in the industrial sector and are administered by qualified personnel, the approach to FM and the use of management systems in Bausch + Lomb was investigated by means of interviews. The objective was to quantify the aspects of a successful approach to SFM in order to broker this knowledge across the boundaries of the model presented in section 5.3.3. Themes from these interviews were then used to inform both the implementation of the conceptual model and the EMS developed with the school in Chapter 7.

6.1 Methodology.

6.1.1 Method of Data Collection.

While postal questionnaires were used to gather information on the current situation regarding sustainability in schools, in order to gather information from FM personnel about their role and the key components that make up a successful EMS, interviews were deemed more suitable. Interviews are useful techniques for gathering data that is unlikely to be obtained via other techniques such as observations or questionnaires (Blaxter *et al.*, 2008, p. 172). In this instance, observations would not elicit the motives or beliefs behind the actions taken while the survey questionnaire would not allow sufficient depth in the answers to create a meaningful understanding of a successful FM strategy. A semi-structured format was used for the interviews as discussed in the chapter 3 (Section 3.3.5).

6.1.2 Sampling.

Sampling was once again purposive whereby personnel with specific expertise in FM and the utilisation of management systems were interviewed. B+L have a proven track record in sustainable management of the Waterford plant and successful yearly recertification of both

ISO 50001 and ISO 14001. The aim of these interviews was to explore what attributes of a team lead to such success and what steps or activities are most effective. As this project is part-funded by B+L and three employees were acting as enterprise mentors, the same three people were approached to take part in the interviews. Two of the participants were electrical engineers who worked on the FM team and the other was an EH&S specialist (environment, health and safety) who also worked with the facilities team. These three professionals had a wide and varying expertise, were passionate about driving sustainability initiatives and were familiar with this project and its aims.

6.1.3 Ethics.

Although ethics is of the utmost importance in all research projects, ethical issues are thought to arise more often with qualitative research designs due to the closer relationship between the researcher and the participants (Blaxter *et al.*, 2008, p. 158). Therefore, it was imperative that the three participants were fully informed of the interview process (including the fact that the interview would be recorded) along with the aims of the interviews. The interviewees were provided with a detailed participant information leaflet (appendix E) and given time to ask questions or query any details before signing and returning the attached consent form (appendix F). This interview process was also detailed in the full ethics application submitted to the Ethics Committee at Waterford Institute of Technology and full ethical approval was received (appendix D).

6.2 Results and Discussion.

Initial analysis of the interview data in NVivo yielded a total of 50 codes. Relevant codes were then chosen due to the frequency of their occurrence across the three interviews, the importance the interviewee placed on the issue or because the interviewer linked it to concepts from either the literature review or themes that arose in the survey of principals. This resulted in 39 codes remaining. Of these, 17 became parent codes under which the remaining 22 were nested. All major decisions made during the coding process were recorded using memos in NVivo. Table 6.1 shows the top parent codes by frequency.

	Code	**Theme**	**Frequency**
1.	Management Systems (Energy = 50, Waste = 16, Water = 5)	*Components of SFM*	71
2.	Finance	*Drivers of SFM*	47

3.	Opportunities	*FM Team*	39
4.	People	*Buildings*	36
5.	Core Business	*Components of SFM*	33
6.	Expertise	*FM Team*	31
7.	Technology	*Components of SFM*	26
8.	Standards	*Drivers of SFM*	22
9.	Built Environment	*Buildings*	21
10.	Environment Success	*Driver of SFM* *FM Team*	10 10

Table 6.1 Top codes by frequency.

These codes were then combined to create four themes – *Components of Sustainable FM*, *Drivers of Sustainable FM, Buildings* and *the FM Team*.

Although the 39 codes were themed into four distinct categories, linkages were evident between codes from different themes and therefore could not be viewed as four distinct entities, but rather four interconnecting facets of SFM. For example, '*technology*' which was a key component of SFM was also viewed as an aspect of '*user behaviour*' which was then seen as an opposing side of '*culture*'.

> *'We want to empower people to say that sustainability is not all about getting in equipment or generating our own power, it's to do with our own individual behaviours…'* (David)

Similarly, while '*success*' was a code under *FM Team* in many ways it could also be viewed as a driver. Connections between codes are explored further during the discussion below.

In the literature, SFM ranges from a *narrow understanding of CO2 emissions to a broad concept of a complex socio-technical system in transition* (Nielsen *et al.*, 2016, p. 546). It is evident from the data gathered from these three interviews that the FM team at B+L view SFM from the broader end of this spectrum encompassing the three pillars of sustainability – economy, society and environment. Elmualim *et al.* (2009 in Price *et al.*, 2010) argue that these three pillars must be taken into account in order to deliver the increasingly demanded rounded FM service. When asked about what areas they targeted as part of their sustainable management strategy *energy* was most frequently cited followed by *waste*. *Water* was also mentioned. These were discussed in terms of both saving money and reducing the plant's environmental footprint. Interestingly, the surrounding natural environment was not commented on. However, when specific projects were discussed, such as energy-saving lighting or indeed this project regarding working with schools, it was clear that there was also a strong social element to their initiatives.

6.2.1 Components of Sustainable FM.

The first theme, *Components of Sustainable FM* included aspects of the management systems as well as technology and a focus on core business (Figure 6.1).

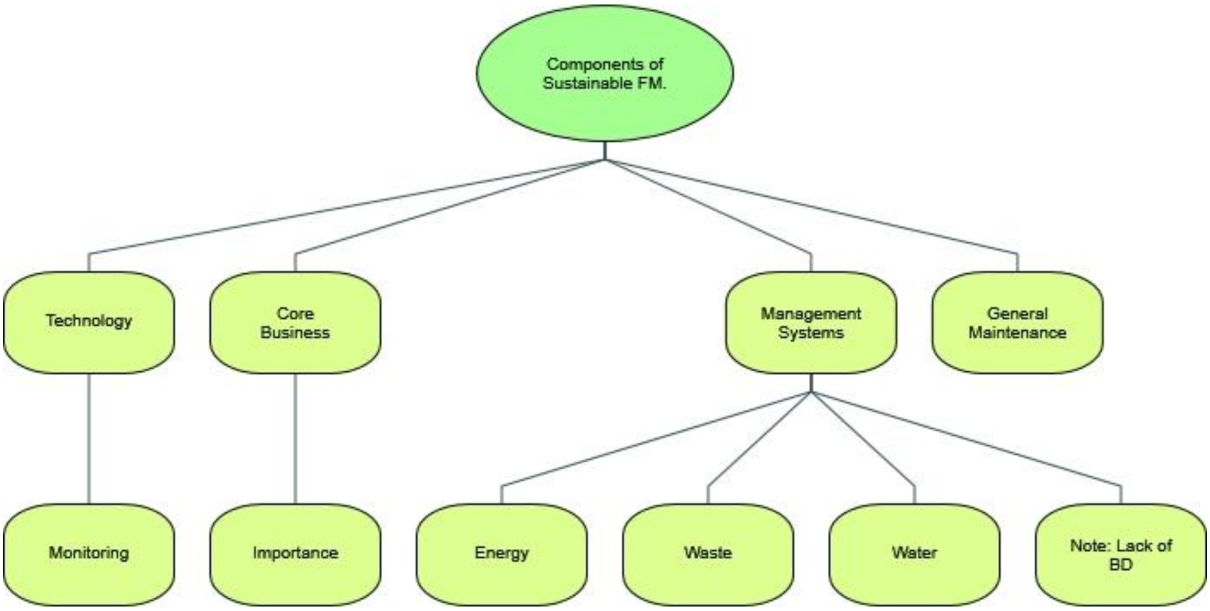

Figure 6.1 Components of Sustainable FM.

Management Systems.

The management systems provided the blueprint in approaching sustainable management and offered the staff not only guidance, but also assurances that they were compliant with statutory obligations. Some research has questioned the long-term impact of EMS and concluded that certification to an EMS standard has no effect on environmental performance (Tung *et al.*, 2014). This query was reflected in the thoughts of one participant who felt the framework provided gave assurances that they were compliant but did not necessarily make them do things differently.

> *'… any standard, it puts discipline and it puts manners on an organisation. Especially an organisation of this size. Would you do things any different if you didn't have them – maybe not. It's just, you're focused maybe different… you need some kind of*

standardization to make sure that you're not missing anything and you are planning ahead and you are in compliance.' (Trevor).

Energy management is often a key focus for industry, particularly energy-intensive processing or manufacturing sites, and authors cite the need for it to be approached systematically (Schulze *et al.*, 2016). Energy was the aspect of sustainable management that was addressed the most during these interviews. Indeed, energy management is strategically targeted with an Energy Management System (EnMS) and yearly ISO 50001 recertification. The standard was viewed as a useful tool for putting a framework on energy management and also for providing external recognition of the work being done.

> *'There's a third party out there proving to both yourself and your management that yes, these people are … they do sustainability, i.e. they get their 50001 recertification every year. So, that's really important, that external recognition and standard'.* (David)

Therefore, while the EnMS was a key component of SFM, it was also a significant driver for undertaking the initiatives in the first place.

Along with ISO 50001 certification, the Waterford B+L plant has also attained ISO 14001. When asked about components of SFM, this standard proved to be an extremely useful tool with one participant responding - '*I tie it very much back to the aspects and impacts registers that we use under ISO 14001 and the environmental management standard'* (Trevor).

Energy, waste and water were the most discussed aspects during these interviews suggesting that these were viewed as most important. After energy, waste was the most discussed aspect of the EMS. The management of waste was perceived in an interesting fashion and was linked strongly with the *finance* code under drivers.

> *'For us in the plant here, because we generate so much waste, we've changed the profile of waste – we don't call it waste, it's a commodity now … that's a huge revenue stream for us'* (Trevor).

While water was only referred to intermittently, it was evident that a reduction in water usage was also a goal for the team; '*We try to make a year on year reduction in the fuel, energy, waste and water'* (Trevor). Water was also viewed as an important component of the EMS when speaking about key target areas for schools '*It's critical. Particularly water… for a school. Water and electricity'* (John).

Interestingly, the issue of biodiversity or the surrounding green areas were not mentioned as aspects of either B+L's EMS or when discussing what they believed to be crucial components of an EMS for schools. According to the school survey in Chapter 4, this was an area in which school leaders felt reasonably confident, perhaps indicating an opportunity for knowledge flows in both directions across the CoP boundary.

Core Business.

Sustainability issues are highly industry specific (Renukappa *et al.*, 2013) and this was reflected in the ways the interviewees spoke about sustainable management. This plant is a high-volume medical device manufacturing facility and the aspects of sustainable management are critically focused on this.

> *'To the core business – It's essential. We provide - in manufacturing particularly - we provide all the electrical distribution points, we provide all the compressed air, cooling water, hot water… so anything that needs to support manufacturing is provided by facilities'* (John).

> *'Obviously the aspect, well the activity obviously is the manufacturing … at this stage it's in excess of a billion lenses a year. So what aspects are associated with that? So, we would have a huge energy profile. We have a large waste profile. We have about 13 aspects that we believe have a direct impact on the environment. Now the impacts that come out of that obviously is the amount of energy we use and the amount of packaging or waste that we place onto the market. So, that's kind of the key focus areas.'* (Trevor)

Core business was a high frequency code in this interview data and it reflects extant FM literature whereby FM has moved from a technical support position to a top strategic management role (Jensen, 2009). Everything the FM team were engaged in was linked back to the business model of the industry - *'We play a central role in making the company sustainable in terms of cost and operating cost'* (David).

Technology.

Technology proved to be a crucial tool for SFM. This code referred to systems for monitoring, smart systems and sustainable technologies. For this plant, auto-production was an area of significant focus. A highly successful CHP project had been completed the previous year and opportunities for installing a second CHP and photovoltaics were being explored. These projects were strongly linked to the codes *Finance* and *Environment* under *Drivers of SFM*. Smart technologies were also discussed during the interviews. Smart lighting technologies had been installed in both the offices and carparks and this linked strongly with user-behaviour. However, the most referred to subtheme under technologies was *monitoring*. Organisations are more likely to successfully manage an issue that they can measure (Tokos *et al.*, 2012) and understanding energy use was a key objective for this team. To do this effectively, a BMS was used with feedback every 15 minutes. This gave the engineers up-to-date data regarding energy use and the ability to respond quickly to problems that arose.

> *'Going down from auto-production is the management of our energy through our building management system and our energy monitoring system to ensure that we are managing our energy and that our energy is not peaking in some areas, and if it does we are exploring… investigating as to why it has peaked.'* (David)

ICT tools have been identified as enablers of energy efficient manufacturing (Schulze *et al.*, 2016). Metering technologies allowed these professionals to monitor energy more accurately, more effectively and with greater feedback. Furthermore, when asked, in their opinion, what the fundamental components of a SFM strategy for schools were, each participant spoke about monitoring as a crucial element.

> '*I would monitor them. Because there is so much you can do with water now, you know, flush volumes and … you have 100 kids there and they are going in and they are flushing what three, four times a day. How much are you flushing? … These are all things you have to look at. But the savings are there… Electricity is another driver. First of all you have to establish what your load is, because you need to establish what it is and what you believe you can actually get it to do'.* (John)

The aim of SFM according to Nielsen *et al.* (2016, p. 536) is the

'Integrated whole of a complex sociotechnical system at the building level, consisting of elements such as buildings and building operation, use, maintenance and management processes and how this system can be managed to contribute to SD in society'.

Although a complex and multi-faceted objective, the components that make up the sustainability strategy at this plant show an integrated approach using operations, use, maintenance, management and technologies which are contributing – albeit at varying levels, to economy, environment and society.

6.2.2 Drivers of Sustainable FM.

The second theme that emerged from the data was *Drivers of Sustainable FM*. Five drivers were identified from the interview data; Finance, Environmental Impact, Image, Standards and External Stakeholders.

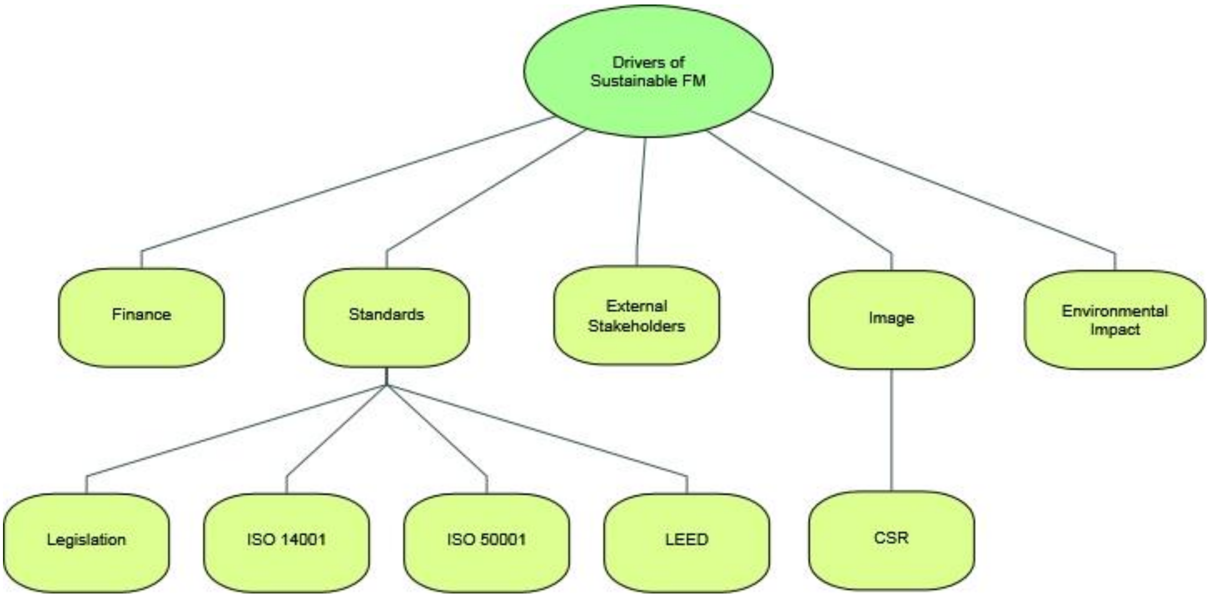

Figure 6.2 Drivers of Sustainable FM.

Drivers for sustainability initiatives have been found to vary across sectors (Renukappa *et al.*, 2013) and unsurprisingly the drivers here differed from those identified in the school surveys. When discussing SFM, all participants focused on the drivers. During the third interview, the interviewer asked specifically about the challenges of SFM and the participant replied '*The challenges keep evolving. You never stand still'* (David).

So, while it was recognised that the challenges were always present, they were not necessarily viewed as barriers. This is in stark contrast to the findings from the surveys conducted with principals in Chapter 4, whereby the participants were only asked about the drivers and many wrote about the challenges/barriers they face under the section 'Comments/other relevant information'. This contrast is most likely due to the lack of expertise on school staff to deal with FM.

Finance.

Finance was the most discussed driver over these three interviews. Many studies have identified finance as a top driver of sustainability initiatives including reducing operating costs (Renukappa *et al.*, 2013) and economic incentives (Pajunen *et al.*, 2016). Financial benefits can be viewed simply as cost-saving benefits or more broadly as long-term added value. Adding value is seen as a contrast to pure cost reductions (Anker Jensen, 2010). Provisions from FM and the impact on core business is where added value lies for a firm (Anker Jensen *et al.*, 2012) and this was recognised in this company.

> *'And for us obviously, we need to increase the profile of the product but also it's about maximising your payback, because you know, ultimately we want to keep making lenses'.* (Trevor)

Environmental management will not always return a profit for an individual initiative (Martín-Peña *et al.*, 2014) but justifying a project financially was seen as important among these interviewees.

> *'We would have a look and review the opportunities but it's all in cost justification'.* (John)

> *'You have to be very specific with your projects, because there are some projects there that are sustainable but they are not financially viable'.* (David)

Return on investment (ROI) was a crucial component when assessing the feasibility of a project; '*It's very difficult to secure financial capital if you don't have some idea of the payback. So, a lot of it is based on finance'* (David).

However, there were examples given when a sustainability project could not be justified financially, but the FM personnel found other ways to get the project over the line.

> '*There was monies available from a central fund in B+L at the time in the United States, and they weren't using it so we used it here. So we did all our non-manufacturing areas*

with LEDs, so we were able to make a very good return on the investment in those areas but when we went to the outside it was pretty poor … we were moving up into, five, six years return time. Now, that's okay but we were putting in LEDs that have a life of probably in and around ten years and we were only getting a guarantee of five years. … But we justified it because it was all going in under the one project, so it didn't look as bad'. (John)

'*Now, some of the cost may be MOB – maintenance of business, so if you can get in a more energy efficient piece of equipment, i.e. a compressor, if there's a compressor on the market that is more energy efficient than your previous supplier then you can see it as a sustainable project as well as MOB because if you don't replace the compressor it'll break down, it will impact operations. So therefore, you can go and buy the compressor, but if you bought a more energy efficient compressor, then you can sell it as sustainability'.* (David)

These examples show both a commitment to the project from a sustainability viewpoint and also a deep understanding of the business environment in which they work.

Sustainability was viewed strongly as a financial opportunity rather than a means of keeping operating costs down. When asked directly if finance was the main driver, one participant responded;

'*Yeah, that would be. Which is good because sustainability is a financial opportunity and people are now identifying that sustainability is not going to cost the organization money, it's actually going to save the organization money'*. (David)

One interesting opportunity that the team at B+L have identified is that of waste management. Waste is viewed as a commodity and therefore a revenue stream resulting in diversion from landfill.

'*For us in the plant here, because we generate so much waste, we've changed the profile of waste – we don't call it waste, it's a commodity now … that's a huge revenue stream for us because we maximise, how do I say, sorry - we minimise the amount of waste we put out so that's obviously giving us more efficiencies in the process. But, we* *maximise our return. We make sure we reuse it, we recycle it and we sell it. And it's tying into this whole circular economy now'*. (Trevor)

'*I suppose the management of waste is ongoing because we have different grades of waste, to ensuring that there's no contamination between a grade A versus a grade B waste, falls under my remit to ensure that they get out to the right bins so that they are taken off site and we'll get more value for that'*. (David)

Perceptively, this company has identified that putting a monetary value on waste changes its profile. '*When you put a commodity value on something … people treat it differently'*. (Trevor)

Although finance emerged as a top driver during these interviews, it is strongly linked to other drivers, such as *environment* –

'*We've had a number of projects. Some have been small, medium and large projects to reduce our energy consumption and that makes sense both sustainably – sustainability in terms of carbon footprint, and also in terms of financial'*. (David)

and also to codes from the other themes such as *culture* –

'*When they see the investment going in, people are very impressed with that. People were coming down to me and saying 'when are we getting our LED lights*?' (John)

As the driver *finance* is somewhat representative of the pillar *economy*, this again highlights the importance of the interconnectivity among aspects of SFM.

Standards.

The B+L plant in Waterford have ISO 50001 and ISO 14001 certification as well as LEED certification for the new expansion. ISO 50001 provides the framework for strategic energy management, ISO 14001 provides the framework for broader environmental management and LEED (Leadership in Energy and Environmental Design) is a green building rating system that is used worldwide. Each of these standards offers something different, yet valuable to the team ensuring their compliance with statutory obligations while also providing motivation for pursuing sustainability initiatives.

Regulation plays an important role in prompting companies' decisions regarding sustainable management practices (Qi *et al.*, 2013) and standards, such as the ISO standards, can provide a framework to ensure companies are abiding by their legislative requirements.

> '*You have a very small team that use things like the ISO standards to help them along the way'*. (Trevor)

> '*When you're dealing with a plant of this magnitude and other plants you need some kind of standardization to make sure that you're not missing anything and you are planning ahead and you are in compliance'*. (Trevor)

However, standards act somewhat as a dual-driver. Not only do they facilitate the compliance to legislative requirements, but it is a driver in its own right, as it urges the team to gain recertification each year.

> '*It's a continuous process – recertification of ISO 50001 every year does help to concentrate our efforts'*. (David)

Although some research suggests that actual certification to a standard does not affect environmental performance (Tung *et al.*, 2014) the responses here suggest that it does drive sustainability in terms of giving confidence in compliance and giving motivation in terms of yearly recertification.

Image.

The image that a company portrays is an important component of its overall public profile affecting market place success and potential growth opportunities. While image was not as strong an influence as finance, it did emerge as a driver. '*Sustainability for your company image is quite important as well'*. (David)

Implementing an EMS helps companies to improve their corporate image by being perceived as 'environmentally friendly' (Tung *et al.*, 2014). Being environmentally responsible is often a consumer demand nowadays.

> '*From our clients' side – yes, they want to see that we're accredited to external accreditation projects and it also backs up the profile or the proof that you're complying with… with everything and every piece of legislation that's out there… so yeah. It's hugely important'.* (Trevor)

This shows the association between image, stakeholders (clients) and standards, again highlighting that no one driver stands on its own.

FM has the potential to play a key role with regards to an organisation's environmental and social profile (Galamba and Nielsen, 2016). As B+L are a medical devices manufacturing facility, the product itself is not sustainable in terms of materials. However, all of the processes surrounding the manufacture of this product are sustainable and FM plays a significant role in ensuring this.

> '*The environmental impact of the site and the environmental profile of the site is huge. We tie that very much into the profile, the sustainability profile of our product - to give an example- the BioTrue one day product we've developed here does have a very key sustainability metric associated with that in the fact that it's manufactured in a plant that puts sustainability and energy management very much high on their priority list'.* (Trevor)

CSR is another area where FM has great potential to add value, but little research has been undertaken on FM and CSR to date (Anker Jensen *et al.*, 2012). Here, the phrase 'CSR' was only mentioned once during the three interviews and it was in relation to the recent expansion of the plant.

> '*Say on the CSR piece – corporate social responsibility, we're also looking at how the building fits into the profile of the surroundings, right'*. (Trevor)

The nascent literature on CSR and ESD is critical of this relationship and it remains an area that requires further development and in-depth critique. Manteaw (2008) discusses the emergent discourses of CSR and ESD and strongly argues that the ideals of each need to be intentionally aligned. Huckle (2013) looks at how corporate sponsorship may limit the potential of ESD programmes pointing out that the guidance materials often fail to promote ethical or political debate. However, any conversation about an ESD approach would be incomplete without the role of business (Welford 2006 in Manteaw, 2008) and as Webster (2007) identifies, there are innovative businesses engaging fully with SD that are potentially a valuable resource to education. The model presented in Chapter 5 encourages partnership between local business and schools, noting that one of the reasons that businesses may be agreeable to entering into such partnerships is improved CSR. Indeed, it was under the umbrella of CSR that this research came about in the first place and B+L funded this project as part of their CSR. However, during these interviews, when asked about schools and this project, no interviewee referred to CSR but rather spoke more personally about their own experiences or that of their children when giving reasons as to why they felt sustainability should be addressed more in schools.

> '*I never had that in primary school, we never really cared about sustainability, but having two children myself, yeah they are passionate about sustainability… and it's only because some of the teachers in primary school have taken it on themselves to train them, but if it was actually based in a bit of the curriculum and all the teachers had to do it, it would be fantastic*'. (David)

There does exist a criticism of the desire of businesses to have input into the knowledge and skill development of young people in order to enhance market advantage in the long term (Manteaw, 2008). Yet this is often in relation to technological subjects/skills and it could be argued that SD would not fall into the same bracket. It is essential that ESD permeates the curriculum at all levels (UNECE, 2005) and business partnerships could be very valuable in supporting this if teachers guide the practice in their schools and ensure a critical approach to all aspects of ESD and curriculum.

Environment.

The environment emerged as a clear driver of sustainability initiatives across two of these interviews. Environmental benefits were often viewed in tandem with other benefits, such as finance, emphasising the connectedness among these codes. Environment does not emerge as a stand-alone driver in the industrial literature, with environmental initiatives being undertaken to obtain the financial benefits (Pajunen *et al.*, 2016) or to improve corporate image (Küçüksayraç, 2015).

Pajunen *et al.* (2016) argues that financial goals need to be integrated with environmental goals to enhance the valuable relationship between them.

> '*We've had a very successful CHP project, but we're now looking at photovoltaics and we are presenting a presentation to finance on the paybacks and the benefits of photovoltaics which is zero carbon emissions*'. (David)

Here we see the environmental benefits being discussed jointly with the financial benefits. The importance of *environment* as a driver was similarly reflected in one interviewee's response to the question 'is finance the main driver?'

> '*No, no. To be fair… obviously the environmental impact of the site and the environmental profile of the site is huge - as well as the other sites.'* (Trevor)

If consumers perceive that a company respects the environment, sales and market share can grow (Martín-Peña *et al.*, 2014) and *environment* was also linked with the code *external stakeholders*.

> '*It's not a token gesture. It's what our clients want. It's ultimately probably what the end user wants to see. And for us obviously, we need to increase the profile of the product.'* (Trevor)

It appears that the success of industrial companies will depend significantly on their ability to internalize the value of environmental thinking (Pajunen *et al.*, 2016). Through the FM department, environmental thinking has been adopted in terms of energy management, waste management and water management throughout the manufacturing process and also the development of the plant's built environment. As already noted, there is scope to extend this environmental thinking into the management of the surrounding outdoor site.

External Stakeholders.

External Stakeholders was the least discussed code under drivers, but it did emerge strongly in the second interview and is discussed widely in the literature. In this case, clients were identified as the main external stakeholders. Customers have proven to be a substantial motivator for companies to implement environmental management practices (Phan and Baird, 2015) and this was reflected in the data here.

> '*The commercial teams have come on board with this because our clients, the likes of the big ones like Walmart, ASDA, Boots for instance, they want to see that where we're making these products, … take on sustainable profiles to suit the kind of impact or profile of the product they make'*. (Trevor)

Although these large clients were clearly important, the end-user was also influential; '*It's what our clients want. It's ultimately probably what the end user wants to see'* (Trevor). The influence of clients also became evident when discussing specific projects in the area of energy or waste management.

> '*For instance, two or three years ago we attained zero landfill status for the site so, that's huge for a process like us because we generate, say, 4,000 tons of hazardous waste a year. So, to be able to say to our clients we don't put anything of that into the ground… anything…, is a massive thing for the site.'* (Trevor)

When a company's key stakeholders have a high demand for sustainability, a motivation is there for firms to implement various sustainable management practices (Qi *et al.*, 2013). Here, the external stakeholders certainly acted as a motivating factor.

Identifying and understanding drivers of sustainability initiatives is a complex process (Renukappa *et al.*, 2013) and this was reflected in these codes whereby the boundaries were blurred and the codes overlapped on various levels. However, attempting to understand what motivates a team to pursue a sustainability strategy is important as lessons can be learned regarding what incentivises a group and what deters them. Understanding how each of the drivers influences the other is also constructive as it highlights the important relationships between them and raises questions as to how these relationships can be harnessed and utilised effectively.

6.2.3 Buildings.

The third theme, *Building*, was made up of the codes Built Environment and People. People were viewed as an integral part of the building and engaging with them was an important aspect of the sustainability strategy (Figure 6.3).

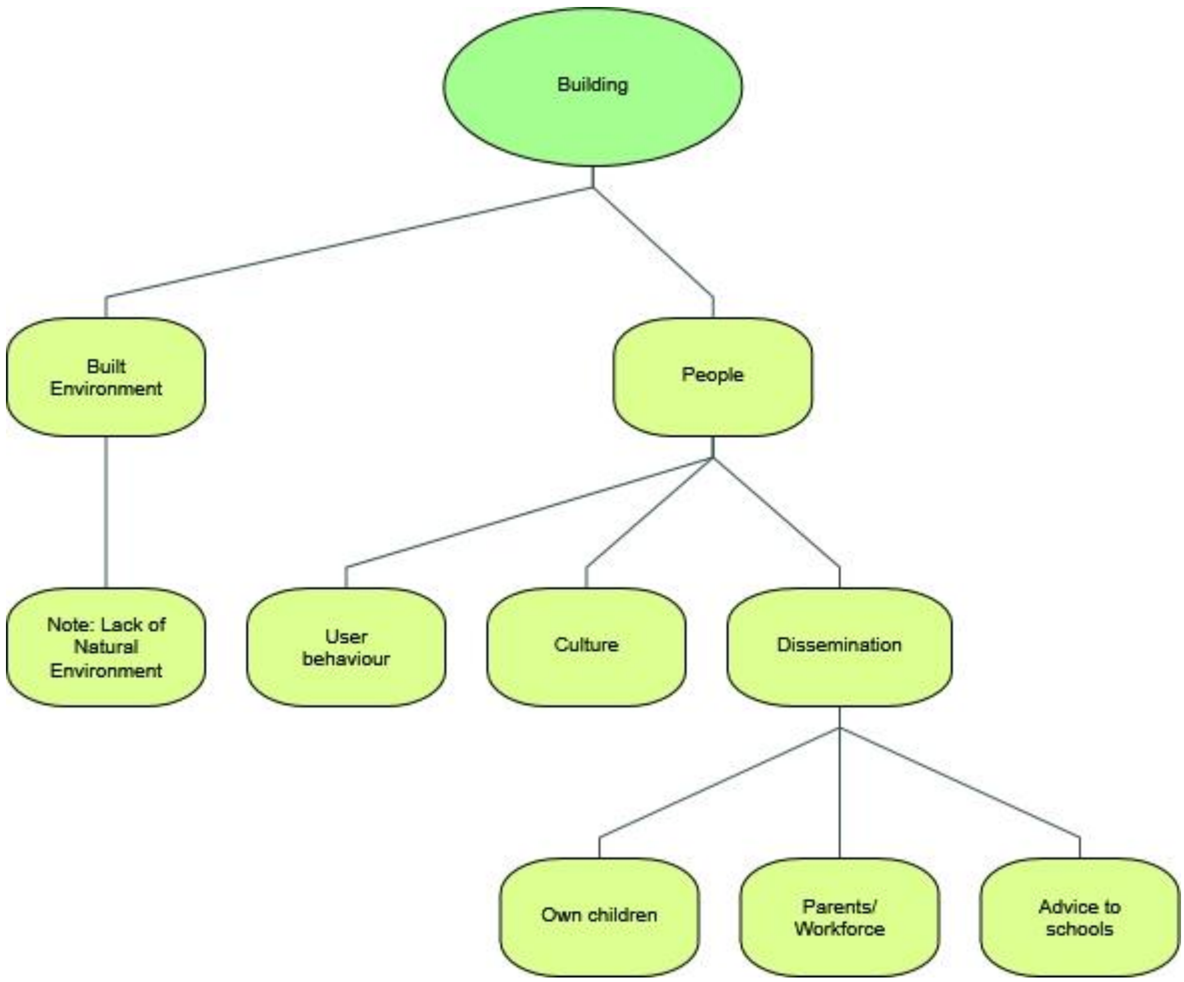

Figure 6.3 Building

As the focus of FM is at the building level (Nielsen *et al.*, 2016), it is unsurprising that *Buildings* emerged as a theme. The building itself was viewed as an important component of the company - '*Well you need a building to even start the business*' (John). What is unexpected, perhaps, is the strong connection of the *built environment* with the code *people*. But this connection does again reflect the move towards a more holistic FM to include people and process as well as place (IFMA).

The Built Environment.

There is now improved awareness regarding the impact of the physical setting on the development of organisations (Jensen, 2009). This can occur with how the building supports the core business or processes of the company and also how it supports the people working there. By viewing the building as a tool, both how the building functions and how the building impacts value creation for the company are important (Lindahl *et al.*, 2012). At B+L, FM supports the manufacturing process in numerous ways through the effective management of the built environment.

> '*We provide, in manufacturing particularly, we provide all the electrical distribution points, we provide all the compressed air, cooling water, hot water… so anything that needs to support manufacturing is provided by facilities.'* (John)

> '*We minimise the amount of waste we put out so that's obviously giving us more efficiencies in the process.'* (Trevor)

Depending on how well they support user-activity, the built environment contributes to efficiency, effectiveness and satisfaction in an organisation (Blakstad *et al.*, 2010). The impact of the built environment on its occupants was very much recognized by these interviewees.

> '*People were coming down to me and saying 'when are we getting our LED lights?' Right, because what we did is put in the LED lights and if you look up over the ceiling there, they are in and around four to six thousand, so you have that white light, so it's not that yellowy, dreary light. It's much more pleasant light. And particularly with the colour scheme in the offices now, everything is very bright … yes, people like to see their LEDs (laughs), no flickering…*' (John)

> '*You see in a building like this, when you do get into a scenario where your process is kind of stabilized, your productivity goes up and your morale goes up*'. (Trevor)

As part of the energy management plan, it was an objective that all the offices would have natural light to enhance the work environment. '*It's all bright, cheerful. The objective would be that everybody has natural light*' (John).

The discussion on the influence of the built environment led one interviewee onto the topic of school buildings. Again, he used personal experience when expressing his opinions on the impact of school buildings on young learners.

> '*I'll tell you, my own personal view is that my three kids right, especially the two older ones went to school all their primary life in pre-fab buildings. The younger guy, he only spent two years of his primary school life in pre-fab and then went to a custom built new school and I was involved in the Board of Management of the school so, you could visibly see a change, both in the kids and the teachers when they moved out of that*

environment into this beautiful – like the point previous – it feels good, it looks good, you're walking into a place that's conducive with learning, it's not a pre-fab - dusty, smuggy place, right… so yes, it absolutely has an effect.' (Trevor)

This comment reflects that of a participant in a study by Sandström *et al.* (2016) on blended learning environments - '*The spaces don't support knowledge building and interaction'* (p442). The influence of school buildings was an emotive subject and was referred back to later in the interview.

'*You can imagine a child, say my 9 year old right, who has come out of pre-fabs and into this… that's the most formative years of his life, right. And his perception or his interpretation of his surroundings … was completely changed. So, if they come up in that regime, that to them is the norm – it shouldn't be the norm, where you have a building that's not energy efficient, it's not airy, it's dreary, it's damp… your whole formative years are kind of focused that way*.' (Trevor)

Also, when asked about giving advice to schools regarding FM, one of his replies was

'*You go into a dreary place, you're going to feel 'ooff'. So it's the same with schools. And if there is one thing I'd say the Department of Education should concentrate on is that- if you want people to be creative you can't get them thinking in a cave. … You gotta give them the surroundings, right. So FM is a big thing*.' (Trevor)

These comments strongly echo recent works by authors such as Orr (1997) and Taylor (2009) who argue that we learn directly from buildings and that current industrial-style buildings do little to embody learning philosophies.

People.

People naturally interact with their immediate environment, whether this be built or natural, and *user-behaviour* regularly emerged alongside *technology* and *culture*. The electrical engineer regularly discussed user-behaviour when describing the various lighting projects he was involved in. The office lighting had recently been retrofitted as had the carpark lights.

'*We can dim them as well… they have the capability to be dimmed… notice outside in the carpark there if you're walking in during the dusk, the lights ramp up and down as you walk into different areas. So, it all saves energy. So, eight hours during the night* *they are out there probably using just 20% of that power. Then they ramp up to 100% when someone comes within 10 metres of the pole. So, there's a lot of little things. A lot of things then … in offices like this when people are walking in there and you know and the lights come on automatically*…' (John)

The facilities participant was also very mindful of user behaviour and was conscious of the relationship between user behaviour and sustainable technologies.

'*We have trained people that are encouraged to switch off their lights if they are going to be out of the office for more than half an hour, … if we are reducing the car park lighting, they know why and they accept that the carpark isn't lit at 200 lux per square metre, it's down at a more modest 25 lux per square metre, they buy into that, they're okay with that, they don't give out*.' (David)

Getting people on board with changes that were being installed was also important.

'*We have taken them out in a few places where people have said 'I want to be able to switch this on and off as I want', and we say alright but we still leave it in there, we just put it at a higher setting am, where it will pick up the occupancy*.' (John)

One facilities member was also very conscious of tackling the culture of employees as well as upgrading the building and services.

'*At the end of the day if somebody has a room at 24°C, it's because they like the room hotter and if you can change their culture, their behaviour, if they're walking out of a classroom and they're leaving the lights on all through the night, we want to tackle that culture, we want to engage people, we want to empower people to say that sustainability is not all about getting in equipment or generating our own power, it's to do with our own individual behaviours, i.e. switching off items that don't require to be left on, maybe it's somebody wearing an extra layer of clothing so instead of having the room at 24°C, they can have it at a more modest 21°C and that will save 'x' amount so culture is a big one*.' (David)

Another component of tackling the culture of people was knowledge about sustainability. As well as letting the staff know why they were making changes to the built environment, it was felt that the building itself was a visual reminder of sustainability, keeping this issue to the fore.

> '*I think that a lot of people would be proud of the fact that they are in an organization that has reduced its carbon footprint by approximately 4 and a half thousand tonnes of carbon dioxide, am… that they can go home and speak to their children'* (David)

As part of this project, the participants were asked if they had any advice regarding key areas to focus on in schools to help with sustainable management of the building – i.e. for an organisation with no facilities team on site and little expertise in the area, what areas should/could they focus on. The main advice that arose here was to understand your own profile through monitoring.

> '*I would say the simplest thing would be to establish how much energy are you actually using. Now if they done [sic] it for a year they'd get a very good indicator.'* (John)

> '*We look at things like significant energy users and energy profiles. If for a school… I think that's where they should start, right. It's that understanding of where their … like an aspects and impacts register – what aspects affect their environmental profile, right. So, it's going to be very small in a school. But it will still be there*.' (Trevor)

Another key action that was advised here was having a policy or statement. Most of the comments here tend to refer to energy, presumably as that is the largest area of focus for this team.

> '*Every school should sit down with a couple of key stakeholders and do an energy statement or an energy policy, and that will drive then a lot, you know*.' (David)

Responsibility arose as a code under characteristics of the FM team and this also came up when giving advice to schools.

> '*But it makes sense that they get an understanding of their profile, and not to understand it's someone else's issue. I mean, I always say … if you make a small change in a small area, it's still a change.'* (Trevor)

During these interviews, the participants very willingly shared knowledge and advice and this issue of dissemination appears to be, perhaps unconsciously, a part of their 'sustainability' outlook.

> '*[employees] can go home and speak to their children about it or like we say, if the children are bringing it into the home and I think that's where, you know, I get really excited about the fact... If the children are learning it from their teachers and they're bringing it into the home and they are telling their moms and dads "hey, switch off the light" or "switch off the emersion, you don't need that on", you know, and then the parents are seeing it as well in private industry saying "hey, private industry is being sustainable", they'll be responsible, so… it comes from their business life and it comes from their kids' life, it would be fantastic, because we're going to have to try to change cultures, and that double pincer movement of business changing it and the kids bringing it home into the home environment is really important*.' (David)

Throughout these interviews, the built environment and its occupants were deeply connected, so much so that when asked if he thought it was important that pupils should be involved in the management of their school building, one respondent replied '*Yeah, absolutely. And every aspect of the building, because they are the building*.' (Trevor)

This interconnectivity of people and place is a core tenet of an ESD approach and people's engagement with their built environment is becoming more and more a key focus of FM.

6.2.4 The FM Team.

The fourth and final theme was the *FM Team*. This theme emerged from codes that were characteristic of the team and how they worked.

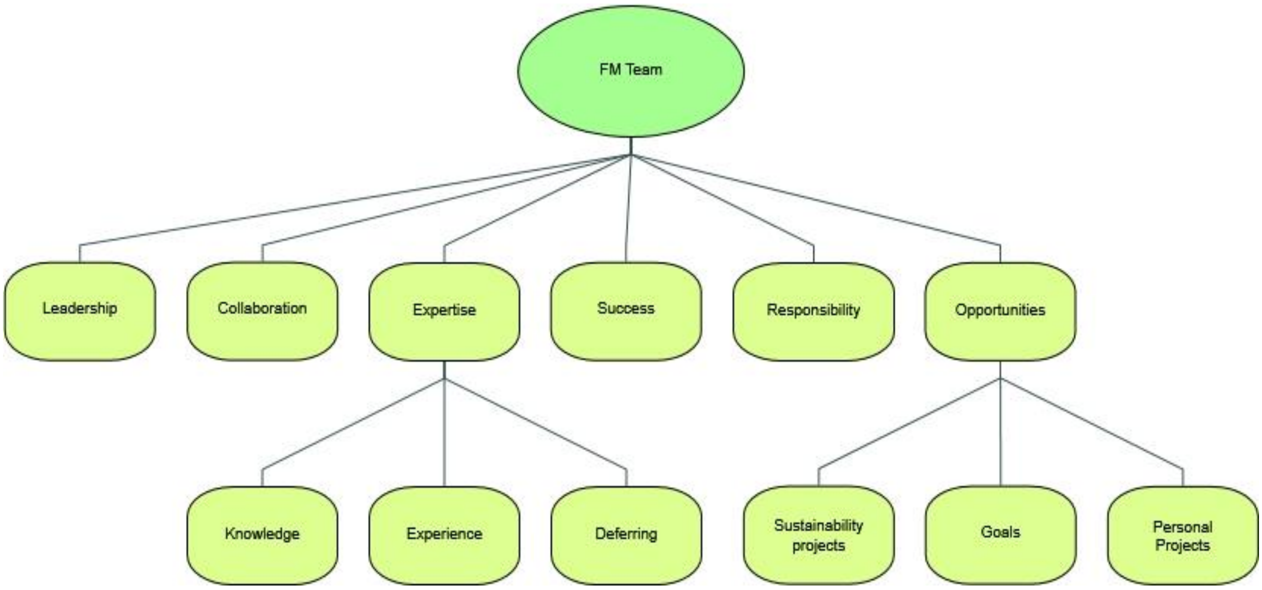

Figure 6.4 FM Team

Opportunities and Success.

The most recent, large-scale project that had occurred at the time of the interviews was the installation of a 3.3MW gas reciprocating engine CHP unit. This was a highly successful project with an ROI of 18 months. Consequently, the CHP was mentioned a number of times over the course of the three interviews.

> '*We're doing very well here. I mean the big eye opener I think for everybody here was the potential of the CHP*'. (John)

> '*So we've had a very successful CHP project, but we're now looking at photovoltaics*…' (David)

When asked if sustainability was now a critical component of FM, one engineer answered '*Oh, it is yeah. It's essential. And I think we found this first hand. We have the company chasing us at the moment to put in a second CHP'*. (John)

The CHP was viewed as a success and became somewhat representative of what this team was about. It showed what one successful project could do in terms of environmental savings, financial savings, morale and image. Also, due to its success, it opened up further opportunities and avenues for investment while simultaneously motivating the team to pursue new projects.

It became evident throughout the interviews that each participant took on their own projects as well which often mirrored their own personal interests.

> '*And a lot of it is personal projects. Like the energy management system would have been there but it wouldn't have been on a case of that, you know, that we have dashboards and everything. They're all little personal projects, as I say… oh I can do that, write a load of macros, do it all through excel, you know, and I like doing that and that's all done in my own time... But it's enjoyable when you get some recognition for the final product'*. (John)

Research has shown that when employees are empowered to take initiative regarding their responsibilities and actions with respect to the EMS they become more accountable and committed to the system (Tung *et al.*, 2014) and this is reflected here whereby members of the team had the freedom to pursue their own 'personal projects'.

Framing sustainability issues as opportunities is an important tactic (Renukappa *et al.*, 2013) and the participants in these interviews were consistently looking for new possibilities.

> '*Sustainability is a financial opportunity and people are now identifying that sustainability is not going to cost the organization money'*. (David)

> '*Our register of opportunities is another one for 50001 where we write down any opportunities we can to obtain energy savings. Some will come to fruition some may not'*. (David)

A study by Renukappa *et al.* (2013) investigating various industrial sectors in the UK found that accepting sustainability issues as opportunities enabled them to benefit from the advantages such as cost savings, increased value, increased market share and higher process efficiencies. At B+L, the FM team clearly view sustainability as an opportunity, acknowledging the challenges but focusing on the possibilities presented and the successes achieved.

Collaboration.

Knowledge sharing and a culture of evaluation have been noted as essential components to ensure lessons are learned by FM teams moving from one project to another (Galamba and Nielsen, 2016). Although individual employees work on their own personal projects, they support each other in these ventures - '*Yes, it was a great project, attributed to David. We all* *kind of take personal projects, and that was David's personal project. And he did a great job on it*.' (John)

The facilities participant had a broad vision for the placement of FM in relation to other departments in the company and believed that FM integrated with all of them.

> '*It interacts with health and safety, it interacts with operations, you know. For example, if a new starter comes in and they want to get a telephone set up, they have to come to the facilities department. And if they want a network point, they go on to our structured cabling so… we interact with every single person, with every single vendor, with anybody who sets foot from public land onto our land'*. (David)

A particularly strong partnership emerged between EH&S and FM.

> '*EH&S would be looking for opportunities so they would be coming to facilities, and to what opportunities are out there… and we would have a look and review the opportunities*.' (John)

> '*Well, I suppose in my role, I coordinate and manage, safety, environmental and sustainability across all our sites for the lens business around the world. So, facilities management is a key, how would I say… it's a key attribute for me in my role because both those departments work very closely together. In general terms, there is an overlap with safety, control systems – especially in dealing with facilities equipment … so yeah, there is a very distinct link between environmental, safety and sustainability and facilities management. They are virtually joined at the hip. That's in my opinion, right. A lot of sites, or a lot of organisations would not look at it that way but there is a link and that link should be there all the time'*. (Trevor)

This participant goes on to later say

> '*Now, where the link for me between FM and safety is general EHS departments won't be able to deliver those projects stand alone. Am, they will have the concept and they'll have the idea and the metrics and where it fits into the overall scheme but they would need very strong links and back-up from a FM group to deliver those, and depending on the complexity and the size of the project. So am, I believe FM has a direct impact on sustainability issues within any plant'*. (Trevor)

The finance department obviously had to be involved in all projects also and participants regularly spoke about discussing projects and presenting ideas to Finance. This collaboration between departments strengthens a 'whole-organisation' approach to sustainability, but the drive and foresight appears to come from within the facilities department. Also, the overlapping of management systems is another benefit of such collaboration. Qi *et al.* (2013) have shown that a number of management systems - ISO 14001, ISO 9001 and OHSAS 18001, are positively correlated with certification in one management system decreasing the cost of certifying others. Research also shows that integrating energy management and environmental management systems avoids parallel processes, enabling greater savings and more successful environmental performance (Amundsen, 2000). Therefore, the strong links between FM and EH&S at B+L facilitate the implementation of a number of management systems, potentially easing the challenges cited in the literature such as lack of time and manpower.

Expertise, Leadership and Responsibility.

The language of each interviewee strongly reflected their area of expertise. The EH&S participant spoke the most about waste management and was the only participant to refer to the circular economy. The electrical engineer spoke mainly about energy management often referring to specific projects he was involved in. The FM participant spoke the most about a culture of sustainability although the EH&S participant also spoke frequently about the building's effect on occupants. Also, the 'higher' the management position held by the participant, the broader view they appeared to have on the issue of sustainability perhaps reflecting the broader scope of their remit.

Numerous studies note the importance of company leaders in initiating changes that create the space for sustainable practices (e.g. Rauter *et al.*, 2017; Renukappa *et al.*, 2013). Although external factors such as finance and company image emerged as strong drivers, much of the language that the participants used showed they were also intrinsically motivated to pursue green initiatives.

> '*They're all little personal projects, as I say… I like doing that and that's all done in my own time*'. (John)

‘*You finish a project and then you move on. And then you focus in on something like say the CHP … but it’s all interesting. … No, I enjoy it now’*. (John)

‘…*we’re going to have to try to change cultures*…’ (David)

Another participant referred to work he had done with a local secondary school.

‘*To me, those things are important, do you know what I mean? … trying to get them into a whole mind-set on green committees and things like this, it’s am… it’s not a chore but they just don’t get it, they don’t understand it and I think if they understand it and they did after the two years, they set up their own little initiatives and started doing things… even things like working out the return on investment on changing out lights, massive thing for them, do you know what I mean, so yeah, I think it’s highly important’*. (Trevor)

Also, these professionals felt that there is a personal responsibility to act on sustainability issues.

‘*It makes sense that they get an understanding of their profile, and not to understand it’s someone else’s issue’*. (Trevor)

‘*We want to empower people to say that sustainability is not all about getting in equipment or generating our own power, it’s to do with our own individual behaviours’*. (David)

Many positive outcomes for sustainability are dependent on managers’ attitudes towards environmental issues (Martín-Peña *et al.*, 2014) and the positive attitudes and concerns of these individuals added agency to their environmental activities.

A challenge that was perceived during the initial schools’ survey was a lack of expertise. During these interviews the expertise of the participants was highlighted through reference to their knowledge, skills and experience with sustainability and buildings management.

‘*Trevor will be able to go through that with you … he would be working on all the waste side. We’re all very focused in on our own little areas. I’m the electrical engineer so I’m focused in on my electricity’*. (John)

'Yes, that's my area of expertise, you know, so am… Even in lighting design… We had so much design (laughs) that we done [sic], you were able to walk into a room and you knew what lux levels you had in the room because, you know … and that leaves you then because you finish a project and then you move on'. (John)

'Judging by my own experience here in this company … we play a central role in making the company sustainable in terms of cost and operating cost and trying to reduce that bucket of energy cost down'. (David)

Each participant was very focused on their own areas of expertise and was aware of their colleagues' areas of strength. They regularly deferred to each other when they were discussing an issue that was even slightly outside of their own area.

'It was a great project, attributed to David. We all kind of take personal projects, and that was David's personal project. And he done a great job on it, you know'. (John)

'I know now Trevor will probably be able to tell you about this but another one is packaging'. (John)

'Oh yeah, in fairness to the guys here, David and the team … that whole piece was very relevant about how the building should look and feel, right'. (Trevor)

'So that would be for John. So, he does that every year and he gets recertification on that'. (David)

The lack of a specific team focused on the environment can hinder environmental management in a company (Martín-Peña *et al.*, 2014). Here we see a dedicated team that is well-structured with a strategic outlook on sustainability issues and this team can ensure that sustainability issues remain a priority for the whole company.

6.3 Summary.

As these interviews were conducted with FM staff at an industrial plant where the core business was manufacturing, SFM strategies were designed specifically around manufacturing and the aspects and impacts directly related to these activities. However, a number of key areas emerged that could be adapted to suit a SFM strategy in other settings, such as schools.

Both the FM literature and the interviews discussed here portray a broader understanding of FM than that currently employed by school leaders in Irish primary schools. Professional FM teams not only look at the technical management of facilities but also look at how the building, a major asset for any organisation, supports the users' activities and adds value to the organisation. At B+L, the focus was on the manufacturing process and the employees' working environment. In schools, the focus needs to be on education and the learning environments of pupils and staff.

Also, at B+L they use the EMS as a framework to structure their sustainability activities. These activities were built around a central statement or policy and began by getting a clear idea of their own profile through monitoring and using an aspects and impacts register. Successful projects were celebrated and both the reasons for such projects and their resulting benefits were disseminated. External drivers, such as finance, were identified, but members of the team were also internally motivated by a strong sense of responsibility.

Table 6.2 shows the potential lessons that schools could take from the findings presented here.

Key Findings from FM Interviews	**Potential implication for Schools.**
SFM must be focused on core business, which in this case is manufacturing.	A SFM strategy must support education – i.e. teaching and learning.
Technology plays a key role in monitoring which is essential.	A more detailed monitoring system would provide better data and therefore inform better decisions.
All opportunities must be explored –they may not all come to fruition due to poor ROI, etc. However, exploring all opportunities appears to promote innovation.	Explore all opportunities regardless of seeming impracticality. Engage pupils in this process to encourage creativity and innovative thinking. Make short and long term plans based on potential opportunities.
One successful project can draw attention to sustainability and motivate for further projects – i.e. CHP	Potentially, one stand alone, key project could get a school started as a sustainable school, act as motivation for further projects and get the attention of all stakeholders in the community.
Management systems ensure compliance and are a tool to support sustainability initiatives. However, the challenges to such initiatives keep evolving and the team here continuously adapt whilst moving from project to project.	Management systems provide a framework to pursue environmental management but these frameworks must be fluid and provide the opportunity to adapt to the needs of the school. (perhaps the Green Schools system currently in use in over 95% of Irish Primary schools is too rigid in structure to allow this at present)

External drivers, such as finance and company image in this case, motivate employees to take on sustainability initiatives. However, these drivers are interconnected and this is recognised and embraced.	*Finance* and *Teaching and Learning* emerged as top drivers in the schools' surveys while almost 40% did not rank *environment* or *school image* as a driver at all. Having a broader outlook on sustainability initiatives and understanding the multiple potential benefits may result in higher motivation towards ESD.
The culture of people was taken into account in tandem with the introduction of sustainable technologies and the rationale behind introduced changes were explained to employees.	All staff and pupils, as building occupants, need to be involved in managing the building and understand the reasons behind any changes taking place or any technologies being introduced.
People's interactions with the built environment were viewed as important as was the influence/impact the building had on its occupants.	While management systems may encourage reductions in energy use, waste produced, etc. a broader view of building management must take into account the buildings impact on pupils and teachers. (e.g. if pupils are encouraged to turn off the lights, are the lux levels at an optimal level for classwork? or if windows and doors are being closed to conserve heat energy, is the IAQ being consequently affected?)
A dedicated and focused team can ensure sustainability stays at the top of an organisation's agenda.	A dedicated team including both staff and pupils could spearhead ideas/initiatives while still ensuring full participation by all students. This group could ensure that sustainability stays to the forefront of a school's agenda.

Table 6.2 Potential implications for schools.

FM knowledge can be transferred as detailed written specifications which could take the form of tools such as guidelines, checklists and databases (Jensen, 2012). The value of such tools was then explored when supporting the school in EMS implementation.

7. The Case Report.

This chapter details the report of the case study that was carried out to investigate the feasibility of the Extended Communities of Practice model that was developed in Chapter 5. The case is bounded temporally and physically, focusing on the generation and implementation of the EMS in Scoil an Bhaile Nua from September 2018 to June 2019. Case reports include extensive narrative description (Stake, 1995, p. 123) as well as the case findings, therefore this chapter gives due consideration to the background against which this case study occurred including descriptions of the building, the school's ethos and the teaching staff. It is hoped that by providing such detail, the reader can engage in vicarious experience resulting in naturalistic generalisation of the findings (Creswell, 1998, p. 186).

7.1 The Case Setting.

This stage of the project involved utilising the FM approach to sustainable management discussed in Chapter 6 to develop, implement and monitor a new EMS with the participating school, Scoil an Bhaile Nua. This school fulfilled the requirements for this research as set out in section 3.2.4 and portrayed a keen interest to develop their school in a more sustainable direction.

7.1.1 Scoil Náisiúnta an Bhaile Nua.

Scoil an Bhaile Nua is a rural, co-educational primary school located in Co. Waterford. It is a Catholic school, under the patronage of the Bishop of Waterford and Lismore and run by a Board of Management consisting of eight persons.

The school day begins at 09:15 with staff arriving from 08:30 and children arriving from 09:00. There is a break from 11:00 to 11:15 and lunch is from 12:30 to 13:00. Junior and Senior Infants finish school at 14:00 while the remaining classes finish at 15:00. The school remains open until 17:30 most days with the principal generally being the last person to leave the building.

The original school house was built in 1937 and consisted of two classrooms. A further classroom was added in 1963 along with a water tower. An extension consisting of two classrooms was finished in 2007 followed by further development in 2014 which saw the addition of another classroom, a sensory room and an office. The building now measures 512m^2.

Figure 7.1 S.N. an Bhaile Nua, 2016.

The building is situated on a pleasant and spacious site measuring approximately 5500m^2. A footpath leads from the gate to the front door and is bounded on either side by a grass sward with a small number of trees and a boundary of Leyland cypress on the east and a native hedgerow on the west.

Figure 7.2 Entrance to S.N. an Bhaile Nua.

At the back of the building there is a large, concrete area for pupils to play that is bounded on the north and east sides by the school building and by the water tower and shelter on the south.

Figure 7.3 Play area at the back of the school.

At the back of the site is a large grass area that is bounded on the east, north and west by a dry stone wall and native hedgerow and to the south by the playground shelter. This area is used for play at break times, for sports and other curricular activities. There is also a water treatment system located in this area.

Figure 7.4 Green area at the back of the school.

Figure 7.5 Water treatment system at the back of the school.

7.1.2 The teaching staff at Scoil an Bhaile Nua.

When visits to this school first began, during the academic year 2017/2018, the school had four classes – Junior/Senior infants, $1^{st}/2^{nd}$ class, $3^{rd}/4^{th}$ class and $5^{th}/6^{th}$ class - with an enrolment of 114 pupils. There were five mainstream class teachers (two teachers were job-sharing in one of the classes) and one learning support teacher.

As there were 114 pupils on the role at the end of September 2017, this meant that the school could appoint a fifth teacher for the academic year 2018/2019. Therefore, when the case study phase of this research began in September 2018, there were seven on the teaching staff and they all participated in the research alongside myself as researcher from Waterford Institute of Technology and the three engineers from Bausch and Lomb. The experience of the teachers ranged from one year to over 30 years teaching. All teachers held degrees in education and partook in regular CPD to enhance their teaching knowledge and skills across all subject areas. Some teachers had additional qualifications, including Master's degrees. Teachers were very giving of their time and talents, using both to provide a wide range of extra-curricular activities for their pupils including a large range of sports, music, entrepreneurship, drama and cookery. All of the teachers at this school were female.

The principal of this school was a teaching principal, meaning that she taught from 09:15 until 15:00 and completed her administrative duties outside of this time.

7.1.3 Education and the Curriculum.

The school implements the Irish Primary School Curriculum (NCCA, 1999) which consists of eleven subjects; English, An Ghaeilge (the Irish language), Mathematics, History, Geography, Science, Music, Visual Art, Drama, Physical Education and Social, Personal and Health Education (SPHE). As the school is under the patronage of the Catholic Church, they also teach Religion as a subject. From September 2018, the New Primary Language Curriculum (covering both English and Gaeilge) was implemented in full from Junior Infants to Second class.

Inclusion is central to the ethos of Scoil an Bhaile Nua. The school's inclusive approach is clearly evident in all aspects of school life from their vision and mission statement to the teachers' approaches to teaching and learning and even in recent upgrades made to the school building. For example, the most recent building project included a sensory room and a wheelchair accessible toilet. In a Whole School Evaluation, carried out by the Department of Education and Skills in November 2015, the inspectors commended the school on their '*spirit of inclusiveness and respect*' and their '*very positive home-school and community relationships*' (Department of Education and Skills, 2016b, p. 2).

This school put important emphasis on the students' voice, which is also an important aspect of ESD. During the case study, this school partook in the Creative Clusters initiative (Department of Education and Skills, 2019). In order to identify the activity in which the school would engage for the year, the pupils were asked to suggest topics. Each class voted on an idea that was then brought to the whole school. Each class created posters to promote their suggestion and had to pitch their idea to the school population. The ideas put forward included gardening, woodwork, baking and digital media. Each pupil then cast their vote. Bringing pupil voice to the centre of such a large school project demonstrates the inclusive environment created in this school.

Throughout this case study, my observations consistently noted the high level of commitment of all staff to inclusive practice and to delivering a high standard of education to all pupils.

7.1.4 Engaging with the Extended CoPs Model.

The principal of this school first made contact following completion of the initial survey for school leaders on managing schools sustainably. She sent an email outlining the difficulties she was experiencing in energy management and the anxiety this was causing. I then contacted the school and was invited to meet the principal and look at the school building.

The first meeting between myself and the principal took place at the end of 2016. At this point, the final shape of the research design and case study had yet to be established but we remained in contact via email for the remainder of the school year. In June 2017, I gave the principal an overview of the proposed case study methodology, and after speaking with her staff, the school decided they would take part.

During the academic year 2017/2018 I visited the school on a regular basis to conduct audits and to monitor energy usage and IEQ parameters. Table 7.1 shows the timeline for the audits. Data from the monitors was downloaded on a weekly basis. Originally, the aim had been to conduct all five workshops with the staff between January and June 2018 with a view to beginning the EMS in September 2018. However, due to a number of unforeseen circumstances, some workshops had to be cancelled and were rescheduled for the following academic year. The main circumstance in question was the implementation of new Child Protection legislation in 2018 which required all schools to revisit and rewrite their policies in this area as well as attending workshops to familiarise themselves with the new guidelines. The second significant event that impacted on the original timeline was the new GDPR legislation (general data protection regulation) whereby schools had to receive training and update all relevant documentation and procedures to ensure compliance.

Data	**Work**
August 2017	• Energy Audit
September 2017	• Ecological audit of the school grounds. • Installation of electricity monitor
October 2017	• Three energy walk-throughs • Installation of IEQ monitors in rooms 1, 3 and 5 • First waste walk-through • First water walk-through
November 2017	• First waste audit (15/11/17) • Second waste audit (29/11/17) • First meeting with full staff to inform them of the project.
December 2017	• First workshop with full staff - *'Sustainable Development, Education for Sustainable Development and The Sustainable School'* • Second waste walk-through • Second water walk-through
January 2018	• Second workshop with full staff on Energy management cancelled due to unannounced SENO review
February 2018	• Second workshop with full staff – *'Energy management in the Primary School'*

	• Third waste walk-through • Third water walk-through • Third waste audit (07/02/18) • Measurements for Revit model.
March 2018	• Third workshop on Biodiversity postponed due to new circular.
April 2018	• Creation of Revit model.
May 2018	• -
June 2018	• Second water audit.
All year	• Data from monitors downloaded every week • Monthly meetings with the principal to inform her of progress and any findings.

Table 7.1 Work carried out in the school 2017/2018

This first year enabled me to get to know the school and staff and give detailed reports back to the school on how they were currently performing in each of the areas – biodiversity, energy, waste and water. These reports created the springboard from which the staff would create their new EMS and gave a baseline from which to measure any changes or improvements.

7.2 Surveys and Audits of Scoil an Bhaile Nua.

An initial audit was carried out in energy, waste, water and biodiversity on the school grounds to provide a baseline from which any change during the study could be identified and also to add to the deep description of the school and how it was engaging with sustainability prior to the research. The school had already successfully achieved Green Flags in the areas of Energy, Water, Waste and Transport implying that they had achieved high standards in managing each of these four areas. A final audit was carried out, in the same four areas towards the end of the case study to see if any changes had occurred over the period.

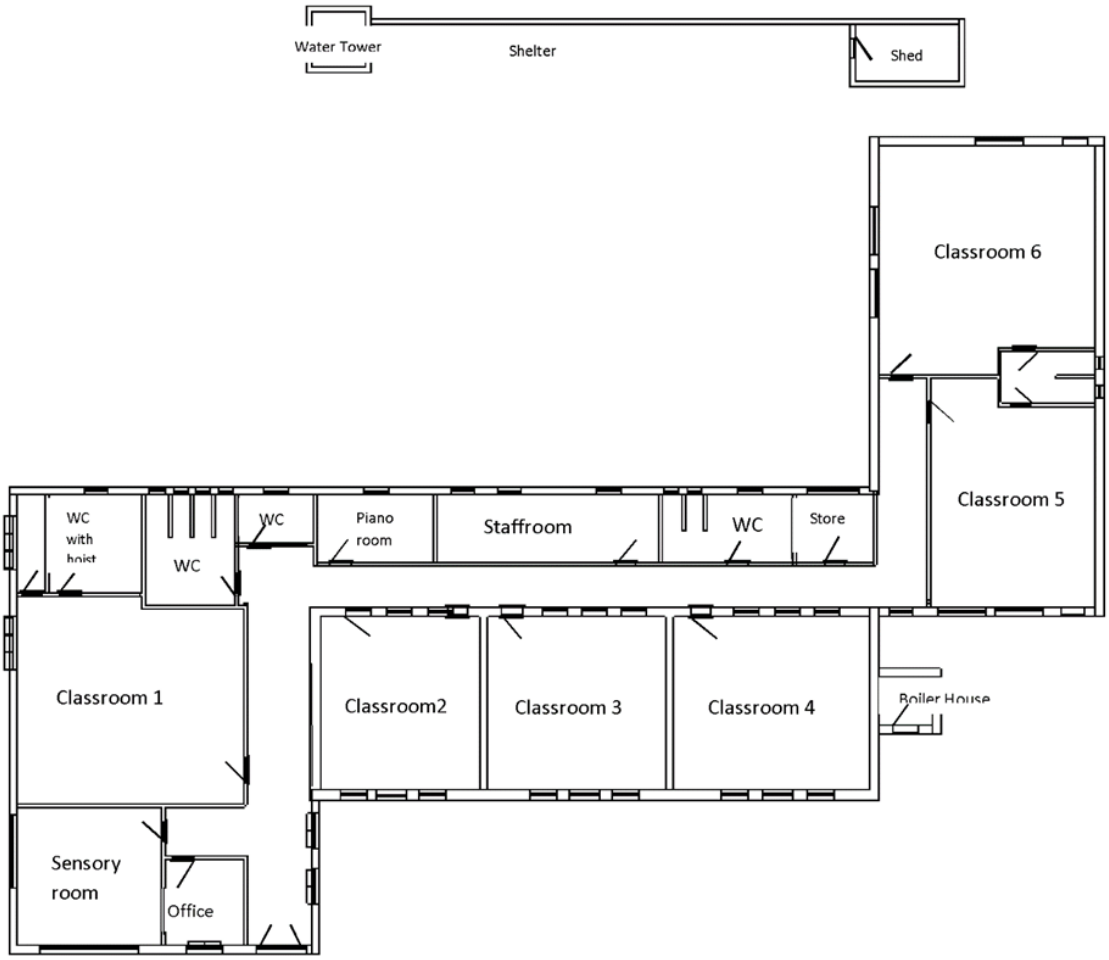

Figure 7.6 Plan of Scoil an Bhaile Nua

7.2.1 Energy.

The school's challenge in energy management first prompted the principal of Scoil an Bhaile Nua to make contact. Although the school had received their Green Flag for energy, the school was encountering considerable difficulty in this area. The principal, Ms. Ryan, indicated that since the last extension in 2014, electricity bills had almost doubled in cost. She said the bill, every two months, was around €600 which the school often had difficulty paying. Prior to this the bill would have been, on average, €350 every two months. Therefore, the energy audit was the first audit performed in the hope of helping the school to identify high energy users or problematic areas in their energy management.

Electricity.

First, historical electricity use was examined by means of their utility bills. Electricity bills were collected from September 2015. From September 2015 to March 2017, the average energy usage every two months was 2302.89 KWh (€470.25 +standing charge €40.32 + PSO levy €36.94 = €547.51) with a yearly average of 13817.33KWh. As the school had a pupil population of 114 and a gross floor area of 512m^2, this worked out at 121.2 kWh/pupil/annum and 27KWh/m^2/annum. In Northern Ireland, typical electricity use is 18 kWh/m^2/p.a. for primary schools (Keohane, n.d). Therefore, this school's energy use was significantly higher than the most relevant benchmark as one of the classrooms was not in use and the sensory room was only used for a few hours each week.

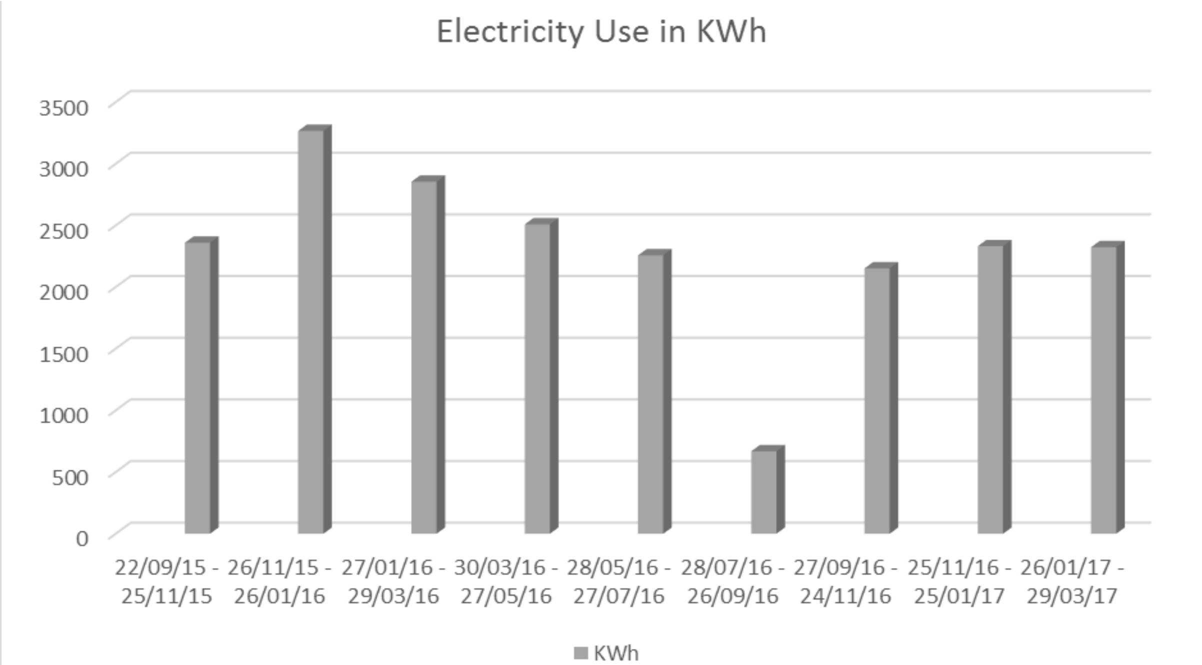

Figure 7.7 Historical electricity use in Scoil an Bhaile Nua.

In order to establish the base load, all items in the school that needed to remain constantly on were identified and the power recorded. This gave a baseload of 0.4kWh which was corroborated later when the energy monitor was installed and all energy users in the building were turned off. However, at night, the external lights were turned on which resulted in a minimum power of 0.65kWh.

Description	**Power**
2x Exit lights	20
Automated External Defibrillator	100
Main PC to power LAN	200
Central PC to power internet	250
Emergency exit lighting	100
Water treatment unit	2000
Fridge	1300
Total	**3970W**
Outdoor lights	2500
Total with outdoor lights	**6470W**

Table 7.2 Established Baseload.

Other significant energy users were recorded also, as were all lighting fixtures in the school.

Description	Quantity	Power
Photocopier	1	800
PC	1	160
Interactive Whiteboard	4	2000
Projector	5	650
Laptop	5	325
Kettle	1	1300
2kW water heater	3	6000
Total		**11235W**

Table 7.3 Significant energy users.

Location	No. of fittings	Tubes	Power
Entrance porch	1	2 x 58 watt	116W
Corridor 1	5	2 x 58 watt	580W
Corridors 2 and 3	7	2 x 58 watt	812W
Office	1	2 x 58 watt	116W
Sensory Room	2	2x 58 watt	232W
Classroom 1	6	2 x 58 watt	696W
Toilet with hoist	2	2 x 58 watt	232W
Girls' toilet	1	2 x 58 watt	116W
Staff toilet	2	2 x 58 watt	232W
Classroom 2	4	2 x 58 watt	464W
Classroom 3	4	2 x 58 watt	464W
Classroom 4	4	2 x 58 watt	464W
Piano room	1	2 x 58 watt	116W
Staffroom	2	2 x 58 watt	232W
Boys' toilet	2	2 x 58 watt	232W
Store room	1	2 x 58 watt	116W
Classroom 5	6	2 x 58 watt	696W
Classroom 6	7	2 x 58 watt	812W
Outside lights	10	1 x 250watt	2500W
Total	**68**		**9.228kWh**

Table 7.4 Light Fixtures

When discussing the energy audit with David from B+L, he volunteered to carry out an assessment of retrofitting the existing lights with LED lighting. To upgrade all of the building's lighting, internal and external, with LED fixtures would cost just over €10,000 with a saving of €2,220 per year, resulting in a payback period of 4.8 years.

Lux readings were also taken in each room on a cloudy day between 15:15 and 15:45. The results show that in all of the classrooms, with the exception of Classroom 6, artificial lighting is required. Each of the corridors receive poor natural light, in particular corridor 2 which has no windows.

Location	Reading without artificial light.	Reading with all lights turned on.	Guidelines as per TGDs (Planning and Building Unit, 2014)
Entrance porch	342	400	120
Corridor 1	40	162	120
Classroom 1	47	1025	300
Corridor 2	3	305	120
Classroom 2	118	260	300
Classroom 3	66	187	300
Classroom 4	200	266	300
Corridor 3	20	217	120
Classroom 5	43	493	300
Classroom 6	402	587	300
Staffroom	72	106	-

Table 7.5 Lux levels at Scoil an Bhaile Nua.

Heating.

The school has an oil-fired central heating system. The boiler was upgraded following the last extension (2014/2015). The heating system is now zoned, offering better control to the occupants. As one of the classrooms was vacant at this time and the sensory room was only in use periodically, the heating was not timed to come on in these rooms.

Heating bills were collected for the academic year 2016/2017. Eight hundred litres of oil was purchased in December 2016 and the tank was filled again in February 2017 and April 2017. This resulted in 2400 litres of oil used in one academic year.

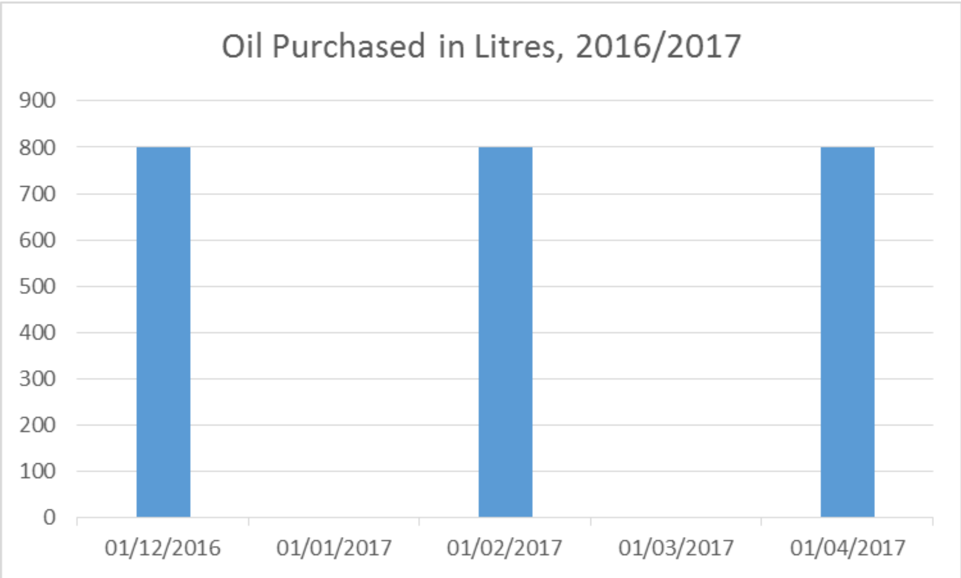

Figure 7.8; Historical Oil use at Scoil an Bhaile Nua.

As Scoil an Bhaile Nua used 2400 litres of oil in one year this equates to 46.04kWh/m^2/p.a. (see appendix G for calculations). Oil use continued to be monitored during the year 2017/2018, as shown in figure 7.9, where 2750 litres were purchased. This equates to 52.73kWh/m^2/p.a. (see appendix G for details).

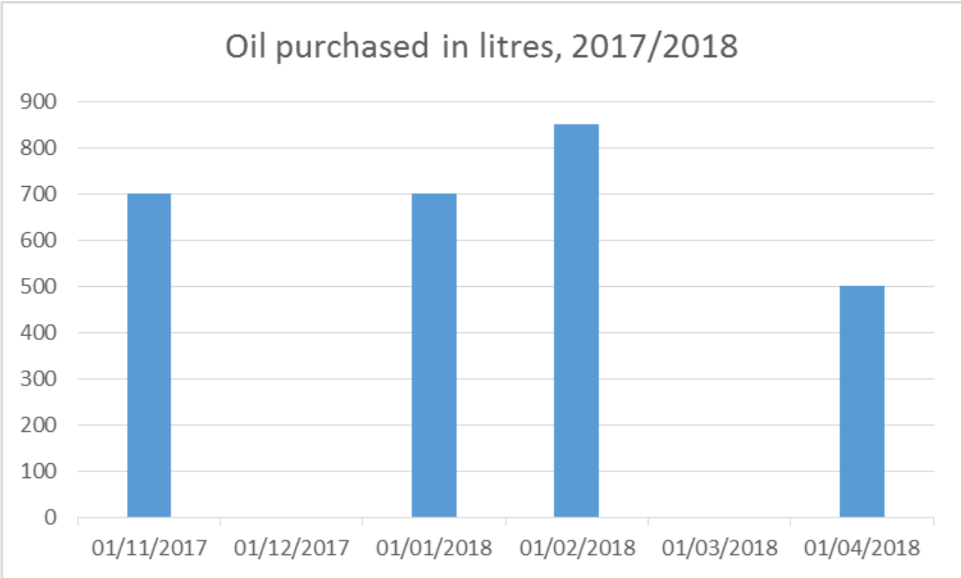

Figure 7.9 Oil purchased at Scoil an Bhaile Nua 2017/2018

These figures compare extremely favourably to the nearest comparable benchmark which is 119 kWh/m^2/p.a. for fossil fuel consumption in primary schools in Northern Ireland (Keohane, n.d.). However, it must be remembered that classroom 4 was not in use at this time (39m^2). Also, average classroom temperatures for the winter of 2017/2018 during the winter months were often under 18˚C (see section 7.3.2) indicating that perhaps the school were overly conservative with their oil use. However, a slightly cool classroom is more conducive to learning than a warm room (Leung and Fung, 2005) and lowest average temperatures were 17 ˚C during a very cold winter in 2017/18.

Building Fabric.

No detailed investigations were conducted into the internal fabric of the building, but a visual assessment of the school determined that there were no major defects with the building envelope. However, in classroom 3, one of the 1930s classrooms that is in the centre of the original school house, black mould growth was visible on the upper external north-facing wall, as seen in figure 7.10. There was also visible mould growth on the ceiling of corridor two which consists of a flat roof and no natural lighting sources.

Figure 7.10 Evidence of mould growth on the north-facing wall of Classroom3.

Following on from the energy audit, three unannounced walk-through visits occurred during the months of September and October 2017. Walkthroughs have been used in research with good effect to determine what conservation measures are being utilised (e.g. waste walkthroughs were used by Ana *et al.* (2011) and energy walkthroughs were used by Lourenço *et al.* (2014)). During each walkthrough, all windows and doors were closed in unoccupied classrooms and the lights were always off. On the three occasions, one projector was left in stand-by mode. On the first and third visits, the lights were on in each of the three corridors but on the second walkthrough, these lights were off. Overall, it was evident that these teachers were consciously turning off all electrical appliances and closing windows and doors before leaving their classrooms in the evening.

7.2.2 Waste.

As already noted, Scoil an Bhaile Nua had a Green Flag award for waste management and on initial contact with the school, the principal expressed the opinion that they were very good at waste separation and she felt the teachers of the school consistently reminded pupils about good waste management practice. Waste separation took place on site and there were separate collection points throughout the building for recycling, waste and organic material. Waste collection took place every second Thursday and senior pupils had responsibility for putting out the bins on a Wednesday evening. Collection took place for recyclables, waste and organic matter. There was no composting facility on site.

Three waste audits took place on 15th November 2017, 29th November 2017 and 7th February 2018. The audits took place on Wednesday evenings when the pupils left the building in order to have a 'full' two-week's waste.

	Audit 1	**Audit 2**	**Audit 3**	Av. Mean Weights.
Recycling	6kg	10kg	7.5kg	7.8kg
Waste	16.2kg	11.4kg	16.5kg	14.7kg
Organic	7.95kg	10.65kg	12.25kg	10.3kg
Notes:				
Recycling bin	✓ Mainly paper and cardboard.	✓ Mainly paper and clean plastic containers. × A number of soiled food wrappers.	✓ Mainly paper.	Weekly av. = 3.9kg
Waste bin	✓ Soiled food wrappers. × Some organic matter and clean paper.	✓ Soiled food wrappers and containers. × A small amount of clean paper.	✓ Soiled food wrappers. × Quite a lot of clean paper and plastic containers (water bottles, milk cartons).	Weekly av. = 7.4kg
Organic bin	✓ Mainly fruit skins/remains. Some used teabags.	✓ Mainly fruit skins/remains. Some used teabags.	✓ Mainly fruit skins/remains. Some used teabags.	Weekly av. = 5.2kg

Table 7.6 Results of Initial Waste Audit.

As can be seen from Table 7.6, the first audit showed that there was potential recyclable and compostable material being placed in the waste bin. The principal expressed her disappointment when she saw the waste had not been separated correctly and when the second audit was being carried out, there were new signs on each of the bins signifying their use. As a result, waste separation had significantly improved. However, it is clear that by the third audit, which took place a number of weeks after the first two, habits had reverted back.

During this initial audit, it was also noted that there were no policies or procedures in place for taking green procurement into consideration when purchasing new equipment or other materials such as art supplies.

7.2.3 Water.

This school had also received their Green Flag in the area of water management. The school had its own well, water tower and water treatment system. This is not common in Irish primary schools but it was not viewed as a barrier to conducting the case study with this school as it had already been determined that EMS are site specific and there would almost always be something unique to each school site.

Figure 7.11 Water tower at Scoil an Bhaile Nua

As the school was not on mains water supply, there was no water meter at the school. It was too expensive to install a meter, therefore the water audit consisted of identifying all water components on site, as shown on figure 7.12, and completing a visual check for leaks. Three unannounced walkthroughs were carried out in October 2017, December 2017 and February 2018 to check for leaks and to see if all taps, etc. were being turned off correctly. There were no leaks identified on any of the three walkthroughs. On the first and second walkthroughs, all taps were turned off correctly. On the third walkthrough, there was one tap that was not closed correctly and was dripping in the boys' toilets on corridor 2. The water audit was carried out in June 2018 and all water components were identified on a plan of the school. It was noted that the cisterns of each of the toilets were installed with water displacement devices to reduce the volume of water used when flushing. The urinals in the boys' toilet were also fitted with a water saving device to reduce the flow of water during closing hours when the urinals would not be used. However, this needed to be turned on manually each evening and the principal admitted to regularly forgetting to do this. Again, there were no leaks identified at this time.

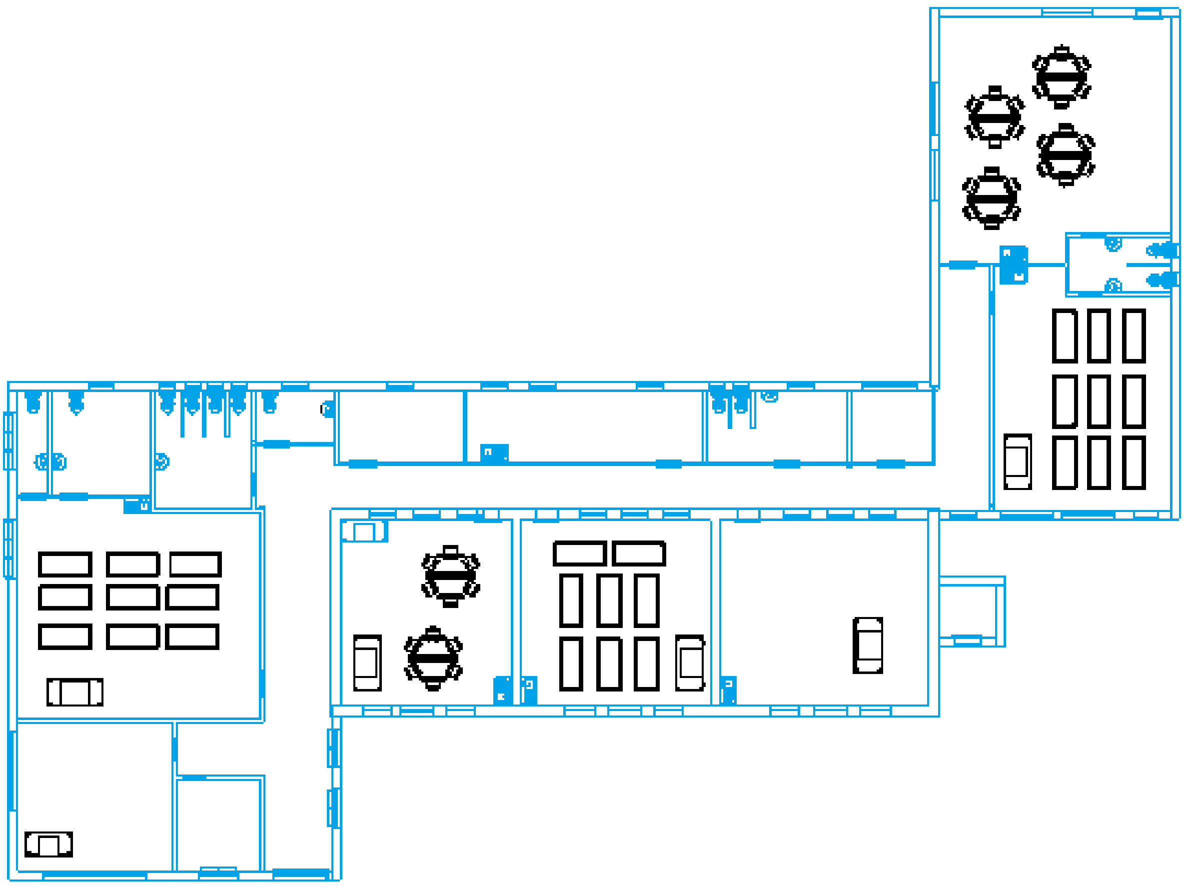

Figure 7.12 Water components at Scoil an Bhaile Nua.

Outside, there was one tap located at the back of the school just outside the staff room. There was also a water butt on site but it was not connected to the drainage pipes.

Item	Number	Location	
Sinks	14	Classroom 1 Girls' Toilet Staff Toilet Staffroom Boys' Toilet Classroom 2 Classroom 3 Classroom 4 Classroom 5 Classroom 6	3 1 1 1 1 1 1 1 2 2
Toilets	11	Classroom 1 Girls' Toilet Staff Toilet Boys' Toilet Classroom 5/6	2 4 1 2 2
Urinals	4	Boys' Bathroom	4
Outdoor taps	1	To the back of the school	1

Table 7.7 Water components at Scoil an Bhaile Nua

7.2.4 Biodiversity and the school grounds.

This was the only theme of the four where the school had not applied for a Green Flag. As the school is located on a large site in a rural setting, there was substantial opportunity to develop this area.

The grounds of S.N. an Bhaile Nua were surveyed on 29th September 2017. The habitats were classified according to '*A Guide to Habitats in Ireland*' (Fossitt, 2000) and marked on a site map, as shown on figure 7.13.

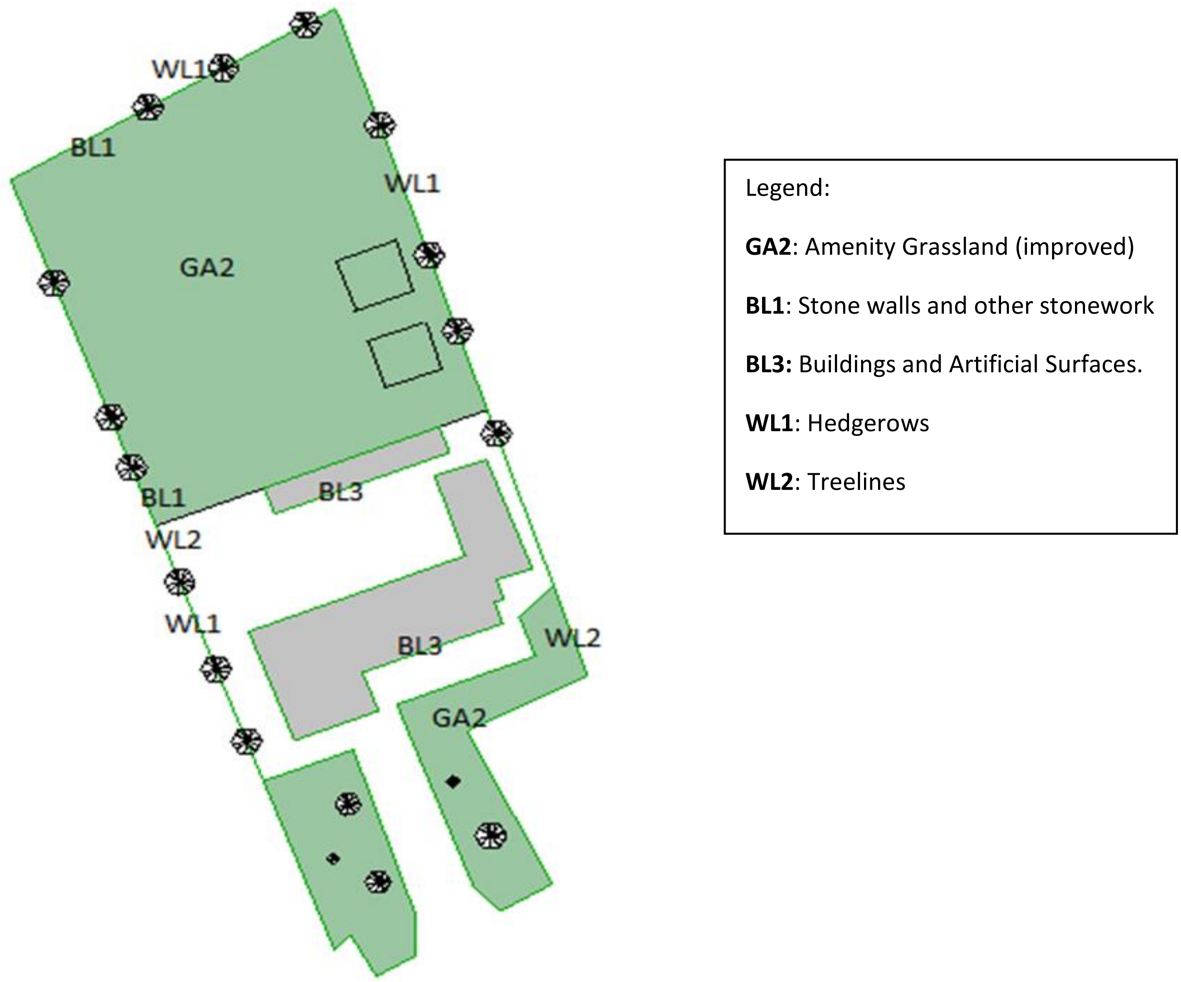

Figure 7.13 Site map with Fossitt Indicators.

On the school site, there were five habitats identified.

GA2: Amenity Grassland (improved).

This was the largest habitat on site, located to either side of the entrance path to the front of the school building and an area measuring approximately 2500m^2 to the rear of the building, behind the concrete play-area. There are a small number of trees located on the grassland to the front of the building, including silver birch *(Betula pendula)* and Rowan *(Sorbus aucuparia)*. The area to the front consists mainly of ribword plantain *(Plantago lancelata)*, clover *(Trifolium spp.)* and self Heal (*Prunella vulgaris*). The grassland to the rear of the site is used by the school for sport and physical education.

Figure 7.14 Amenity Grassland at S.N. an Bhaile Nua.

<u>*BL1: Stone Walls and Other Stonework*</u>.

The site is bounded on the west, north and east by a dry stone wall. Lichens and mosses were found on the wall as well as plant species including bracken *(Pteridium aqulinum)* and dog rose *(Rosa canina)*. Sections of this wall were also covered in ivy *(Hedera helix)*. Some stones had come loose and were located at the foot of the wall creating a habitat for insects such as woodlice. It was noted along a stretch at the east border that thistles (*Cirsium vulgare)* were growing but had recently been sprayed with some form of herbicide.

Figure 7.15 Dry stone wall

Figure 7.16 Hedgerow where recent spraying had occurred

<u>*BL3: Buildings and Artificial Surfaces*</u>.

The built land on this site consisted of the wall at the entrance to the south of the site, a wall at the east boundary, the school building itself including the sheltered area and water tower and the concrete yard and pathways.

Figure 7.17 Building and concrete play area

<u>WL1: Hedgerows</u>.

Hedgerow bordered the school site to the east, north and west on top of and behind the dry stone wall. The hedgerow consisted mainly of Blackthorn (*Prunus spinose)*, Hawthorn *(Crataegus monogyna)* and Gorse (*Ulex europeaus).*

Figure 7.18 Hedgerow at S.N. an Bhaile Nua

<u>WL2: Treelines</u>.

At sections along the hedgerow, treelines were also evident. The main trees noted in the treelines were Alder *(Alnus glutinosa),* Ash *(Fraxinus excelsio)* and Hawthorn *(Crataegus* *monogyna)*. On the east side, towards the front of the site, there was also a dense line of Leyland cypress (*Cupressus leylandii).*

Figure 7.19 Treeline at S.N. an Bhaile Nua

Common name	**Latin name**
Trees front	
Silver birch	*Betula pendula*
Horse chestnut	*Aesculus hippocastanum*
Rowan	*Sorbus aucuparia*
Beech	*Fagus sylvatica*
Grass sward front and back	
Creeping buttercup	*Ranunculus repens*
Clover	*Trifolium spp.*
Bugle	*Ajua reptans*
Dandelion	*Taraxacum offinale*
Self heal	*Prunella vulgaris*
Ribwort plantain	*Plantago lancelata*
Daisy	*Bellis perennis*
Broad leaved dock	*Rumex obtusifolius*
Smooth cats ear	*Hypochoeris glabra*
Yorkshire fog	*Holcus lanatus*
Creeping bent	*Agrostis stolonifera*
Meadow grass species	*Poa spp.*
Perennial Rye grass	*Lolium perenne*
Hedge/Wall	
Ivy	*Hedera helix*
Herb-Robert	*Geranium robertianum*
Bramble	*Rubus fruiticosus spp.*
Dog rose	*Rosa canina*

Ground elder	*Aegopodium podagraria*
Creeping thistle	*Cirsium arvense*
Bracken	*Pteridium aqulinum*
Alder	*Alnus glutinosa*
Ash	*Fraxinus excelsior*
Hawthorn	*Crataegus monogyna*
Sycamore	*Acer pseudoplatanus*

Table 7.8 Vegetation at S.N. an Bhaile Nua

As part of the grounds audit, four soil samples were taken from the site – samples one and two were taken from the front of the school from the east side and west side respectively. Sample three was taken from the west side of the large green area at the back of the school and sample four was taken from the east side.

First, the samples were dried out in a soil oven to calculate water content. The dried samples were ground and analysed for pH using a pH meter and buffer solution of pH4. Last, Stokes Law of Settlement was used to determine the percentage of sand, silt and clay in each sample and the 'texture triangle' was used to determine soil type (FitzPatrick, 1986, p. 89). The results are displayed in Table 7.9.

Sample	**Water content**	**pH**	**Texture**
S1	49.2%	4.8	Loamy sand
S2	72.5%	6.0	Sandy loam
S3	72.5%	5.2	Sandy loam
S4	90%	5.3	Loamy sand

Table 7.9 Results of soil analysis

7.2.5 Survey questionnaires.

Before beginning the new EMS, the seven participating teachers were asked to complete a short survey (appendix C) to assess their opinions on how the school was performing in the various areas. The first section of the survey looked at the school's IEQ. The second section focused on the current EMS which was based on the Green School's approach. The third and fourth sections asked about the teachers' use of the built and natural environment when teaching, while the final section focused on ESD. Six of the participating teachers completed this survey (only one of the teachers who were job-sharing completed the survey as they were sharing a classroom).

Section one, which looked at the school's IEQ, was a Likert style survey where one was 'most uncomfortable' and five represented 'most comfortable'. The results show that, in general, teachers are happy with the lighting and acoustics in their classrooms, although one of the teachers in the older part of the building regarded the artificial light as 'most uncomfortable'. Thermal comfort was generally regarded as good although some of the teachers marked temperature fluctuations and draughts as somewhat uncomfortable. The teachers' opinions on IAQ were also mixed. The teachers in the older part of the building marked air quality lower than the teachers in the newer classrooms. However, one teacher in the older building rated air quality as very comfortable. This teacher generally has smaller numbers of pupils in her room at any given time which may be an influencing factor. Table 7.10 shows the number of responses, as well as the mean and deviation from the mean.

		1 (*n*)	2 (*n*)	3 (*n*)	4 (*n*)	5 (*n*)	Mean	Std. Deviation
Light	Natural light			*1*		*5*	*4.67*	*0.816*
	Artificial lighting	*1*		*2*	*1*	*2*	*3.50*	*1.517*
Sound	Sound/Acoustics			*1*	*2*	*3*	*4.33*	*0.816*
Thermal Comfort	Temperature (general)			*1*	*3*	*2*	*4.17*	*0.753*
	Temperature fluctuations			*3*	*1*	*2*	*3.83*	*0.983*
	Draughts		*1*	*1*	*1*	*3*	*4.00*	*1.265*
Air quality	Air quality		*1*	*1*	*1*	*3*	*4.00*	*1.265*

Table 7.10 Results of 'Indoor Environmental Quality'.

Section two was entitled 'Environmental Management Systems' and involved statements about the current approach (the Green School approach) on a Likert scale, where one equated with 'strongly disagree' and five with 'strongly agree'. Opinions in this area were quite varied, as seen in figure 7.11. One of the new teachers did not answer this section but said that in her old school '*it was extremely successful*' and '*it gave the children a sense of responsibility*' (Ciara). Another teacher didn't answer three of the questions but wrote in that this programme '*has not been done over the last few years*' (Claire). This is interesting as the Green School programme is supposed to be a continuous cycle of auditing, planning and adapting. However, it would appear that this teacher believes that if they are not applying for a flag, they are not engaging with the EMS. This reflects the response to the principal surveys in Chapter 4 whereby a number of principals referred to actions that they did when they were applying for a flag (e.g. composting when applying for the Waste flag) but that they ceased the action once the flag was achieved. However, the teachers perceived their participation in the programme as high with a mean average of 4.25 and only 0.5% deviation from the mean. Table 7.11 shows the number of responses, as well as the mean and deviation from the mean.

	1	2	3	4	5	Not answered	Mean	Std. Deviation
The Green School Programme is a useful programme for our school		*1*	*1*	*3*		*1*	*3.4*	*0.89443*
I fully participate in the Green School Programme in our school.				*3*	*1*	*2*	*4.25*	*0.5*
The children fully participate in the Green School Programme in our School.		*1*		*3*		*2*	*3.5*	*1.0*
The Green School Programme is difficult to implement.		*1*	*3*			*2*	*2.75*	*0.5*
The Green Flag is an important sign of our environmental achievements.		*1*		*3*	*1*	*1*	*3.8*	*1.09545*
I incorporate EMS topics (eg. waste, water, energy, etc.) into my teaching.	*1*		*1*	*2*	*1*	*1*	*3.4*	*1.51658*
Pupils choose topics (eg. energy, biodiversity, etc.) for exploration.	*2*	*3*				*1*	*1.6*	*0.54772*

Table 7.11 Results of 'Environmental Management System'

The third and fourth sections asked teachers to identify the subjects they regularly use the built and natural environments of the school for when teaching. As illustrated in Figures 7.20 and 7.21, the teachers make reference to using the built environment across more subjects than the natural environment. All teachers said they use the built environment regularly in the teaching of maths while five of them use it in the teaching of Geography and Science. Only one teacher said they use the built environment regularly when teaching SPHE or Music. There was an option to comment on the use of the built environment in the curriculum and some teachers noted the various ways they use the building in various subjects. For example, two teachers said that they use the school building when teaching length in Maths, two teachers refer to the built environment when looking at materials in Science and Geography and two use the building to teach about change and continuity in History.

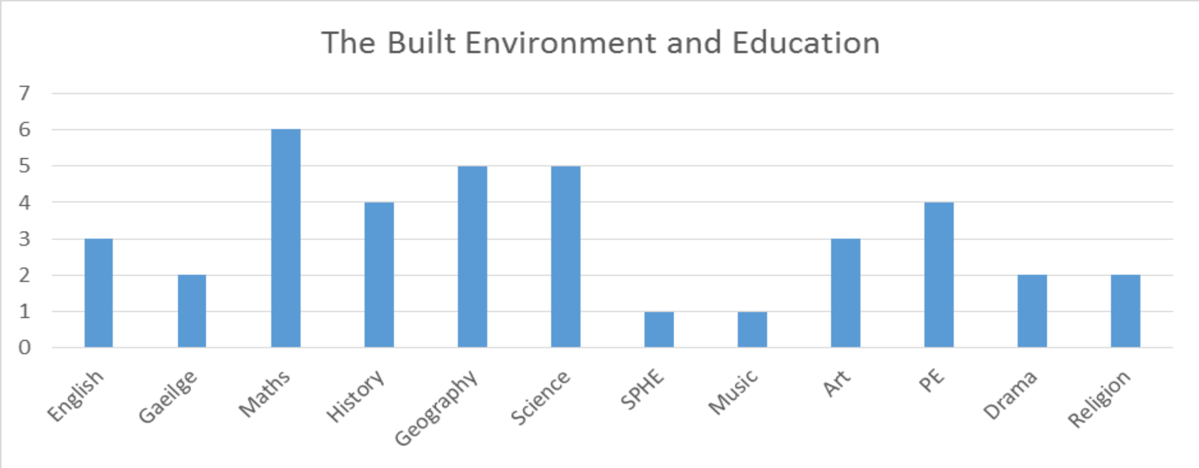

Figure 7.20 Results of 'The Built Environment and Education'

There was less engagement with the school's natural environment for teaching and learning. Five of the teachers said they use the school's natural environment for teaching PE (physical education) and four said they use it regularly when teaching science. This is reflective of the findings in the literature review whereby studies have shown that if pupils are taken outside for classes, it tends to be for physical education or science (Dyment, 2005). For five subjects – Gaeilge, History, SPHE, Music and Religion, it appears these teachers to not utilize the outdoors at all. Many teachers referred to PE when writing their comments on this section, saying they love to bring the children out to the large green area at the back of the school. When referring to science and the natural environment, teachers mentioned studying plants, searching for mini-beasts and going for nature walks.

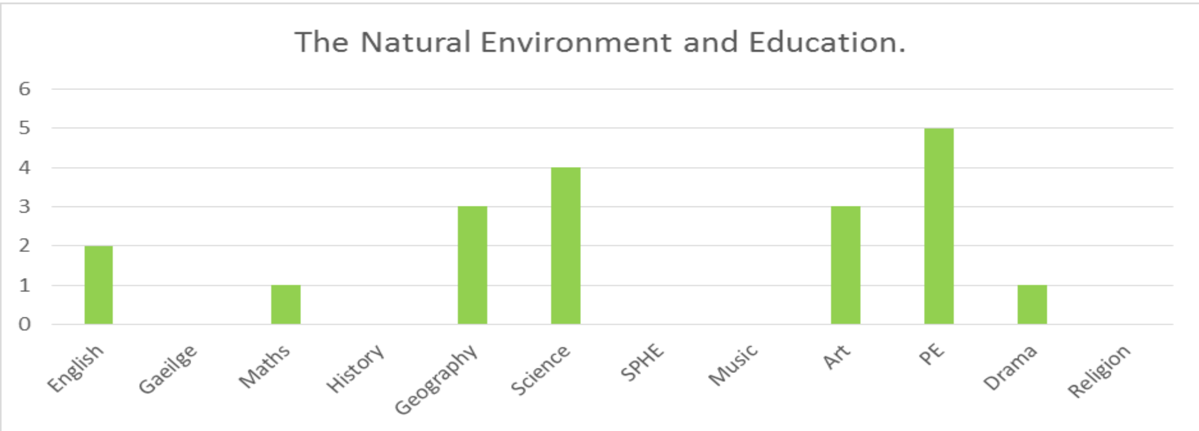

Figure 7.21 Results of 'The Natural Environment and Education'

The final section of this survey was 'Education for Sustainable Development'. For most of the teachers, the only contact they had with this concept was through the workshops as part of this research – three of which they had partaken in prior to their completing this survey. One of the teachers was not long qualified and had encountered ESD on her undergraduate degree. It was this teacher who answered strongly agree to statement five – '*I have the skills to engage an ESD approach to teaching and learning*'. One teacher, who was returning from a career break, didn't answer the last four statements, writing '*this is a new term for me and would not have been in use when I was last teaching five years ago'* (Ciara).

	1	**2**	**3**	**4**	**5**	**Not answered**	**Mean**	**Std. Deviation**
ESD is an important approach to education.			*2*	*2*	*2*		*4.00*	*0.89443*
I regularly incorporate sustainability topics into my teaching.		*1*	*3*	*1*		*1*	*3.00*	*0.70711*
It is easy to access teaching resources to support ESD.	*1*		*2*	*1*		*2*	*2.75*	*1.25831*
I am confident in engaging an ESD approach to teaching and learning.	*1*	*1*	*2*	*1*		*1*	*2.60*	*1.14018*
I have the skills to engage an ESD approach to teaching and learning	*1*	*1*	*2*		*1*	*1*	*2.80*	*1.48324*

Table 7.12 Results of 'Education for Sustainable Development'.

Overall, the survey revealed that the participating teachers were relatively happy with the school's physical environment although some teachers found the artificial lighting uncomfortable and others were unhappy with air quality and thermal comfort. However, they showed an awareness of the school's built environment and the ways in which they interacted with it. For example, one teacher wrote ' *I have great natural light in [my] classroom but find myself drawing blinds on windows facing the yard to reduce distractions as other classes do P.E. etc. outside*' (Deirdre).

It appeared that the teachers used the school's built environment when teaching, mainly in Maths, Science and Geography, but not necessarily for ESD or EMS. It appeared that there was very limited use of the school's natural environment. And overall, the results showed that while the teachers believed that ESD was important, they lacked the skills, confidence and access to resources to implement this approach effectively.

7.3 Building Performance Monitoring.

Monitoring emerged as an important facet of energy management in both the researcher's observations and the FM interviews. Therefore, monitors were installed to record electricity usage and also temperature, CO_2 and RH levels in selected classrooms. As part of a more holistic approach to energy management, and with a focus on the building's impact on teachers and pupils, it was deemed important to monitor IEQ as well as energy consumption.

7.3.1 Electricity Monitoring.

An 'Owl Eyes' monitor was installed in September 2017 as discussed in Section 3.3.3. Up until this point, the school was monitoring their electricity usage via their electricity bills, which were sometimes estimated. The electricity monitor allowed the gathering of more detailed data on the school's electricity use and analysis of this data alongside the findings from the energy audit and the energy walkthroughs gave a more holistic picture of energy performance.

Although this monitor was relatively easy to use, initially there were a number of glitches encountered. For example, the instructions state that the display screen can be placed up to 30m from the distribution board. The principal decided to put the monitor in the main office, which was approximately 13m from the distribution board, so it could be viewed with ease by all staff. However, the readings were sporadic with the monitor regularly losing connection, so on the first visit to download data, I moved the display screen to classroom 2 which was just across the hall from the distribution board. However, the same problems were encountered again so the screen was moved into the same room as the distribution board. The reason for these issues was probably the thickness of the walls in the old school building. On another occasion, when the researcher visited, the screen was receiving no readings from the monitor. This time, the induction clamp had come loose from the incoming cable and had to be reattached more securely. While these are only small malfunctions, it shows the potential complications schools may face if they choose to use such equipment with no external support.

As a result of these minor issues, December 2017 is the first uninterrupted month of data recorded in this way and is displayed in Figure 7.22.

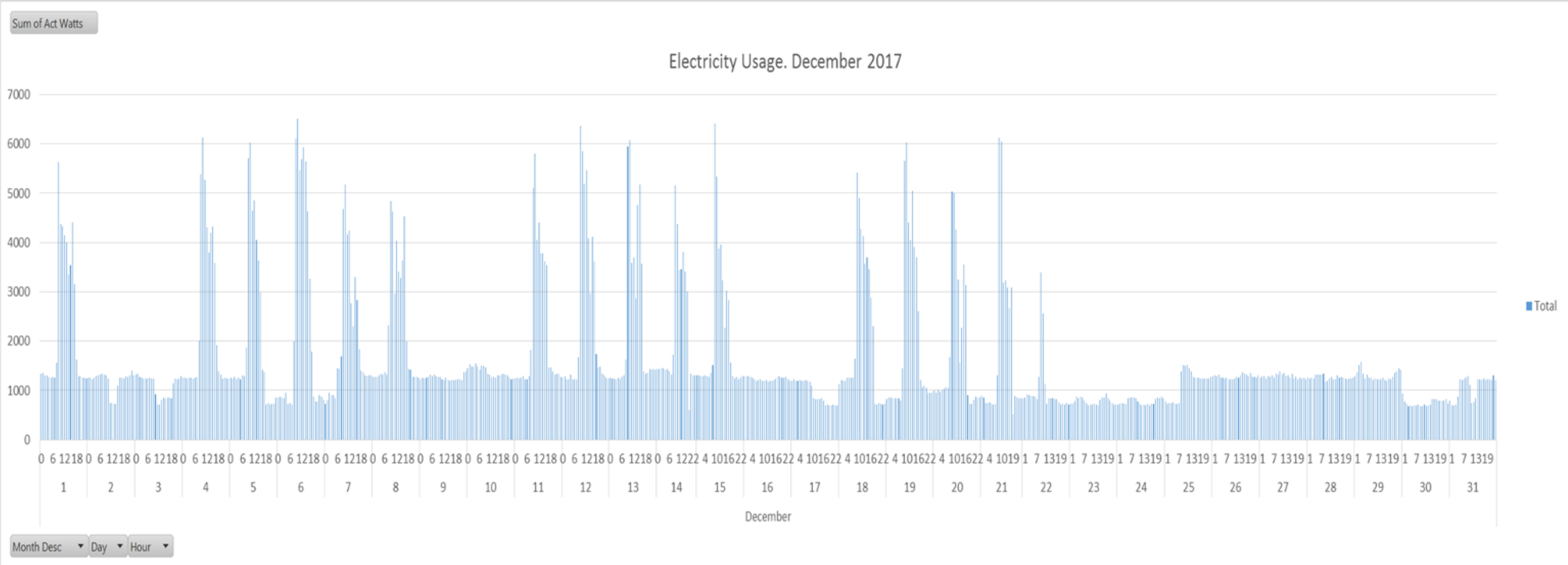

Figure 7.22; Electricity Use for December 2017.

From this initial graph, it can be seen firstly, that the base load is much too high for the load established in the energy audit. The monitoring indicated that there was approximately 1.4kWh of energy being used during unoccupied hours. The second finding from this graph indicated that this power use was most likely connected to an item on a timer. On the Monday of the Christmas holidays (25th) there was an increase in electricity use which was maintained throughout the week until Friday evening (29th). As the school was unoccupied at this time, the indication was that an automated timer had come on. As the heating system was the only item on timer control, it then became possible to locate the issue. David and John, engineers from B+L, identified the problem - the setting on the new boiler system was at local control which was interfering with the timer. This was identified in January 2018 and the principal was made aware. Figure 7.23 shows the electricity used for the month of March 2018. During this month, the school was closed for the Easter break from the 24th, where we can see the base load is now reduced to around 0.5kWh.

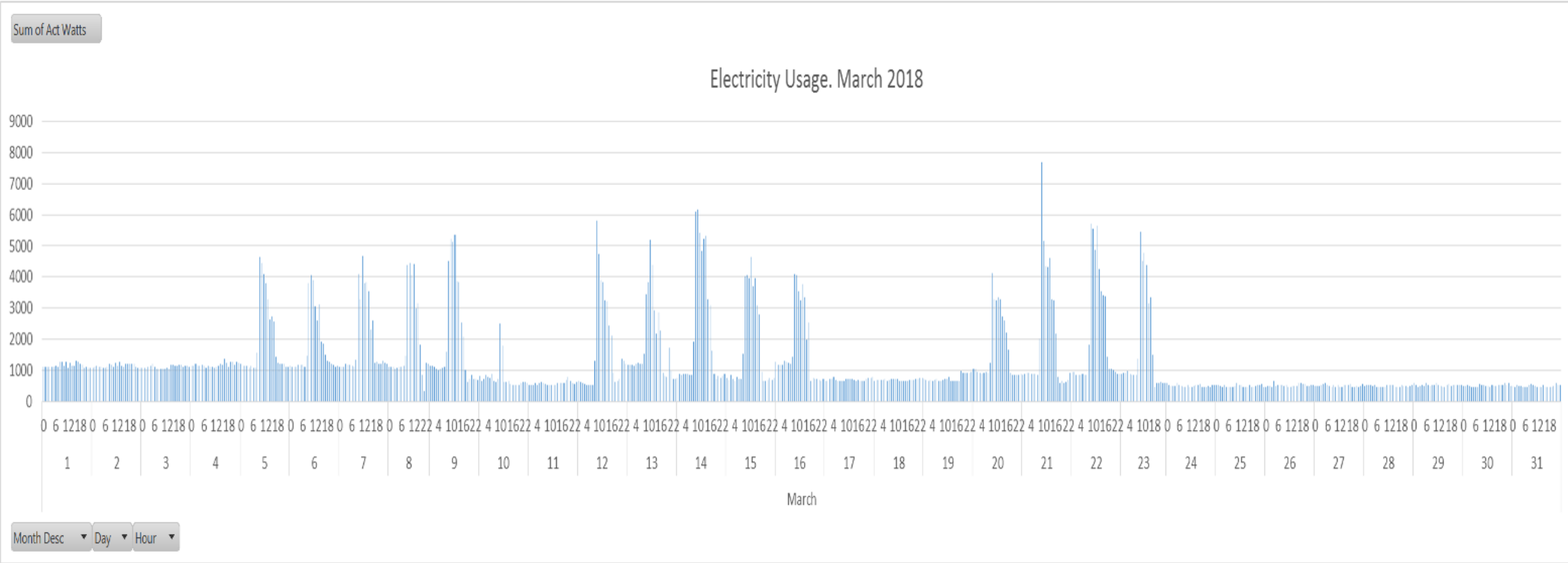

Fig 7.23; Electricity Use for March 2018.

Monitoring electricity use in a more detailed manner using available technology resulted in the identification of the problem that this school had been grappling with since 2014. Figure 7.24 shows electricity use from December 2017 to August 2018. Across these nine months, average electricity use was 792kWh per month. Based on the historical usage outlined in section 7.2.1, the average electricity use prior to this was 1151kWh per month.

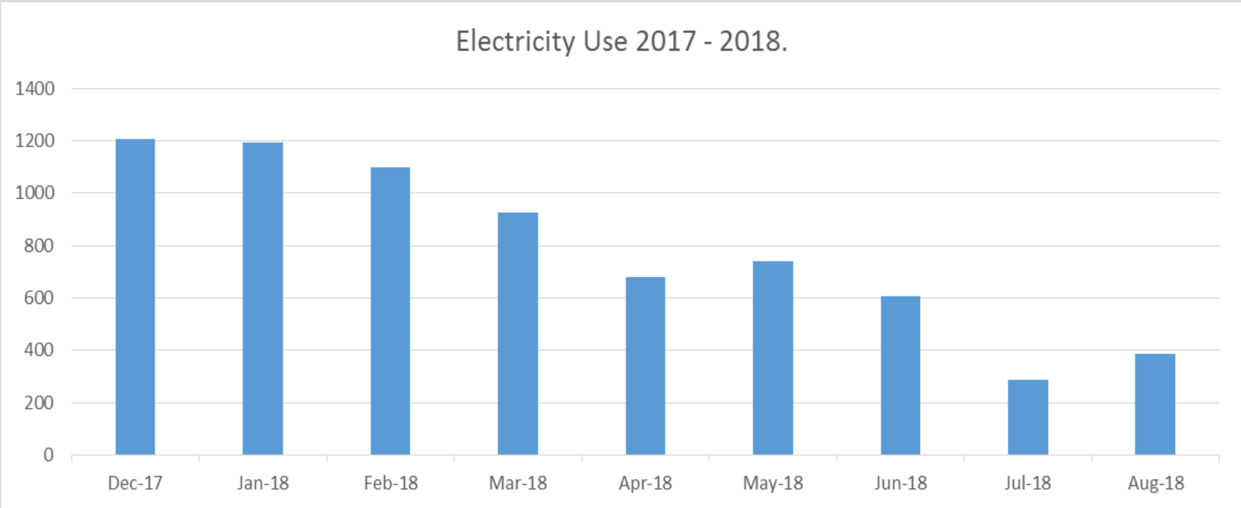

Figure 7.24 Electricity Use 2017/2018

Therefore, prior to the establishment of the new EMS, electricity use had already been improved through the energy audit and continued electricity monitoring.

7.3.2 Indoor Environmental Quality.

Three 'Green Eye Data Loggers' were installed in classrooms 1, 3 and 5 in October 2017, representing three building phases – 2014, 1937 and 2007 respectively. Again, there were a number of small glitches initially, the main one being the monitors turned off accidently by pupils. These monitors run on mains electricity, and pupils were in the routine of going around the classroom at 3pm to turn off all items.

The monitors in classrooms 1 and 5 had to be withdrawn in December 2017 due to shared use within the college. The remaining monitor was left in classroom 3 at the request of the principal. Classroom 3 had the poorest performance in relation to IEQ out of the three classrooms monitored, which was not surprising as it was the oldest part of the building.

Classroom 1, which was constructed in 2014, was a bright and spacious classroom. The classroom teacher reported that thermal comfort and air quality was very good in her opinion. This room appeared to have good ventilation and there were manual vents under each of the windows. Monitoring showed that for the three months, indoor temperature during occupancy hours was between 17˚C and 18˚C. (This was a particularly cold winter with average outdoor temperatures between 6˚C and 7˚C for these months (Met Éireann, 2019). This classroom preformed more favourably than both of the other classrooms in relation to CO_2 (see figure 7.26) and more favourable to classroom 3 in relation to RH (see figure 7.27).

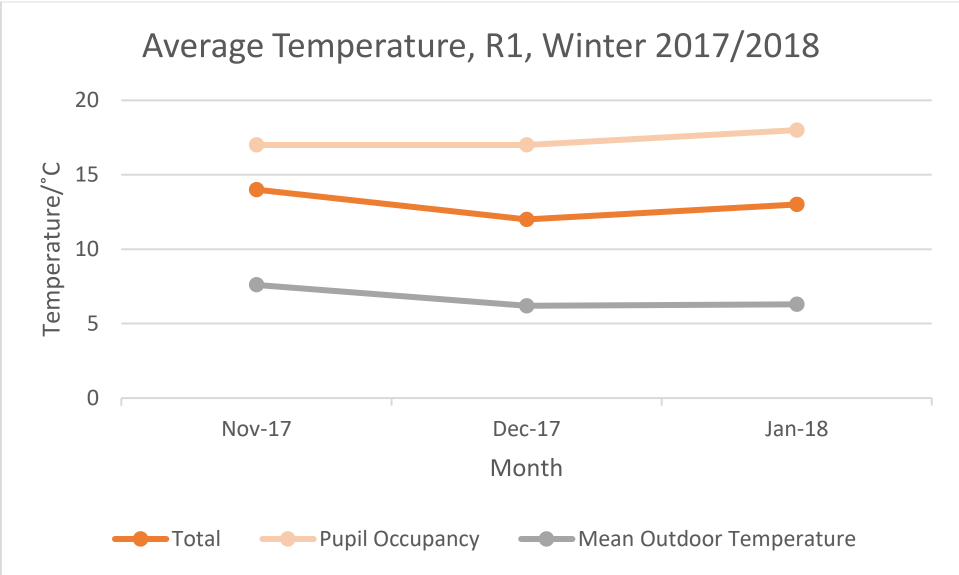

Figure 7.25 Temperature in Classroom 1

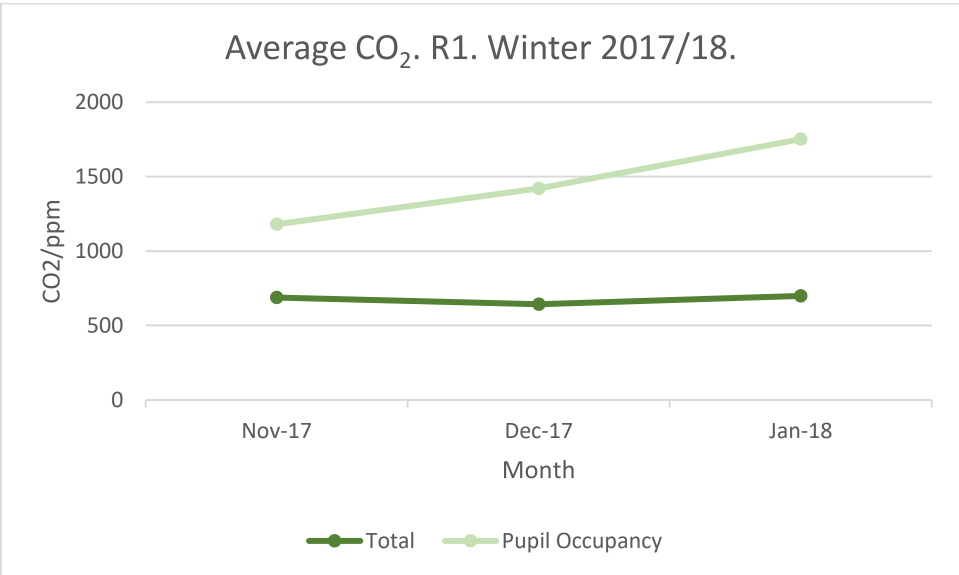

Figure 7.26 CO2 levels in Classroom 1

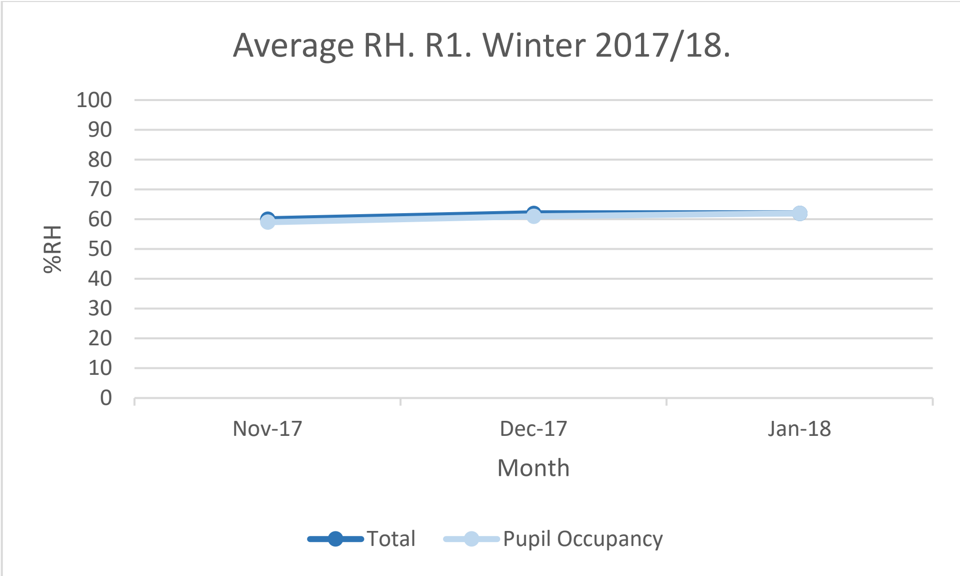

Figure 7.27 RH levels in Classroom 1

Classroom 5, which was constructed in 2007, was also bright and spacious. The class teacher described all IEQ parameters, including natural light, as being very good. This classroom was slightly warmer than classroom 1 during the three months it was monitored, but CO2 levels were higher as were RH levels.

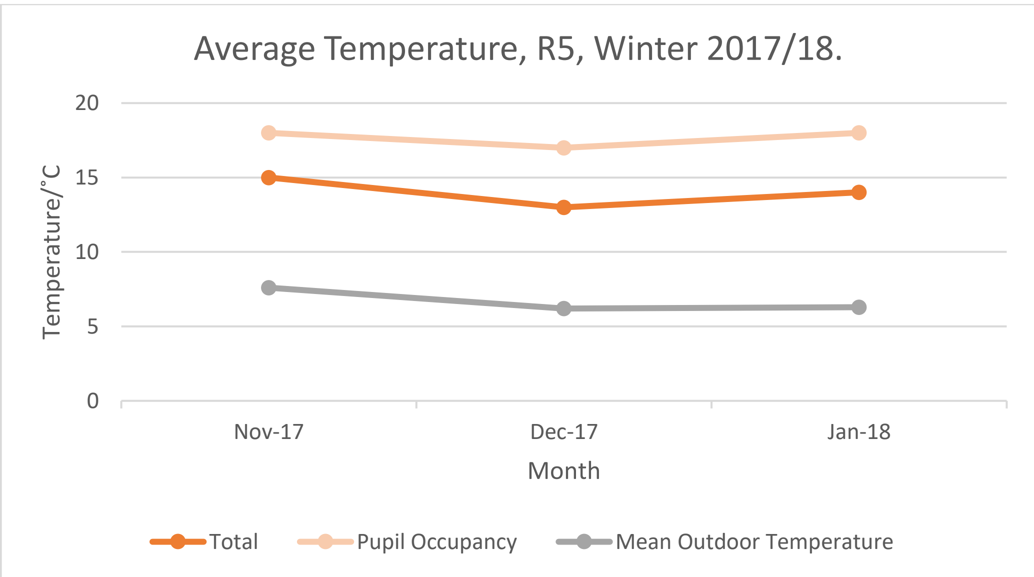

Figure 7.28 Temperature in Classroom 5

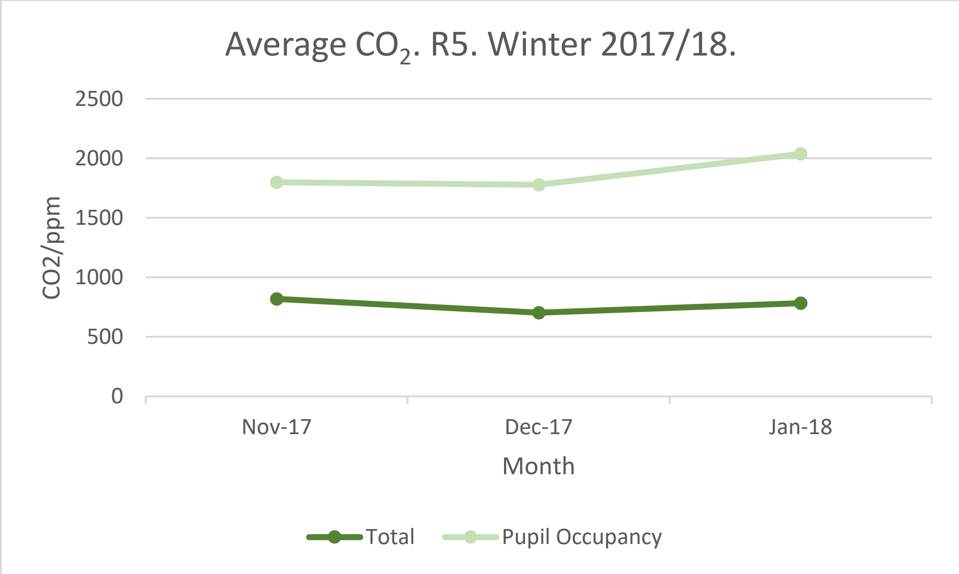

Figure 7.29 CO_2 levels in Classroom 5

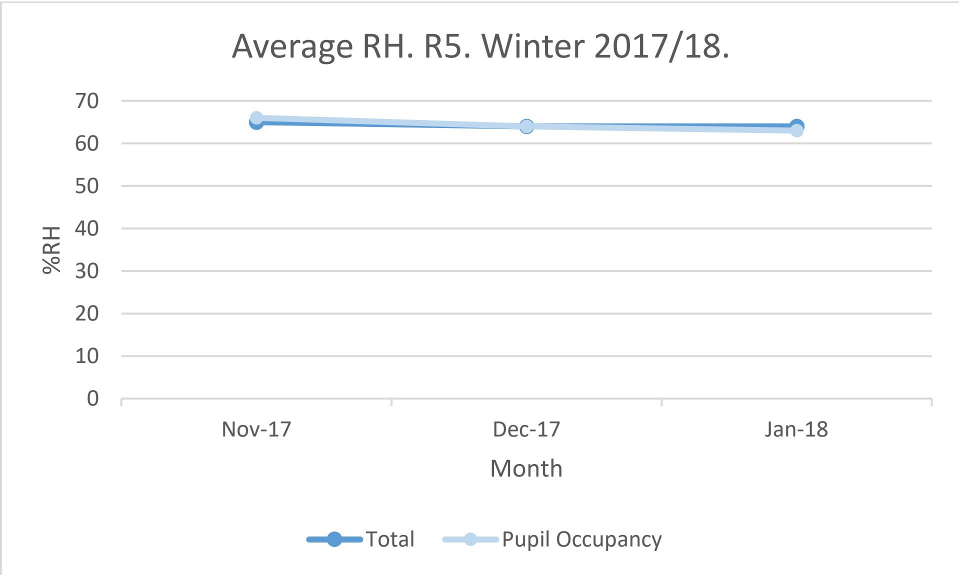

Figure 7.30 RH levels in Classroom 5

Classroom 3, which was constructed in 1937, was slightly warmer than the other two classrooms but had the poorest performance in terms of CO_2 and RH levels. The class teacher reported that thermal comfort was satisfactory but air quality was quite poor. Monitoring in this room began January 2017 (the monitor was consistently turned off by mistake during the initial months) and continued through to the end of the project. Figures 7.31, 7.32 and 7.33 show IEQ data from January 2018 through to August 2018.

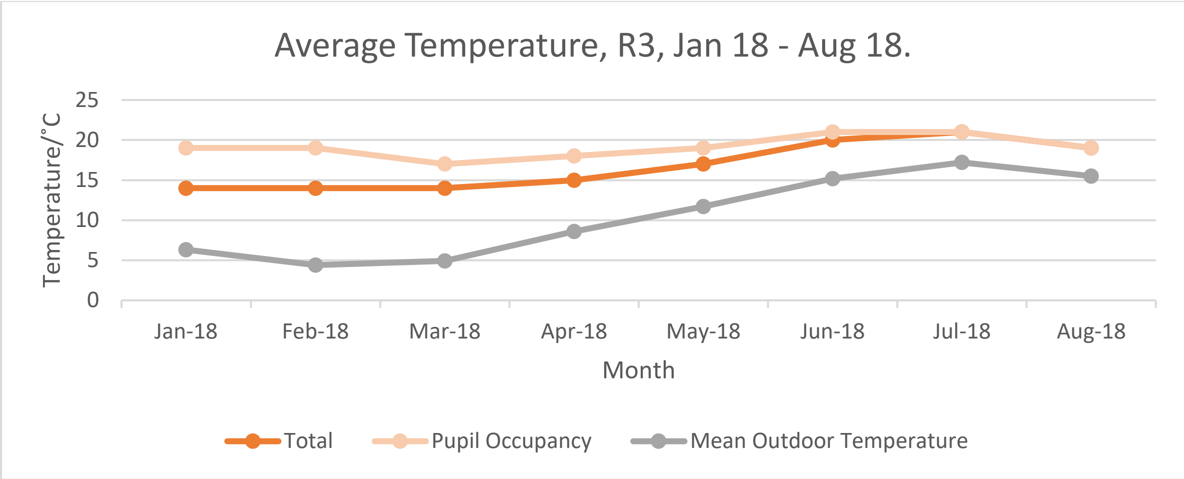

Figure 7.31 Temperature in Classroom 3

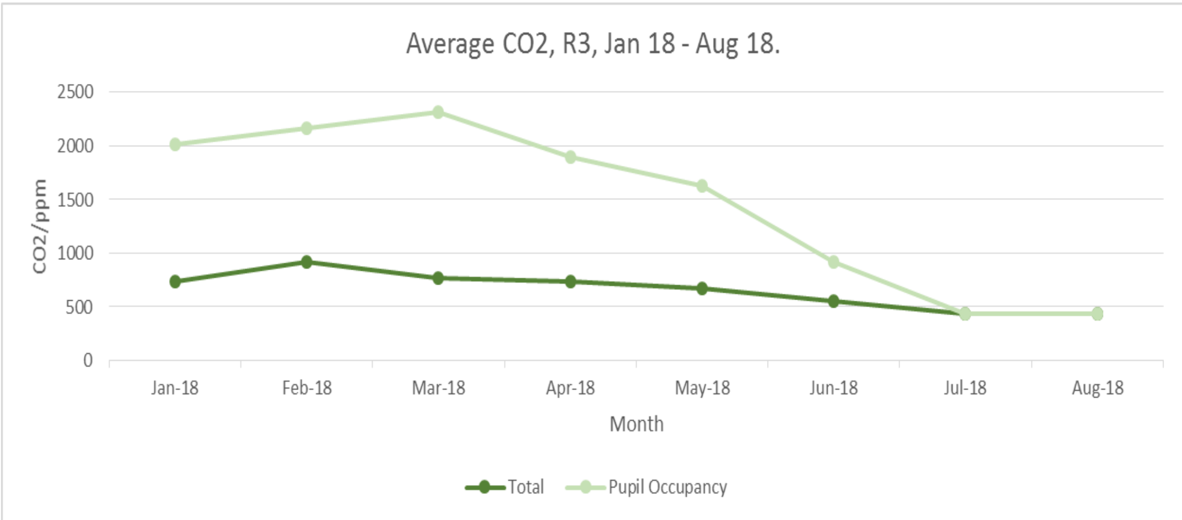

Figure 7.32 CO_2 levels in Classroom 3

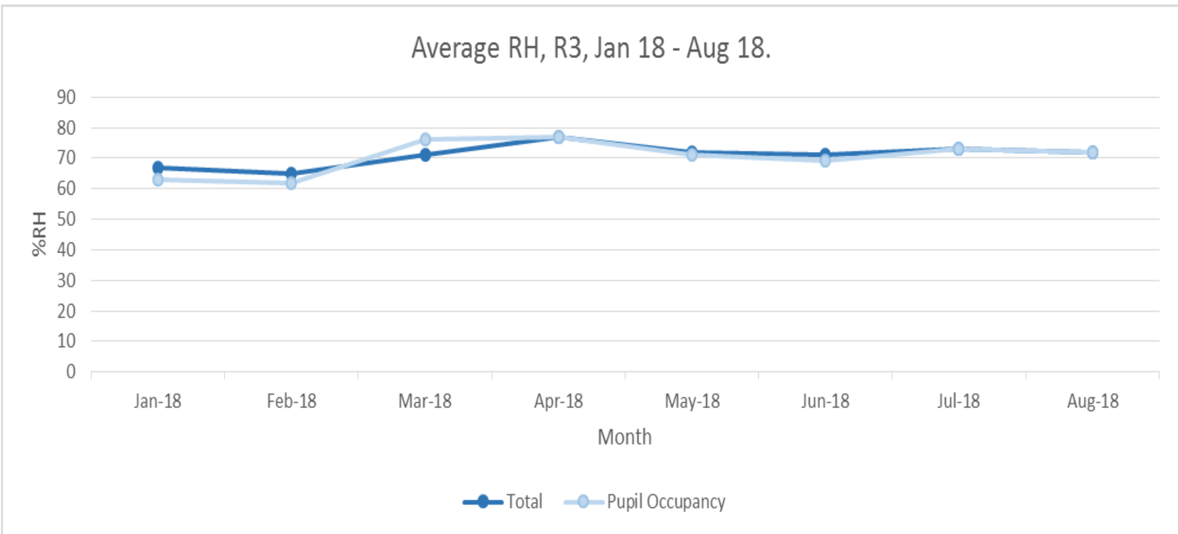

Figure 7.33 RH Levels in Classroom 3

Average temperature levels were below 18˚C in the two newer classrooms, rooms 1 and 5, for some of these winter months. However, both class teachers reported that the temperature of their classrooms was comfortable. Classroom 3, located in the oldest part of the school, was consistently warmer, most likely due to poorer ventilation. Classroom 3 performed the poorest in relation to CO_2, although all classrooms saw high CO_2 levels during occupancy hours. It appears that average CO_2 levels are higher during the colder months, most likely due to windows remaining closed to retain heat. RH levels were also highest in classroom 3 with average levels often above 70%, but RH levels were also quite high in the two newer classrooms with averages over the recommended 60% (Bakó-Biró *et al.*, 2012). Although the monitors had to be removed from classrooms 1 and 5 at the end of January, both teachers said they were more aware of the indoor environment and were more conscious of opening the windows when they felt it was needed.

7.4 Workshops at Scoil an Bhaile Nua.

Five workshops were prepared for the schools' teachers, as outlined in 5.3.3, to introduce them to the concept of ESD and to explore the four areas of the EMS. We met on Tuesdays at 3pm, and each workshop lasted between one to one and a half hours.

Workshop 1: Sustainable Development, Education for Sustainable Development and Sustainable Schools.

The first workshop, entitled '*Sustainable Development, Education for Sustainable Development and Sustainable Schools*' was an introductory session which gave an overview of each of the three concepts and showed how they were connected. The teachers were introduced to the concept of SD and the three pillars of sustainability – environment, society and economy. There was a brief discussion on the topic of climate change as a major contributing factor to the need to reorient livelihoods towards sustainability and this led into the Sustainable Development Goals. This then led into the need for ESD and the Irish policy document 'Education for Sustainablity – the national strategy for education for sustainable development, 2014 – 2020' was summarised and its aims discussed. At this point, the UNESCO website http://www.unesco.org/education/tlsf/ was explored and potential curricular impacts for this school were discussed. A significant portion of this workshop was given to discussing various interpretations of ESD and authors from the literature review were used as examples including Webster and Johnson (2009) and Orr (2002). This was done with the intention of helping the teachers to critically evaluate the current approach they were using (the Green School approach) and to question what aspects fit with their school's ethos and teaching approaches and which did not. The teachers then discussed what they thought a 'sustainable school' might mean to them and I showed some examples of 'sustainable schools' from around the world and their various approaches and philosophies were explored. My written observation following this session noted '*I felt the teachers were engaged with the topic and while most of it seemed to be very new to them, they showed a lot of interest in it*'.

Workshop 2: Energy Mangement.

The second workshop was entitled 'Energy Management'. To begin, the ISO 50001 framework was used to introduce the concept of energy management and an energy management system. Next, I informed the staff of the steps taken to conduct the energy audit and shared the results of the audit with the staff. IEQ data from December was also shared with the teachers and the graphs explained. Potential behavioural actions, such as opening windows instead of closing windows and doors during lunchtime were discussed which led into the idea of a more holistic approach to energy management. The staff expressed huge interest in the IEQ data and the $5^{th}/6^{th}$ class teacher said that her pupils were very interested in the monitor and often asked to open the windows when they saw the CO_2 levels rising. Following this, we began to look at energy management and the curriculum and identified and discussed how each subject could be used to explore energy with each class and how the built environment could be used to support teaching about energy in the curriculum. This was approached with an ESD focus with a view to exploring how the concept of energy management could permeate the curriculum, the campus and the local community.

Workshop 3: Managing the School Grounds

The third workshop began by looking at the definition of biodiversity and discussing its importance to healthy ecosystems and the various ecosystem services it provides. We continued by looking at current threats to biodiversity and species depletion, focusing on pollinator species. Following this, we explored various means of improving biodiversity on the school grounds – planting for pollinators, native wildflowers, attracting birds, bees, butterflies, etc. We took bees as an example and looked at the concept on connectivity within ecosystems. Following this, I distributed the report from the grounds audit, explained the current habitats that were on site and the potential to develop areas for planting, gardening, composting, etc. Finally we looked at the potentialities of using their school grounds to support all subjects across the curriculum. My observational notes following this session state '*The staff, and in particular the principal, showed significant interest in this topic and appear excited about the possibilities for developing their own grounds*'. It appeared that the teachers were most engaged during this session thus far. Whether this was to do with the topic in question or the fact that they were becoming more familiar with the structure of the workshops and ESD in general was unclear. Also, during this workshop, the principal told the staff that during the summer, when she met with me at the school during the month of July, all of the grass was scorched due to the heatwave that summer. Because of this, the foundations of the original 1800s school became visible on the front lawn. She told the staff that she would somehow like to mark the original school. I followed up on this idea by speaking to a landscape architect at WIT and delivered ideas to the staff at a later session. This then grew into a whole-school sustainability project, discussed later in section 7.5.5.

Workshop 4: Waste Management and Water Management

Due to time constraints, I decided to amalgamate the final two workshops on waste and water management. This was the last workshop and it took place in September 2018. Water management was looked at first with a view to a more holistic approach – that the focus would not be on conservation alone but would also consider issues such as hygiene and hydration (encouraging pupils to drink a healthy amount of water). The results of the audit were shown to the teachers and it was explained why metering did not occur. We then looked at the concept of water across the curriculum. As a focus, we looked at the idea of using a class novel on the theme and looked at a number of books that explore the concept of water management and conservation through a narrative approach. The teachers recalled how they monitored water previously, with pupils using checklists to record how many times the toilets were flushed during the day and totalling the amount of litres used per day.

Following this, we moved onto waste management. We began by looking at the waste management hierarchy and immediately the teachers expressed surprise at the position of recycling on the waste pyramid. One teacher said she had never thought of recycling as 'slowing the journey to landfill' and all teachers expressed the opinion that judging their waste management on recycling alone was not good practice. One teacher raised the issue of consumption and the other teachers agreed that this was an issue that would need to be explored with pupils. I showed the staff the results of the waste audit and the principal in particular expressed disappointment that the results dis-improved between audits two and three. From here we discussed how waste management could be incorporated across the curriculum and looked at some examples of projects where waste materials were used for art lessons.

Each teacher was given a USB key with a copy the powerpoints from each session, the written reports from each of the audits, links to any websites we had referred to or used to date and any other material that had been generated to date, such as the Revit model. These USB keys were updated with new resources as we came across them over the year.

7.5 EMS implementation at Scoil an Bhaile Nua.

During the academic year 2018/2019, the school created and implemented a new EMS. The school staff determined the direction the EMS would take in their school and the nature of its implementation. The role of the researcher/HEI social actor at this point was to enable the transfer of the FM knowledge and to facilitate the school staff in adapting it to their own EMS.

In September 2018, three new members joined the teaching staff of S.N an Bhaile Nua. As a result, the first meeting included another overview of the project and bringing the new staff up to date on the work carried out so far. During this phase, the researcher and teachers met once a month for an hour to an hour and a half. In September, as there were workshops to be carried out that had been carried over from the previous year, meetings took place on three occasions. Table 7.13 shows the timeline of work carried out during this phase.

Data	**Work**
September 2018	• Meeting with all staff. Introductions and briefing to new staff. • Staff completed initial teacher survey. • Workshops with teachers – *Biodiversity and the School Grounds, Water management in Primary Schools, Waste Management in Primary Schools.*
October 2018	• Meeting with teachers – creating a new EMS. First, we went over the findings from the FM interviews and literature review and discussed how these may manifest in the school setting.
November 2018	• Meeting with teachers – finalising the new EMS.
December 2018	• -
January 2019	• Meeting with teachers – discussing how the EMS is going so far.
February 2019	• Focus group

March 2019	• Meeting with teachers – establishing a plan for this year's main sustainability project – new wildflower garden.
April 2019	• Meeting with teachers – mapping out the grounds for the new wildflower garden and sensory path. • Meeting with teachers – discussing EMS implementation to date. • Waste audit 1
May 2019	• Waste audits 2 and 3. • Energy audit. • Waste walk-through 1 & 2 • Energy walk-through 1 • Water walk-through 1 & 2
June 2019	• Staff completed final teacher survey. • Water audit. • Grounds audit. • Waste walk-through 3 • Energy walk-through 2 & 3 • Water walk-through 3
All year	• Data downloaded from monitors on weekly basis • Brief meeting once a month with principal to discuss any issues arising.

Table 7.13 Work carried out in the school 2018/2019

7.5.1 Taking a Facilities Management Approach to EMS creation.

Two sessions, timing one and a half hours each, were devoted to the development of the EMS. The teachers also worked on the EMS between the two timetabled sessions. I had prepared a presentation for the first session to recap on some of the key points that had arisen during the workshops. In particular, we went back over the circular economy and the concept of 'closing systems'. The teachers felt that this was a very tangible approach to take in the classroom as they could take examples at the school where pupils could eliminate waste from certain actions – such as packing their lunches. The presentation ended with a potential structure for writing up the EMS – including the headings 'curriculum', 'management' and 'community'. I also included an option for a 'sustainability statement' for each area as suggested by David from the facilities team at B+L. The teachers felt that the template was very user friendly but by the second meeting, the teachers had decided to change the heading 'management' to 'campus' as this kept with the three Cs of sustainability and they felt that term 'management' could potentially eliminate the pupils' voice. This showed that the teachers felt that this was 'their' project and that they were comfortable to change things as they saw fit.

At the first meeting, a summary of the findings from the FM interviews were distributed and discussed. The teachers said that they found the findings very interesting and overall, they agreed with the potential implications for schools as outlined in the conclusion of Chapter 6. All of the teachers agreed that SFM must be focused on core business, which for them was education, and that this should guide their EMS. The principal in particular felt that in managing the building and grounds, she needed to look for educational opportunities. This became very apparent as the staff worked to develop plans for the outdoors as they constantly made reference back to the curriculum and individual subjects. The teachers already agreed with the importance of monitoring at this point as they had seen the results with electricity monitoring. Therefore they decided that this approach should be taken with the other areas as well and they spoke in particular about the need to start weighing their waste at regular times throughout the year to keep on top of it. The teachers also liked the idea of focusing on one key project a year to stimulate motivation and to encourage awareness of the issues within the wider school community.

The teachers were also asked to consider a normative reference point for the research – i.e. a set of guidelines or values that would underpin the project and which we could all work from. After discussing a number of potential options, such as the aims of the national curriculum or developing their own reference points, it was decided to use the principles of the policy document '*Education for Sustainability. The National Strategy on Education for Sustainable Development in Ireland. 2014 – 2020*' to underpin the case study (see Section 3.1.3).

The teachers then looked at each topic, and decided what each class would cover in terms of the curriculum, what each class would take responsibility for in terms of campus, and how each class could connect with the wider school community. This was filled in to the agreed upon template and I printed these off as posters which were then displayed at the school. Figure 7.34 shows the EMS grid on display at the school while Figures 7.35 to 7.38 show the EMS grids for each of the individual areas - biodiversity, energy, waste and water.

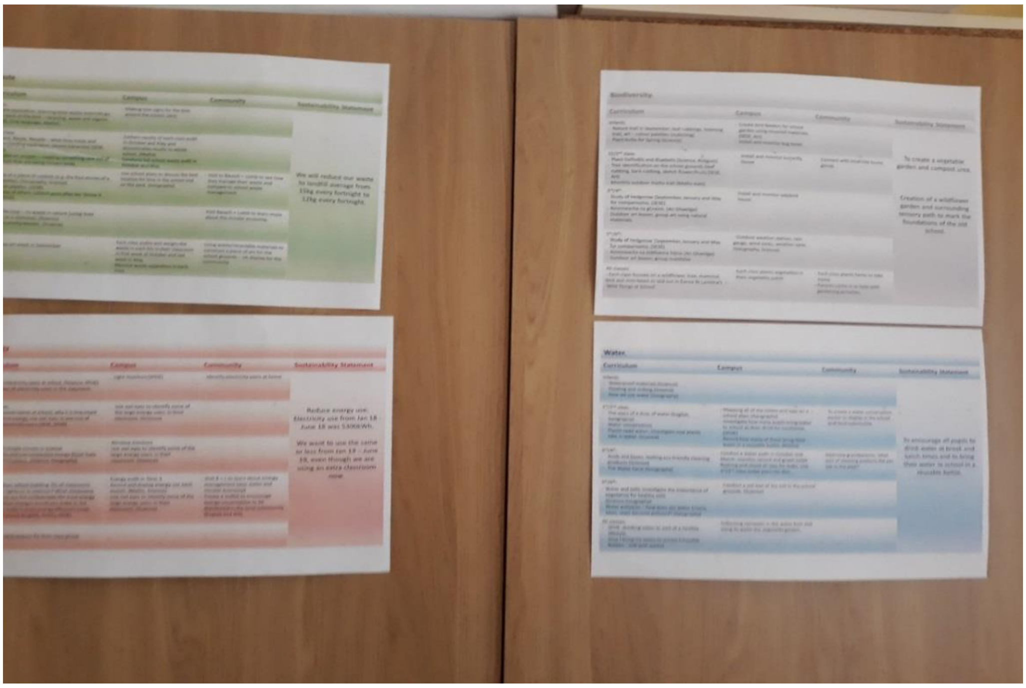

Figure 7.34 EMS on display at the school.

Biodiversity.			
Curriculum	**Campus**	**Community**	**Sustainability Statement**
Infants: - Nature trail in September; leaf rubbings, listening trail, art – colour palettes (matching) - Plant bulbs for Spring (Science)	- Create bird feeders for school garden using recycled materials. (SESE, Art) - Install and monitor bug hotel.		To create a vegetable garden and compost area. Creation of a wildflower garden and surrounding sensory path to mark the foundations of the old school.
$1^{st}/2^{nd}$ class: - Plant Daffodils and Bluebells (Science, Religion) - Tree identification on the school grounds (leaf rubbing, bark rubbing, sketch flower/fruit) (SESE, Art) - Monthly outdoor maths trail (Maths eyes)	- Install and monitor butterfly house	- Connect with local tidy towns group.	
$3^{rd}/4^{th}$: - Study of hedgerow (September, January and May for comparisons). (SESE) - Ainmneacha na gCrainn. (An Ghaeilge) - Outdoor art lesson; group art using natural materials.	- Install and monitor ladybird house.	-	
$5^{th}/6^{th}$: - Study of hedgerow (September, January and May for comparisons). (SESE) - Ainmneacha na bláthanna fiáine (An Ghaeilge) - Outdoor art lesson; group mandalas	- Outdoor weather station; rain gauge, wind socks, weather vane. (Geography, Science)	-	
All classes: - Each class focuses on a wildflower, tree, mammal, bird and mini-beast as laid out in Éanna Ní Lamhna's 'Wild Things at School'.	- Each class plants vegetables in their vegetable patch	- Each class plants herbs to take home - Parents come in to help with gardening activities.	

Figure 7.35 EMS; Biodiversity.

Energy			
Curriculum	**Campus**	**Community**	**Sustainability Statement**
Infants: - Identify electricity users at school. (Science, SPHE) - List (draw) all electricity users in the classroom. (SESE)	- Light monitors (SPHE)	- Identify electricity users at home	Reduce energy use: Electricity use from Jan 18 - June 18 was 5300kWh. We want to use the same or less from Jan 19 – June 19, even though we are using an extra classroom now.
1st/2nd class: - Energy conservation at school; why it is important to conserve energy, use owl eyes to see cost of various electricity users (SESE, SPHE)	- Use owl eyes to identify some of the large energy users in their classroom. (Science)		
3rd/4th: - Construct simple circuits in science - Renewable and non-renewable energy (fossil fuels and CO2 emissions). (Science, Geography)	- Window monitors - Use owl eyes to identify some of the large energy users in their classroom. (Science)	-	
5th/6th: - Evaluate their school building. Do all classrooms need their lights on in summer? What classrooms do you think are the coldest/take the most energy to heat? What changes would you make to the building to make it more energy efficient? (revit model and plans) (English, Maths, SESE).	- Energy audit in Term 1 - Record and display energy use each month. (Maths, Science) - Use owl eyes to identify some of the large energy users in their classroom. (Science)	- Visit B + L to learn about energy management (also water and circular economy) - Create a leaflet to encourage energy conservation to be distributed in the local community (English and Art).	
All classes: - Follow the SEAI lessons for their class group.	-		

Figure 7.36 EMS: Energy

Waste			
Curriculum	**Campus**	**Community**	**Sustainability Statement**
Infants: - Waste separation: learning what waste materials go into each of the bins – recycling, waste and organic. (SESE, Oral language, Maths).	- Making new signs for the bins around the school. (Art)		We will reduce our waste to landfill average from 15kg every fortnight to 12kg every fortnight.
1st/2nd class: - Reduce, Reuse, Recycle – what they mean and understanding each term. (waste hierarchy) (SESE, SPHE) - Recycled art project – creating something new out of materials that are being thrown away.	- Gathers results of each class audit in October and May and disseminates results to whole school. (Maths) - Conducts full school waste audit in October and May.		
3rd/4th: - Timeline of a piece of rubbish (e.g. the four stories of a plastic bottle). (Geography, Science) - Lesson on plastics. (SESE) - Awareness of where rubbish goes after we 'throw it away'. (SESE)	- Use school plans to discuss the best location for bins in the school and on the yard. (Geography)	- Visit to Bausch + Lomb to see how they manage their waste and compare to school waste management	
5th/6th: - Closing the loop – no waste in nature (using their lunchbox as a stimulus). (Science) - Circular economy lessons. (Science)		- Visit Bausch + Lomb to learn more about the circular economy.	
All classes: - Waste free art week in September	- Each class audits and weighs the waste in each bin in their classroom in first week of October and last week in May. - Monitor waste separation in each class	- Using waste/recyclable materials to construct a piece of art for the school grounds – on display for the community.	

Fig 7.37 EMS: Waste

Water.

Curriculum	Campus	Community	Sustainability Statement
Infants: - Waterproof materials (Science) - Floating and sinking (Science) - How we use water (Geography)			To encourage all pupils to drink water at break and lunch times and to bring their water to school in a reusable bottle.
1st/2nd class: - The story of a drop of water (English, Geography) - Water conservation. - Plants need water; investigate now plants take in water. (Science)	- Mapping all of the toilets and taps on a school plan. (Geography) - Investigate how many pupils bring water to school as their drink for lunchtime. (SPHE) - Record how many of these bring their water in a reusable bottle. (Maths)	- To create a water conservation poster to display in the school and local community.	
3rd/4th: - Acids and bases; making eco friendly cleaning products (Science) - The Water Cycle (Geography)	- Conduct a water audit in October and March: monitor, record and graph toilet flushing and check all taps for leaks. Use 1st/2nd class water plans for this.	- Interview grandparents; 'what sort of cleaning products did you use in the past?'	
5th/6th: - Water and soils: investigate the importance of vegetation for healthy soils. (Science,Geography) - Water pollution – how does our water (rivers, lakes, seas) become polluted? (Geography)	- Conduct a soil test of the soil in the school grounds. (Science)		
All classes: - SPHE: drinking water as part of a healthy lifestyle. - How I bring my water to school (reusable bottles – link with waste)	- Collecting rainwater in the water butt and using to water the vegetable garden.		

Figure 7.38 EMS: Water

The teachers also decided that the ‘sustainability project’ for the year would be the development of a wildflower garden at the front of the school which would mark the site of the old 1800s school house. This was a very interesting project. The teachers had already expressed their desire to develop a wildflower garden for the school but the location was chosen after the drought that occurred in the summer of 2018 – an unprecedented weather event that many attributed to climate change. During this time, the grass became so scorched that the foundations of the original school became visible on the lawn at the front of the school. The principal felt that to mark the foundations of the old school in some way would be something that would be greatly appreciated by the wider community. The researcher spoke to a landscape architect at WIT about ways in which the foundations could be marked and relayed the possibilities to the teachers who agreed that a path would be the best idea. Further discussion brought this initial idea along and it was agreed that the path should be a sensory path, in keeping with the focus on education. So the project was finalised as a wildflower garden that would cover the area of the old school house and would be bordered by a sensory path that would also mark the original foundations.

The principal then informed the wider school community of the project and the local Tidy Towns committee became involved as did the school’s part-time grounds caretaker. Following discussion with these partners, it was decided to unearth the foundations of the school and to place the sensory path around the foundations as opposed to on top of them.

While the caretaker rotivated the earth to prepare it for planting the wildflowers, the pupils took on much of work. The pupils ‘excavated’ the site in June 2019 as part of their History curriculum and not only exposed the stone foundation of the old school house, but also found numerous interesting objects such as broken pottery, old coins and objects such as pencils (one had ‘made in the Republic of Ireland’ stamped on it). The area inside the foundations was rotivated again (many of the wildflowers that were planted here did not flower as hoped) and the pupils are to sow the area anew in the Autumn. The teachers have also planned for the classes to design and make the sensory path as part of their art programme in the new school year.

A post-audit was carried out in energy, waste, water and biodiversity on the school grounds to record any changes that had occurred over the course of the new EMS. Comparing these audits to the results of the initial audits enabled the identification of areas that the school had managed with success, and when combined with the results of the qualitative data in the following chapter, helped to give a more broad and balanced picture of the implementation of the new EMS.

7.5.2 Energy.

Another energy audit was carried out in May 2019. The number of significant energy users increased during this year and are noted in Table 7.14. The first reason for this increase was the use of the fifth classroom which required an extra interactive whiteboard (500W), projector (130W) and laptop (65W). This also meant an increase in lighting and other necessary power. Also, the school scaled up their cookery programme and invested in a new oven to support this venture. Changes to the energy users table are noted with red italics.

Description	Quantity	Power
Photocopier	1	800
PC	1	160
Interactive Whiteboard	*5*	*2500*
Projector	6	*780*
Laptop	6	*390*
Kettle	1	1300
Oven	1	*4800*
2kW water heater	3	6000
Total		***16730W***

Table 7.14 Significant energy users 2018/2019.

Electricity

During the academic year 2018/2019 (from September to the end of June measured, July and August estimated based on last year's use), average electricity use was determined at 20KWh/m^2/a compared with 27KWh/m^2/a from the historical usage calculated during the first energy audit. This also compares more favourably with the Northern Ireland benchmark of 18KWh/m2/p.a. (Keohane, n.d.) although it is still slightly above the mark. Figure 7.39 shows the measured electricity use for the year 2017/2018 and 2018/2019.

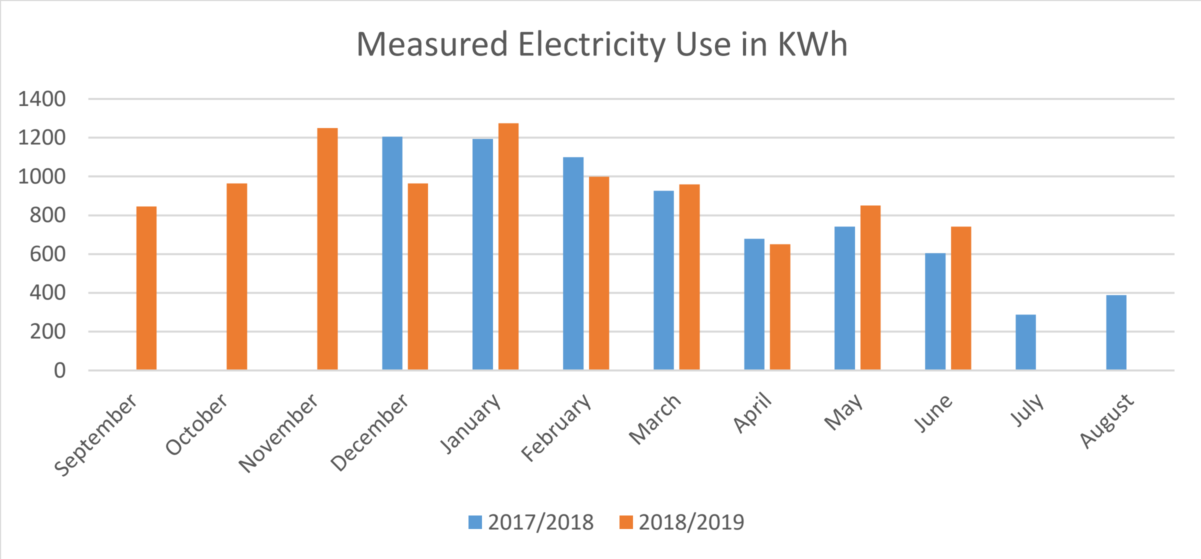

Figure 7.39 Comparing measured electricity use before and during the EMS

Three walk-through visits were conducted in relation to energy during May and June 2019. Again, lights were always off in unoccupied classrooms. One projector was left on stand-by on one occasion. Lights were on in corridor 2, but this is necessary as there is no natural light in this area.

Heating

For the year 2018/2019, the year the new EMS was in situ, 3700 litres were purchased equating to 70.98kWh/m^2/p.a. (see appendix G). All six classrooms were being heated during this period.

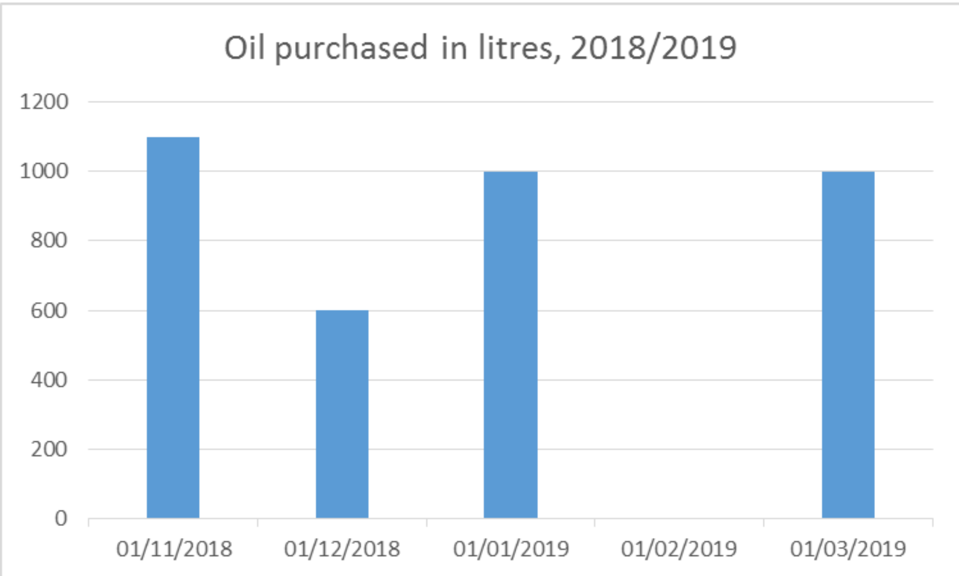

Figure 7.40 Oil purchased for 2018/2019.

During the walkthrough visits, the settings on the thermostats were also checked. The results are summarised below.

Room	Visit 1	Visit 2	Visit 3
Classroom 1	20 ˚C	20˚C	20 ˚C
Classroom 2	20 ˚C	20 ˚C	25 ˚C
Classroom 3	20 ˚C	18 ˚C	18 ˚C
Classroom 4	18 ˚C	19 ˚C	19 ˚C
Classroom 5	20 ˚C	22 ˚C	22 ˚C
Classroom 6	Off	Off	Off
Corridor 2	16 ˚C	16 ˚C	22 ˚C
Corridor 3	18 ˚C	18 ˚C	18 ˚C

Table 7.15 Thermostat settings during energy walk-throughs May/June 2019

Although oil use increased over the EMS period, 70.98kWh/m^2/p.a. is still significantly under the nearest comparable benchmark of 119 kWh/m^2/p.a. for fossil fuel consumption in primary schools in Northern Ireland (Keohane, n.d.).

Building Fabric

The only defect noted in the initial audit was mould growth on the upper external wall in Classroom three. With the implementation of IEQ monitoring, it was found that RH levels were particularly high in this classroom. The teachers were made aware of this and became very conscious of opening windows when possible. During the summer of 2018, the BOM had the upper windows of this classroom altered so that they could be opened manually by the classroom teacher and also had the mould cleaned and the walls of this classroom repainted.

Figure 7.41 Walls cleaned and repainted in Classroom 3

Indoor Environmental Quality.

IEQ parameters were monitored in Classrooms 3 and 4 during the EMS year. The principal requested that a monitor stay in classroom 3 and that the second monitor be installed in classroom 4 as this classroom had been out of use since the last extension and she was interested in how it would perform.

In classroom 3, the average internal temperatures were lower during the winter of 2018/19 than they had been the previous year, despite the fact that this winter was much milder than the previous one. A potential reason for this may be that the teachers in this classroom were much more conscious of opening windows and this could have become a source of heat loss. However, CO_2 levels during occupancy hours were much more favourable during the EMS year with lower levels each month with the exception of June. Relative humidity was higher during the occupancy hours of January and February compared with the previous year but March through to June were significantly lower although still consistently over 60%. Figures 7.42, 7.44 and 7.46 show average temperature, CO2 and RH levels in classroom 3 during the EMS year. Mean outdoor temperatures were taken from https://www.met.ie/climate/available-data/monthly-data (MET Éireann, 2019). For comparative purposes, figures 7.43, 7.45 and 7.47 show mean IEQ averages during pupil occupancy hours for January to June 2018 and 2019.

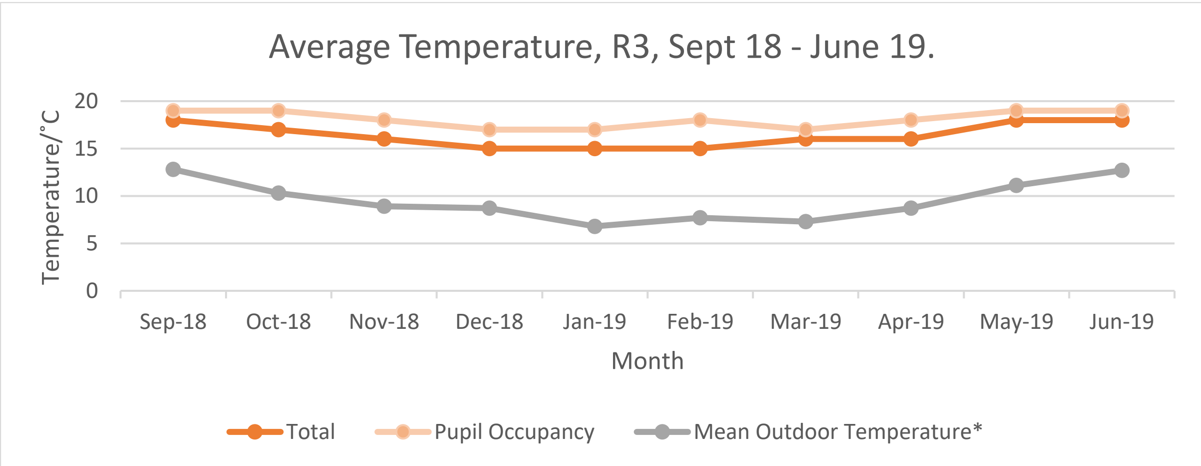

Figure 7.42 Average Temperatures in Classroom 3 during EMS

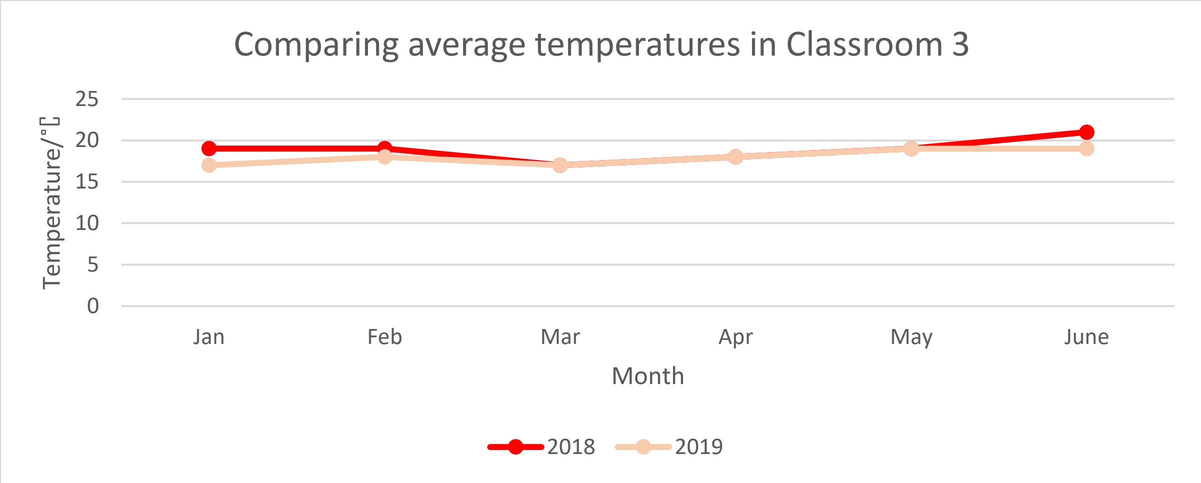

Figure 7.43 Comparing average temperatures in Room 3.

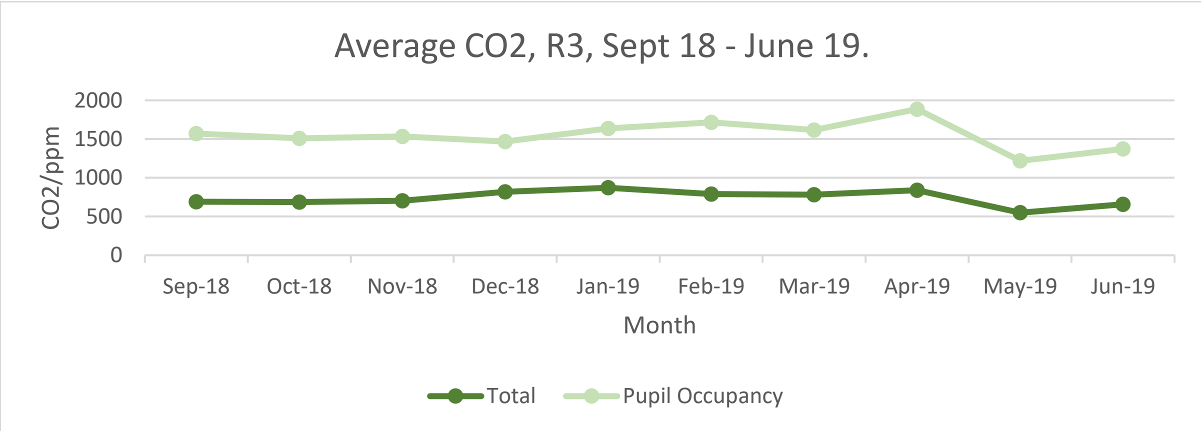

Figure 7.44 Average CO2 in Classroom 3 during EMS

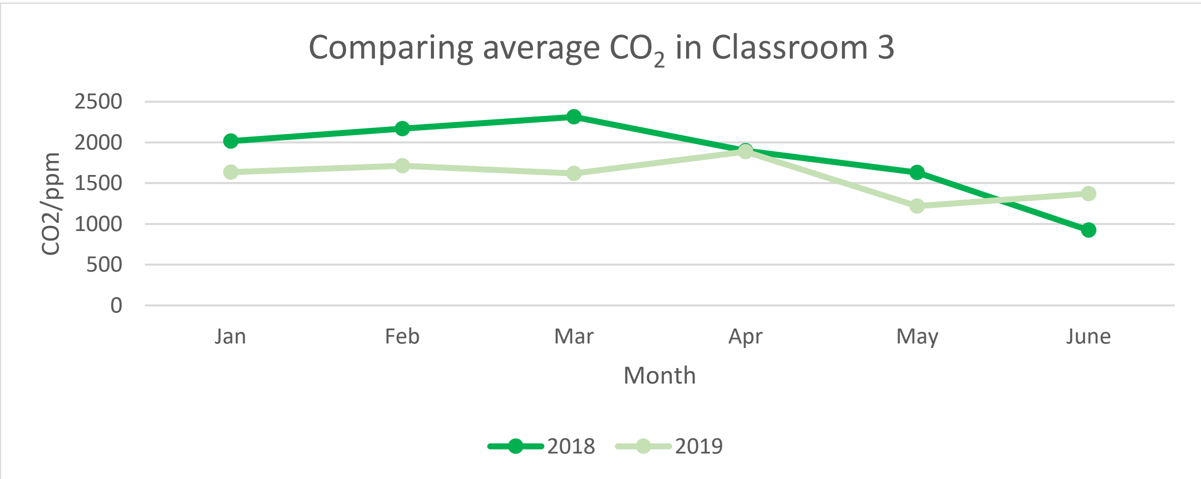

Figure 7.45 Comparing average CO_2 in Room 3.

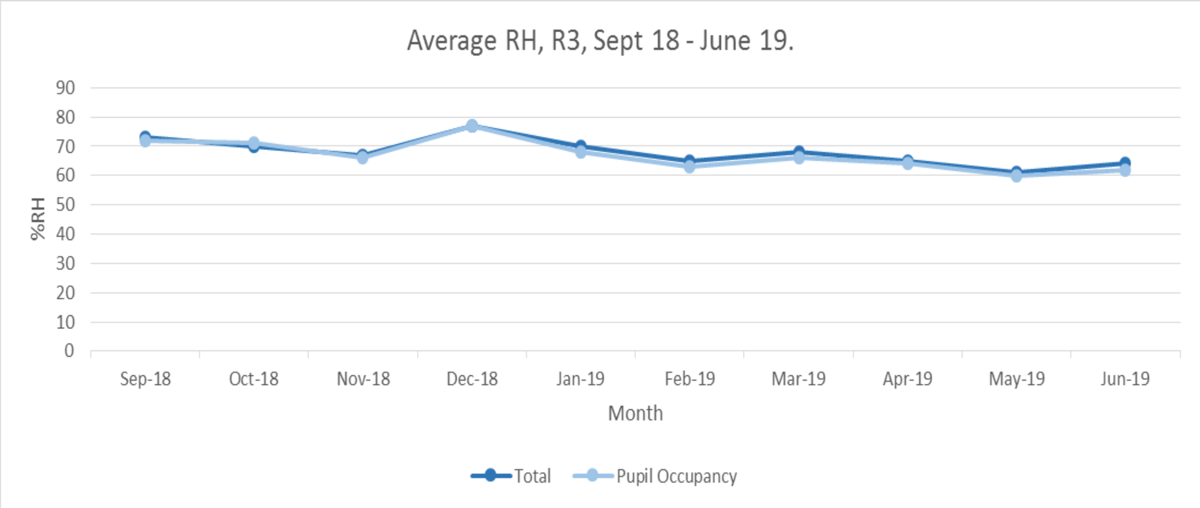

Figure 7.46 Average RH in Classroom 3 during EMS

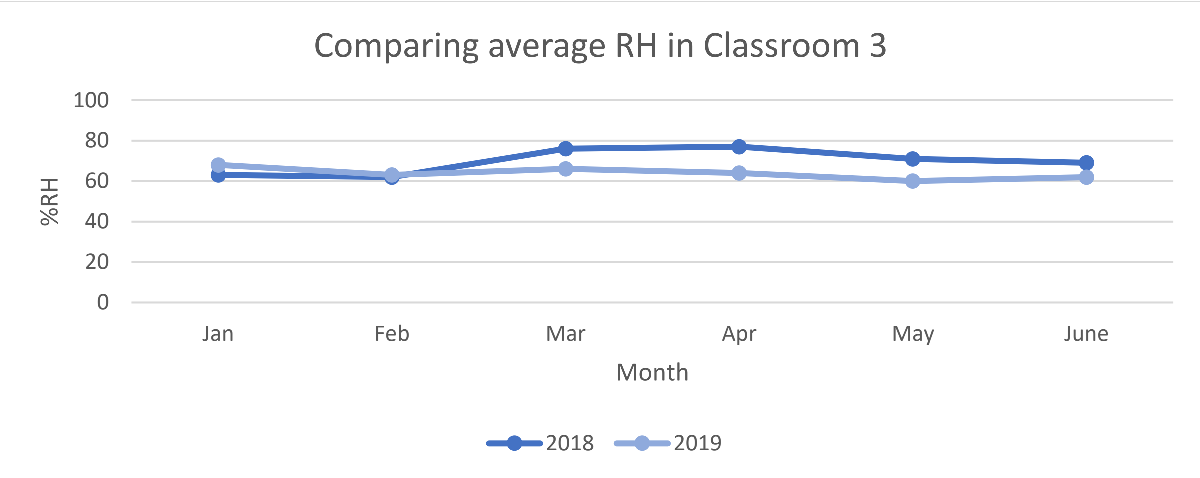

Figure 7.47 Comparing average RH in Room 3.

The second monitor was moved to classroom 4, a room constructed in the 1960s. A bright and airy room, this classroom had been unoccupied for the previous five years and was used as a multi-purpose room. The principal was interested to see how this room performed as the other classrooms had had a monitor installed for three months of the previous year.

Average temperatures were under 18˚C from November through to March but could again be a result of the teacher regularly opening the windows. Average CO_2 levels were quite good during occupancy hours with the highest average of 1968ppm reached in February. RH levels were very high during the winter months with more favourable levels evident as the summer approached.

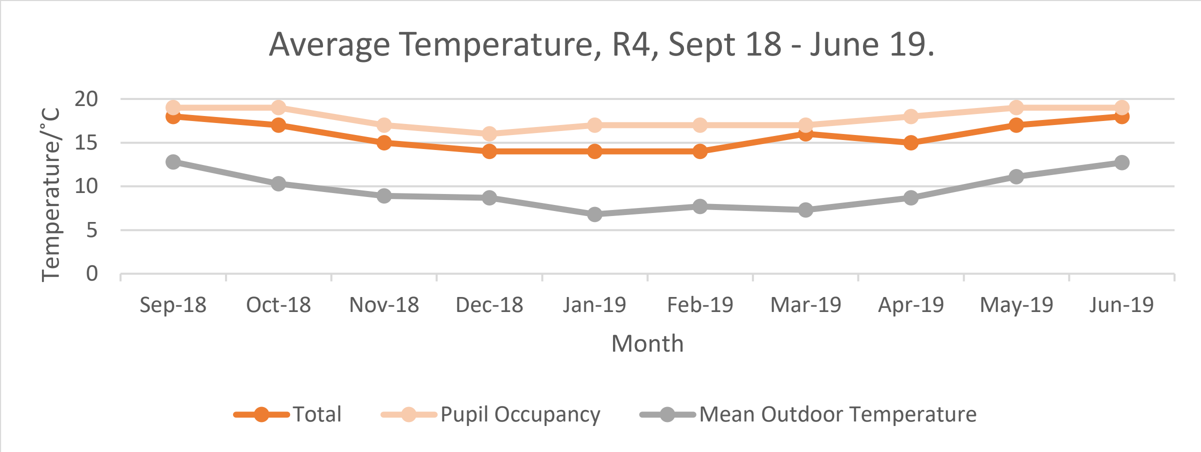

Figure 7.48 Average Temperature in Classroom 4 during EMS

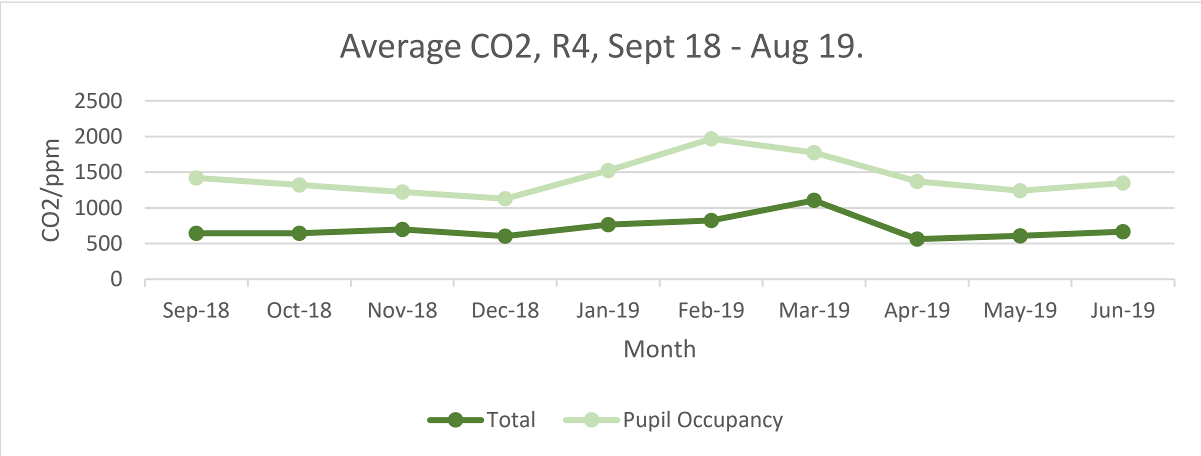

Figure 7.49 Average CO_2 in Classroom 4 during EMS

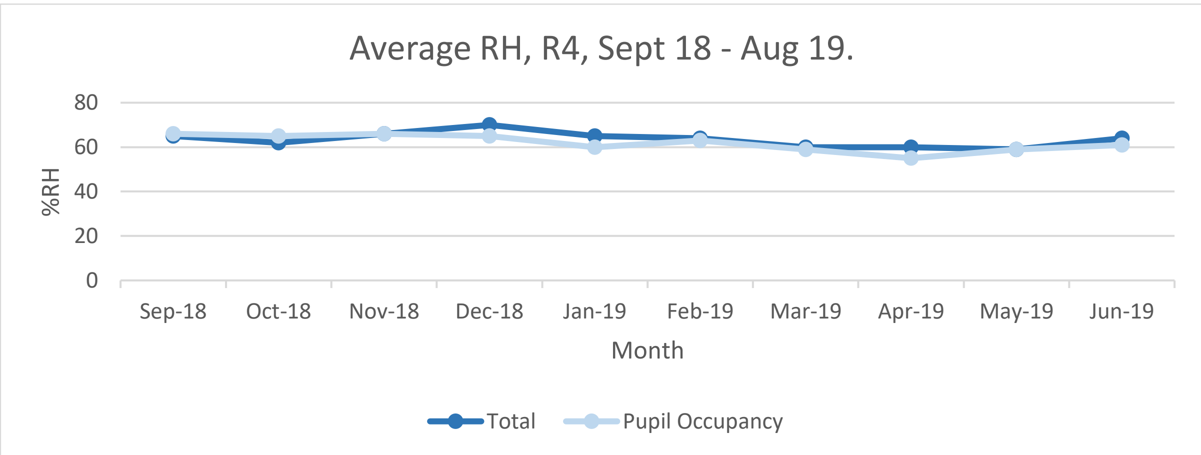

Figure 7.50 Average RH in Classroom 4 during EMS

In both rooms, it is important that the behavioural changes of opening windows be maintained to help manage CO_2 levels and RH levels. The management of the RH levels is particularly important to prevent the reoccurrence of mould growth.

7.5.3 Waste.

The findings from the initial waste audit showed the staff at S.N. an Bhaile Nua that perhaps they were not performing as well in waste management as they had thought. The new EMS for waste was implemented and there was a focus on educating pupils as to the 'path' that waste takes depending on how we deal with it. The school aimed to eradicate the use of single-use plastic drink bottles and encourage reusable bottles and increasing water intake among pupils. Also, there was a focus on reducing the amount of waste from art lessons.

Three post waste audits took place on 3rd April 2019, 15th May 2019 and 29th May 2019. The audits took place on Wednesday afternoons when the pupils had put the schools waste into the wheelie-bins for Thursday morning collection. The labels on the bins had also been updated to include pictures which the teachers felt would help the younger pupils to separate waste correctly.

Figure 7.51 New labels on bins.

	Audit 1	Audit 2	Audit 3	Av. Mean Weights.
Recycling	10kg	9kg	10kg	9.66kg
Waste	10kg	11.5kg	8.5g	10kg
Organic	9kg	*12kg (10.5kg in the organic bin and 1.5kg taken from the waste bin)*	8.6kg	9.9kg
Notes:				
Recycling bin	✓ Mainly paper and cardboard.	✓ Mainly paper cardboard. × A small amount of soft plastic.	✓ Paper and cardboard ✓ Clean hard plastic (yogurt tubs) × Quite an amount of soft plastic this week and some tinfoil.	Weekly av. = 5kg
Waste bin	✓ Soiled food wrapper – soft plastic and foil. × Some organic matter and clean paper. × Numerous dirty plastic containers that could have been washed and recycled	✓ Soiled food wrappers – soft plastic and foil. × A small amount of clean paper. × A 1.5kg bag of organic waste × Numerous soiled containers that could have been washed and recycled	✓ Soiled food wrappers – soft plastic and foil. × Some organic material including sandwich crusts and orange peel.	Weekly av. = 5kg
Organic bin	✓ Mainly fruit skins/remains. Some used teabags.	✓ Mainly fruit skins/remains. Some used teabags.	✓ Mainly fruit skins/remains. Some used teabags.	Weekly av. = 5kg

Table 7.16 Results of the final waste audit.

Looking at changes in the data from the initial waste audit, it appears that recycling increased slightly while waste output was reduced. However, when we look at the notes on materials that were in each of the bins, it can be seen that waste separation procedures are still causing difficulties for some of the students.

Three unannounced walkthrough visits also occurred at this time to check the bins in individual classrooms. These walkthroughs took place on 17th May, 30th May and 10th of June 2019.

On the first visit, the bins in R1 and R6 were correctly segregated. The waste bin on corridor 2, which 3rd to 6th class share had correct waste material in it. However, the recycling bin had waste material in it including crisp packets and wrappers from cereal bars.

On the second visit, the bins in R1 were correctly segregated. In R6 there was a small amount of soft plastic in the recycling bin. The bins on corridor 2 had incorrect material in both bins, including soft plastic in the recycling bin and clean paper in the waste bin.

On the final visit, the bins in R1 and R6 were correctly segregated. The waste bin on corridor 2, had correct waste material in it. However, the recycling bin had waste material in it including laminated paper cut-offs.

The results of these walkthrough visits indicate that waste separation is very good at the junior end of the school (Junior Infants to Second Class occupy rooms 1 and 6). The older pupils from Third to Sixth class are not doing as well when it comes to separating their waste. There are a number of possible reasons for this. First, the fact that the bins are not located in the classroom may be an influencing factor as it is more difficult for the teachers to monitor pupil behaviour. Second, pupils could lose interest in doing 'what is right' as they move up through the school. At numerous occasions over the course of the research teachers of the senior classes commented on the difficulty of motivating students to correctly separate waste. Another potential factor may be that in fact these pupils are trying to do 'the right thing' by increasing the amount of waste they recycle but are still unsure of what can actually be recycled. The fact that the amount of incorrect material in the recycling bins increased since the first audit would suggest that this is a possible factor.

7.5.4 Water.

S. N. an Bhaile Nua implemented their new EMS for water in 2018/2019. While the main focus was still on water conservation, there was also a focus on water pollution (being aware of what was being disposed of in the sink) and a focus on a healthy intake of water for pupils.

Water metering was not introduced during this phase as it was too expensive to install an appropriate monitoring device. Therefore the final audit included a visual check of all water services on 5th June 2019 and three unannounced walkthrough visits on 7th May, 30th May and 10th June. All indoor and outdoor taps, visible pipes and WCs were checked and no leaks were found.

On the first and second walkthroughs in May, all taps were turned off correctly. On the final walkthrough in June, one tap in the boys' toilet was not closed correctly and was dripping.

A further addition to water management included a water butt installed close to the new vegetable garden. Pupils used this harvested water to water the vegetable patches each morning.

7.5.5 Biodiversity and the school grounds.

Biodiversity was the only one of the four areas where the school did not have an existing management system in place under the Green Schools programme. However, the staff fully embraced the potentials that the school grounds had to offer and developed and implemented the biodiversity section of their EMS. In many ways, this was the most successful aspect of the EMS as it provided opportunities for the school to connect with parents and community groups and it offered new and exciting avenues for teaching and learning.

The grounds of S.N. an Bhaile Nua were surveyed again on 12th June 2019. The originally identified five habitats remained and were relatively unchanged. *GA2: Amenity Grassland (improved)* remained the largest habitat on site. While there were no additions in terms of new plants or trees, there were some changes in respect to how this area is managed. The most significant change here is that the school is no longer using any form of herbicide or weed-killer to control the weeds at the edges of the site. *BL1: Stone Walls and Other Stonework* and *BL3: Buildings and Artificial Surfaces* remained unaltered since the initial survey described in section 7.2.4. While there are no major changes with *WL1: Hedgerows* and *WL2: Treelines* these habitats are benefiting from the elimination of spraying herbicides.

Over the course of this year, the school grounds were enhanced with the development of further habitats - *Horticultural Land* and *Dry calcareous and neutral grassland*.

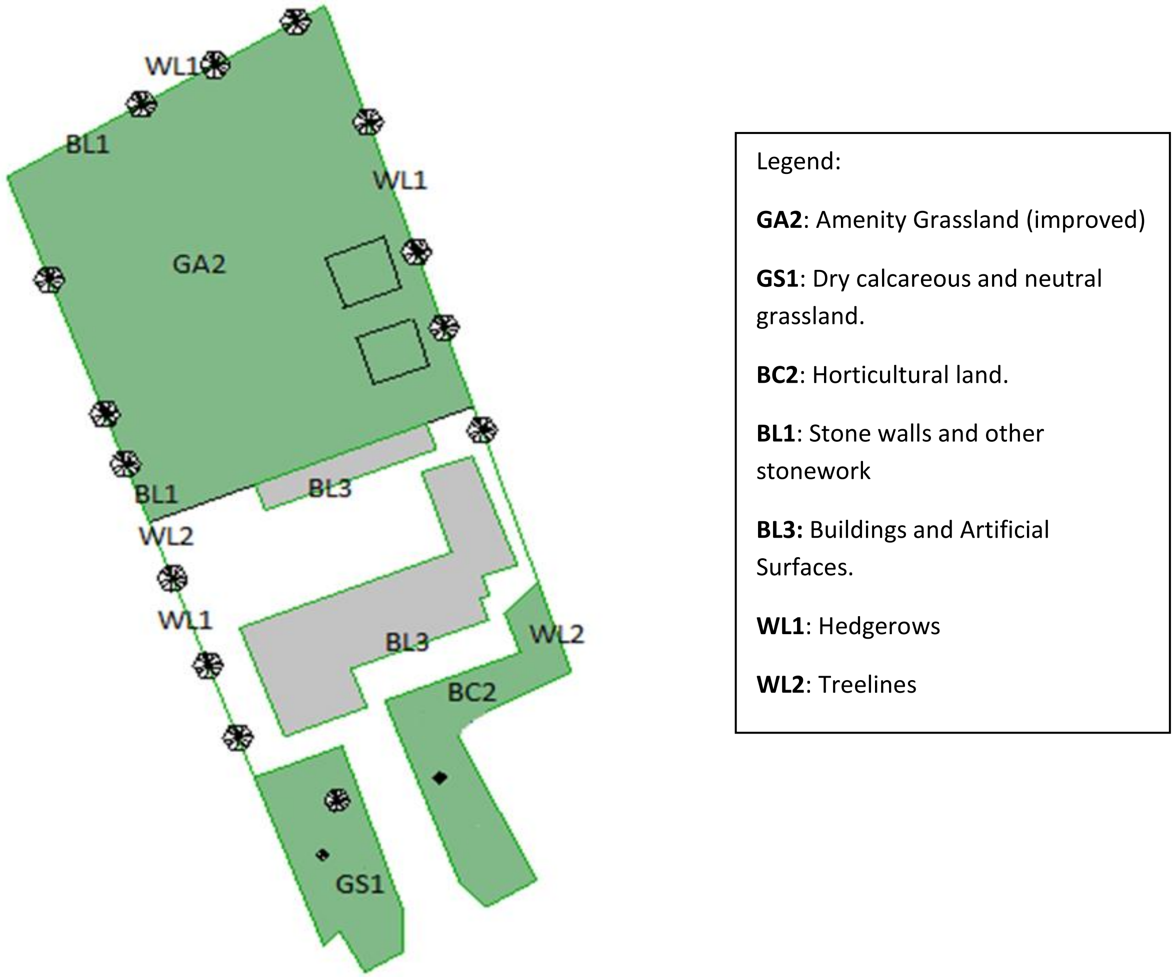

Figure 7.52 Site map with Fossitt indicators following new EMS implementation.

As a result of the soil analysis, the area in front of the school where sample S1 was taken was designated as the best location for the vegetable garden. This area not only provided easy access and was south facing with good light, but the drainage was also best in this area. The pH however was quite acidic but this could be rectified with the addition of lime to the garden beds. As part of the new EMS, the school established a small garden in this area which included some raised plots for growing vegetables and herbs. Using '*A Guide to Habitats in Ireland*' (Fossitt, 2000), this is categorised as BC2 and was identified on the sitemap. The senior classes prepared the beds and added the compost. There were five raised beds – one for each class group and a shared bed for planting herbs. A parent, who was interested in gardening, came in to help each class establish their area of the garden. A selection of vegetables were planted including kale, a number of varieties of lettuce, courgettes, potatoes, onions, garlic and rhubarb. A selection of herbs were planted including chives and parsley. Sunflowers were also planted in this area.

Figure 7.53 Site of new vegetable garden

Although not in place when writing up the audit, the school intended on creating a compost area next to the vegetable garden to compost leaf litter and organic material from the garden.

Used wooden crates had also been collected and were stacked in the corner of the garden with the intention of creating a 'bug hotel' in this area to encourage biodiversity and to aid pollination of the vegetables. Used and broken bricks, plant pots, etc. were being placed on the crates to create spaces for mini-beasts to live.

Figure 7.54; Beginning a new 'bug hotel'

The school have also made plans to construct a poly-tunnel in their garden during the year 2019/2020 to extend the growing season and create more teaching and learning opportunities outdoors.

As their sustainability project for the year, the school had also created a new wildflower area to the front of the school. Using '*A Guide to Habitats in Ireland*' (Fossitt, 2000), this is categorised as GS1 and was also identified on the sitemap. This is something that the teachers had expressed an interest in doing from the beginning, but it arose as an idea for this project following the drought during the summer of 2018 when the grass became scorched and the foundations of the original school house became visible on the front lawn of the existing school. The staff expressed an interest in highlighting the original school house location and the idea for their sustainability project was born.

Figure 7.55 Site of new wildflower garden

Native Irish grassland wildflower seeds were sown in this area. New species that were not evident in the first audit now included corn marigold, corn poppy, corncockle, cornflower, cowslip, kidney vetch, knapweed, yarrow and yellow rattle. Four insect houses were placed on trees in the wildflower garden – a bee house, an insect house, a ladybird house and a butterfly house. Each class group had responsibility for one of the houses and the teachers were using these as part of the SESE curriculum. However, the wildflower area was rotivated again in June 2019 so that the pupils could 'excavate' the old school site. The school intends to re-sow the wildflowers following the creation of their sensory pathway.

The participant engineers at B+L found the development of the school grounds a very interesting project. They were particularly interested in the school's focus on biodiversity as a part of their EMS and have thought about the benefits of biodiversity for their own site. The FM manager has a biodiversity audit of the B+L site planned for this year with a view to drawing up a biodiversity plan to incorporate into their own EMS. Although the focus of this case study was on the implementation of the new EMS at a school site, this demonstrates that within the Extended CoPs model, there is potential for feedback loops to the FM team to encourage them to think about environmental management in new ways. The National Biodiversity Data Centre (2016, p. 3) outlines a number of benefits for businesses to support the All Ireland Pollinator Plan ranging from improved CSR to improved employee health and wellbeing. If B+L engage with the Pollinator Plan and increase opportunity for biodiversity at their site, it will also improve their ISO 14001 application.

7.5.6 Survey questionnaires.

In June 2019, following the implementation of the EMS, the participating teachers were again asked to complete a short survey. The survey was the same as the initial survey (section 7.2.5) but this time section two was focused on the new EMS rather than the Green school version (see appendix H). Five of the participating teachers completed this survey (one of the participating teachers was absent in June and one of the two teachers from room 3 completed the survey).

Section one, once again, looked at the school's IEQ using a Likert scale where one was 'most uncomfortable' and five represented 'most comfortable'. Unsurprisingly, there was not much variation in these results as no major works took place on any of the building systems (lighting, heating system, etc). There was a very small decrease in the mean results of 'light' and 'sound' which can be accounted for by the absence of one teacher who scored these parameters as very comfortable on the first survey. The teachers remained very happy with the natural light in their classrooms but remain less happy with the artificial lighting. The measurement of the lux levels in the classrooms suggests that artificial lighting is required on overcast days and an assessment of the current lighting estimated a full retrofit to upgrade all lights to LEDs would cost just over €10 000 (see section 7.2.1). While this is too expensive for the school to carry out at the moment, the principal said that the board will consider looking at upgrading the lighting on a phased basis. Also, the BOM submitted an application to the DES to have the ceiling/roof of corridor 2 replaced and to have skylights fitted as part of this project as currently there are no natural light sources on this corridor.

Although the mean averages did not differ greatly on 'thermal comfort' from the first survey, the deviation from the mean decreased suggesting that the teachers are closer in their opinions about the thermal comfort of the building. 'Air quality' was the only parameter that improved on this survey (the absent teacher had also given this a rating of '5' on the first survey) with the mean value increasing from 4 to 4.4 and a very low standard deviation. The teachers had become very aware of the air quality in the classrooms over the year and the use of the monitors helped to keep a focus on this. The teacher from room 3, which had the black mould problem that had been treated during the summer of 2018, noted on her survey that the '*monitors [are] great as a reminder to open the windows, even on colder days – even if briefly to freshen/aerate the room*'. Table 7.17 shows the number of responses, as well as the mean and deviation from the mean for this section.

		1 (*n*)	2 (*n*)	3 (*n*)	4 (*n*)	5 (*n*)	Mean	Std. Deviation
Light	Natural light				*2*	*3*	*4.60*	*0.548*
	Artificial lighting	*1*		*2*	*3*		*3.20*	*1.304*
Sound	Sound/Acoustics			*1*	*2*	*2*	*4.20*	*0.837*
Thermal Comfort	Temperature (general)			*1*	*3*	*1*	*4.00*	*0.707*
	Temperature fluctuations			*1*	*4*		*3.80*	*0.447*
	Draughts			*3*	*1*	*1*	*3.60*	*0.894*
Air quality	Air quality				*3*	*2*	*4.40*	*0.548*

Table 7.17 Results of 'Indoor Environmental Quality'.

Section two was again titled 'Environmental Management Systems' but this time involved statements about the new approach as opposed to the Green School approach. A Likert scale was used where one equated with 'strongly disagree' and five with 'strongly agree'. While on the initial survey opinions were quite varied in this section, this time the teachers' opinions are more aligned. In fact, the standard deviation increased in only two areas – '*The Green*

School programme/new EMS is difficult to implement' and '*pupils choose topics for exploration'*. On the pre-survey, teachers' took the middle ground with regards to the statement '*The Green School programme is difficult to implement'* with a mean average of 2.75 and a deviation of only 0.5. On the post survey, however, the statement was 'The new EMS was difficult to implement' and the responses are very dispersed as can be seen in Table 7.18. Also on the initial survey, the teachers were very much in agreement in stating that pupils did not choose topics in their classrooms. On the post-survey, however, the responses have become more dispersed with two teachers giving a four out of five for this statement, implying that pupil choice in EMS and ESD topics has increased, in some classrooms at least.

With regards to the other five statements, the teachers answered more favourably on the post survey relating to the new EMS. Overall, the teachers find the new EMS a more useful tool than the Green School approach. The teachers' perception of their own participation increased slightly while their perception of the pupils' participation in the new EMS increased considerably. Initially, the teachers expressed their opinion that the Green Flag was important as a visual representation of their achievements and similarly, on the post-survey teachers expressed a desire to have the new EMS recognised more formally. Finally, teachers were more positive on this survey about their inclusion of EMS topics in their teaching, implying that the new EMS has increased the amount of integration with curriculum. Table 7.18 shows the number of responses, as well as the mean and deviation from the mean.

	1	**2**	**3**	**4**	**5**	**Mean**	**Std. Deviation**
The new EMS is a useful tool for our school				*1*	*4*	*4.8*	*0.447*
I fully participate in the implementation of the new EMS this year				*2*	*3*	*4.6*	*0.547*
The children fully participated in the implementation of the new EMS this year.				*3*	*2*	*4.4*	*0.547*
The new EMS was difficult to implement.	*1*	*2*	*1*	*1*		*2.4*	*1.140*
I would like to have external recognition/ accreditation for implementing the EMS this year (e.g. a flag).			*3*	*1*	*1*	*3.6*	*0.894*
I incorporate EMS topics (eg. waste, water, energy, etc.) into my teaching.				*3*	*2*	*4.4*	*0.547*
Pupils choose topics (eg. energy, biodiversity, etc.) for exploration.	*1*	*1*	*1*	*2*		*2.8*	*1.303*

Table 7.18 Results of 'Environmental Management System'

The third and fourth sections once again asked teachers to identify what subjects they regularly utilised the built and natural environments of the school for when teaching. Interestingly, some teachers who noted using the built environment for certain subjects on the pre-survey did not identify these same subjects on the post-survey – such as English and Art (the teacher who was absent had noted that she used the built environment for all subjects with the exception of SPHE and Music on the pre-survey). The utilisation of the school's natural environment when teaching increased in most subjects however, which may have had a small impact on the use of the built environment (i.e. teachers choosing to go outside and use aspects of the natural environment rather than using the building/built environment). No teacher noted using the natural environment when teaching SPHE or Music on either survey but all five teachers now use the grounds when teaching Geography, Science and PE while four teachers use it when teaching Art.

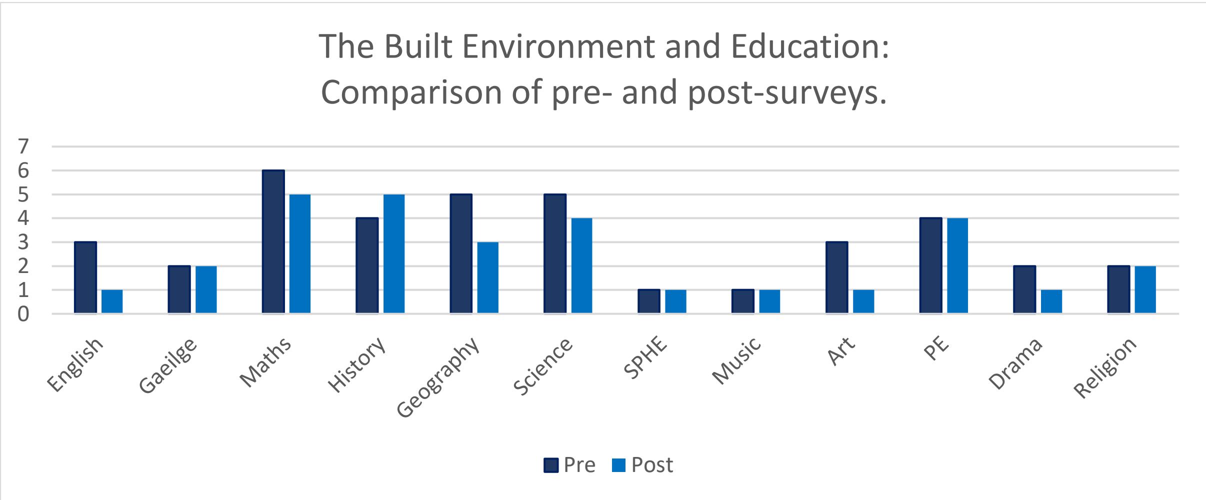

Figure 7.56 Results of 'The Built Environment and Education'

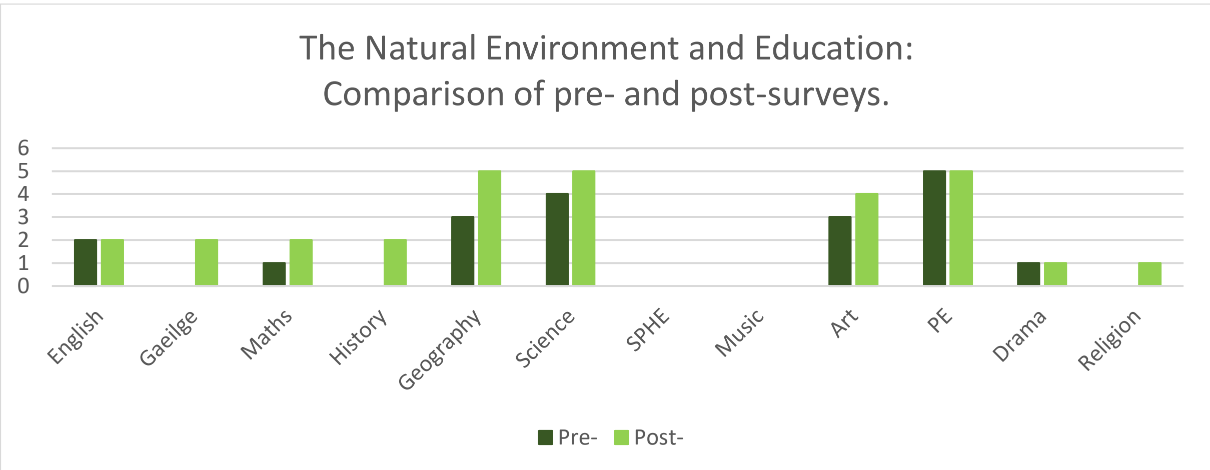

Figure 7.57 Results of 'The Natural Environment and Education'

The final section of this survey was again 'Education for Sustainable Development'. It was hoped that by enabling the teachers to align their EMS with ESD when they were initially creating it, that it would have a greater impact on ESD in the classroom.

Although the participating teachers felt that ESD was an important approach to education at the beginning of the year, it appears that following the creation and implementation of the new EMS, their belief in its importance has increased. While more teachers are now saying that they incorporate sustainability topics into their teaching (with the mean average rising from 3 to 3.8), it is interesting to note that the mean average on the statement '*I incorporate EMS topics into my teaching*' had a mean of 4.4. This would suggest that while these teachers are teaching about EMS topics (such as energy, waste or water) they are either not connecting it with ESD or feel it is not being approached in a manner that aligns with ESD. The last two statements were related to the teachers' confidence in engaging with ESD and their belief that they had they skills to engage with it, and beliefs in both areas increased with deviation from the mean decreasing.

	1	**2**	**3**	**4**	**5**	**Mean**	**Std. Deviation**
ESD is an important approach to education.				*1*	*4*	*4.8*	*0.447*
I regularly incorporate sustainability topics into my teaching.			*2*	*2*	*1*	*3.8*	*0.836*
It is easy to access teaching resources to support ESD.			*3*	*1*	*1*	*3.6*	*0.894*
I am confident in engaging an ESD approach to teaching and learning.			*3*	*1*	*1*	*3.6*	*0.894*
I have the skills to engage an ESD approach to teaching and learning			*2*	*3*		*3.6*	*0.547*

Table 7.19 Results of 'Education for Sustainable Development'.

Overall, the survey revealed that the participating teachers remained happy with the school's physical environment and were possibly even more aware of the built environment and on how it impacts on teaching and learning in their classrooms. – '*Classroom can get very stuffy from 1 – 3pm and I have to be conscious of opening windows'*. Monitoring in particular appears to be a tool that has helped teachers to manage the indoor environment of their classrooms and as can be seen from the IEQ monitoring in Room 3, where overall, CO_2 concentrations and RH levels reduced during occupancy hours.

The participating teachers strongly agreed that the new EMS was a useful tool this year and agreed that both teachers and pupils fully participated in its implementation. It also appears that teachers are now incorporating more EMS topics into their teaching, something that may be attributed to the fact that their confidence in engaging with ESD has also increased over the period.

Although use of the school's built environment for pedagogy may have decreased slightly over the course of the EMS, the use of the natural environment increased significantly. In particular, it appears that the teachers are using the new school garden to support teaching and learning in subjects such as science and geography. Teachers wrote comments on these sections of the surveys stating that they grow plants in the vegetable patch for Geography and Science.

And finally, the results show that there have been moderate increases in the teachers' confidence in engaging with ESD although they believe it to be a very important approach to education.

7.6 Summary.

This chapter detailed the case study phase of this research which entailed engaging social actors from a primary school in the creation and implementation of a new EMS based on the FM approach. This case report included not only the empirical results, but also a detailed description of the various aspects of the embedded case study, including the people involved, the school where the research was carried out and all the processes that were engaged in.

The following table summarises the main points from each area of the EMS.

Energy	• Electricity use was greatly reduced due mainly to the real-time monitoring which helped to identify the incorrect setting on the heating system. However, electricity use only increased slightly over the EMS year even though a fifth classroom was now fully occupied, suggesting that conservation improved also. • Oil use increased over the EMS period. This could be a result of the teachers frequently opening windows to aerate their rooms to keep CO2 levels in check. This will be a challenge going forward – balancing thermal comfort with indoor air quality. • Results from classroom 3, the only classroom where we could compare year on year IEQ data, suggest that the monitors helped the teachers to manage their indoor environment, with improvements in both CO2 and RH levels.

Waste	• There was an increase in the weight of recyclable material which would suggest that the school is now recycling materials that they were previously throwing out as waste. As a result, there was a decrease in the weight of material going in the waste bin/to landfill. • There was no change in the weight of material in the organic bin. The school intends to set up a composting area in their new school garden but only for garden waste and leaf litter from the grounds. • The walkthrough visits and audits show that there are still some challenges with waste separation, particularly evident in the bins used by 3rd to 6th class.
Water	• There were no notable changes in water management, although this was the area that received least attention from a management perspective. • A water butt has been installed close to the garden to be used for watering the vegetables.
Biodiversity	• There are two new habitats on site – horticultural land and a wildflower meadow. • There is now increased opportunity for biodiversity on the grounds with the new habitats and the pupils' bug houses. • The outdoors are being used more frequently for teaching and learning. • There is no use of herbicides on site.

Table 7.20 Outcomes of the EMS.

Exploring the use of the Extended CoPs model with this school over an academic year demonstrated the feasibility of the model while also identifying challenging areas and areas for improvement. While the success or otherwise of this model was never going to be determined by this case study, a number of interesting points arose which are explored further in the next chapters in order to further develop and theorise the model.

8. Reflecting on the New EMS.

In schools, environmental management systems generally take the format of the Green Schools programme. While this programme is widespread in Ireland and has certainly brought environmental management of schools into focus, a study of the literature and a survey questionnaire administered to principals, identified gaps in the current approach. The Extended CoPs model was designed to address these and support schools in EMS and ESD. Through this model, the participating school developed a new EMS based on the sustainable FM approach and implemented the system for the academic year 2018/2019.

8.1 Sources of Qualitative Data.

During the year 2018/2019, I met the participating teachers once a month for between an hour to an hour and a half. During these meetings we developed the EMS, made changes as necessary and discussed the progress being made or any challenges being encountered. As outlined in section 3.3.8, five of the teachers kept reflective journals during the process, I recorded my observations and field notes and we conducted a focus group in February 2019. These methods helped to monitor the progress of the EMS and to identify any changes that the school wanted to make during this time or any further supports that the school required. It ensured both the EMS and research were flexible and could be adapted as needed. The written notes that the teachers made on the pre- and post-surveys were also entered into the Nvivo software. These sources of qualitative data were coded and then combined to create themes.

First, each data source was coded separately to identify what codes were occurring across data sources and what codes were particular to certain sources. Table 8.1 shows the number of codes per source.

Source	**No. of codes.**
Teachers Journals (5)	56
My Journal	46
Pre- & post - survey notes	28
Focus Group	27

Table 8.1 Number of codes from individual data sources.

Following this, the codes were combined to identify recurring themes. Six themes emerged from the coded data – *Teaching and Learning, School EMS*, *Place*, *School IEQ*, *Pupils* and *Teachers*. Two further themes, *Social Actors* and *Reflexivity,* emerged in my observational notebook only and are discussed in the next chapter.

Similar to the analysis of the interview data in Chapter 6, there were linkages evident between the six themes, and some codes were relevant to more than one theme. For example, 'monitoring' as a code was relevant to both *EMS* and *IEQ.* Table 8.2 shows top codes by frequency from the combined data sources. There were a total of nine sources – five teachers' journals, my observational journal, the focus group, notes from the pre-surveys and notes from the post-surveys.

	Code	**Theme**	**Sources**	**Frequency**
1.	Waste	*School EMS*	5	35
2.	Built Environment	*Place*	8	33
3.	Lesson Activity	*Teaching and Learning*	5	30
4.	Lesson Content	*Teaching and Learning*	5	29
5.	School Grounds	*Place*	7	24
6.	Natural Environment Biodiversity	*Place* *School EMS*	9 7	23 23
7.	Monitoring	*School EMS/School IEQ*	5	22
8.	Resources Energy	*Teaching and Learning* *School EMS*	7 4	21 21
9.	Teacher Commitment	*Teachers*	1	17
10.	Skills Development Teaching Methodology	*Teaching and Learning* *Teaching and Learning*	4 4	16 16

Table 8.2 Top codes by Frequency

Looking at the top codes by source shows a different picture (Table 8.3). Here we can see that the theme of *Place* emerged strongly across sources and the theme *Pupils* appears here whereas it did not emerge high on the frequency count.

	Code	**Theme**	**Sources**	**Frequency**
1.	Natural Environment	*Place*	9	23
2.	Built Environment	*Place*	8	33

3.	School Grounds	*Place*	7	24
	Biodiversity	*School EMS*	7	23
	Resources	*Teaching and Learning*	7	21
4.	Science	*Teaching and Learning*	6	15
	Geography	*Teaching and Learning*	6	14
5.	Waste	*School EMS*	5	35
	Lesson Activity	*Teaching and Learning*	5	30
	Lesson Content	*Teaching and Learning*	5	29
	Monitoring	*School EMS/School IEQ*	5	22
	Pupil engagement	*Pupils*	5	13
	Pupil responsibility	*Pupils*	5	13
	Curriculum planning	*Teaching and Learning*	5	9
	Art	*Teaching and Learning*	5	9
	History	*Teaching and Learning*	5	7
	Making Connections	*Teaching and Learning*	5	6

Table 8.3 Top codes by source

While each theme is discussed separately, they are very much interconnected. For example, while 'built environment' is a strong component of *Place*, it is also central to the theme *School IEQ*. Indeed one process that the school continually engaged in is altering or adapting *Place* (be it the building or grounds) to the needs of the school community. As mentioned in the previous chapter, the school had completed two building extensions in the recent past to accommodate growing pupil numbers and individual pupil needs. During this research, an increased understanding of IEQ (which can also be linked to 'new learning' in the theme *Teachers*), resulted in adaptions made to windows in rooms 2, 3 and 4 so that they could be opened manually. This was done in an effort to control CO_2 levels and improve IAQ. This is just one example of the overlapping of themes and others are highlighted in the discussion below.

8.2 Teaching and Learning.

Teaching and Learning, perhaps unsurprisingly, emerged as a strong theme over the course of the EMS. This reflects the finding in Chapter 6 that SFM must be focused on core business, which for schools, is education. In the reflection journals in particular, teachers regularly used the vocabulary of their discipline and noted the content of the lesson, resources, methodologies and activities used, opportunities for skills development and of course, the subjects they were teaching. Figure 8.1 shows the codes that combined to make up the theme *Teaching and Learning*.

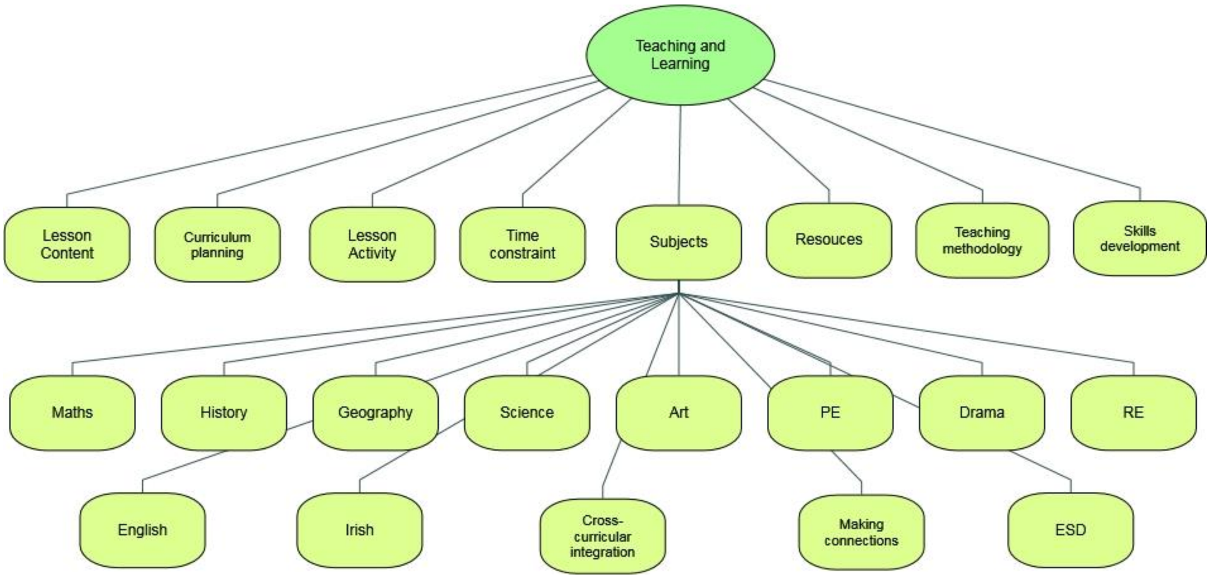

Figure 8.1 Teaching and Learning.

8.2.1 Lesson Planning and Teaching.

During the meetings on EMS development, there was a clear focus on anchoring the EMS in the curriculum. When the teachers looked at the findings from the FM interviews, the observation that SFM must be focused on core business was one that resonated with them. It was through the curriculum that they believed they could anchor ESD in their school. Even when developing the EMS, it was the 'curriculum' column that was always filled out first.

Lesson content and activities.

When reflecting on lessons taught, the participants often began by recapping on the lesson content and referring to the lesson activities they had developed to engage their pupils with the content.

> '*We learned about the different trees that are to be seen around our school and locality. We looked at the leaf, flower and buds of each of the trees – Oak, Ash, Hawthorn, and Sycamore'* (Jennifer, reflective journal).

> '*In depth week focusing on bees and their vital part in our world. JIGSAW lesson on their function, their colonies, their diet, different types of bees – finally finishing with a*

lesson on how we can help bees. The children made a pact not to kill any bees, to leave out a small dish/saucer of sugar water and also to plant colourful flowers beside our garden plot in the yard to attract them to pollinate.' (Áine, reflective journal).

A clear understanding of the content that is being taught is an important prerequisite for a stimulating and engaging lesson (Ladwig *et al*., 2010 in Kennelly *et al.*, 2012) and this can be problematic within ESD as the content can be challenging and research has shown that teachers often have a poor conceptual understanding of ESD (Taylor *et al.*, 2015). During this case study, the teachers built on their content knowledge through the workshops and resources provided and through their own research into areas of interest. This in turn motivated them to engage with their ESD practice further - '*Now we're all increasing our knowledge and that motivates you – the more you know the more you want to do it*.' (Jennifer, focus group).

ESD is for every child, regardless of age or ability (Breiting *et al.*, 2009 in Madsen, 2013), and the teachers in this study worked to ensure that each of the themes of the EMS were accessible to all students. Deirdre, the infant teacher, thought about the language she was using when working with her four to six year olds. For example, when teaching about biodiversity she made simple connections to the wider issue of global warming and climate change; '*We learned about parts of trees and how trees are helping to reduce bad gases in the environment and how more trees should be planted everywhere!'* (Deirdre, reflective journal). Throughout the year, Deirdre regularly used concrete, meaningful examples for her pupils to help them to grasp subject content. When teaching about water conservation, she recalled

> '*We also spoke a bit about saving water, e.g. have a shower instead of a bath. They were amazed at how much water we use in a bath. I told them how I have a shower over my bathtub and how I put the stopper in to see how much water I used. It only came up to my ankles!!*'

All teachers tried to engage their pupils with the sustainability topics in a meaningful and sometimes critical manner. When teaching about waste, Jennifer aimed to engage her students in critical discussion that moved beyond recycling and individual habits to question the broader issues around waste management.

> '*Used Lidl catalogue to discuss what packaging [is] made of and why? Is all packaging needed? Great discussion teasing out ideas. We cut and glued packaging under headings recyclable/non-recyclable, etc. Discussion led to how supermarkets do it for reasons, e.g. handiness and it could be different*.' (Jennifer, reflective journal)

Jennifer went on to say how this influenced some of her students.

> '*This worked really well as children weren't fully aware of packaging. Two children came in and told the class about how they were shopping and didn't use a plastic bag for the red peppers – just put [them] in the basket! Delighted! Children great for saying how their behaviour changed and sharing with the class*.' (Jennifer, reflective journal)

In Jennifer's class, the pupils have begun to move beyond 'just recycling' as a means of waste management and have begun to consider strategies higher up the waste management hierarchy such as 'refuse'. Studies have shown that schools often equate recycling with sustainable waste management (Goldman *et al.*, 2018; Kolbe, 2014) and that students do not relate their own consumption with environmental consequences (Goldman *et al*., 2018). This was an issue that the infant teacher encountered.

> '*Did first lesson of waste management today. Decided to elicit prior knowledge of recycling from children. They didn't know much really. They said 'putting rubbish in the bin' and 'using the rubbish to make other things'. When I asked 'Why do we recycle?' they said so we wouldn't have rubbish everywhere so I think most of them think recycling = picking up rubbish*' (Deirdre, reflective journal).

Creating means by which students can question current practices and consider new ways of thinking about sustainability issues, such as waste management, can address both the managerial and educational aspect of the practice (such as waste) in schools.

Teaching methodologies and skills development.

As well as creating interesting lesson activities, the teachers had a clear focus on the methodologies they were using. There was a significant emphasis on group work which puts emphasis on social learning and is conducive to experiential approaches. A key principle of ESD which underpinned the normative reference point for the case study is evident here – '*use a variety of pedagogical techniques that promote active and participatory learning and the development of key dispositions and skills*' (Department of Education and Skills, 2014a).

As mentioned above, Áine used the JIGSAW approach for teaching about bees which puts the onus on the children to be both teacher and learner and ensures the responsibility for learning is shared (Adams, 2013). Many of the activities that teachers spoke about also had to be completed in groups. For example, following a lesson on waste reduction, Jennifer put her class into groups to create 'Top Tips' posters for display in the school. This approach (rather than pupils creating their own posters individually) gives pupils the opportunity to further discuss their learning with their peers. Similarly, Claire used a group-work approach to a construction project at the end of a series of geo-literacy lessons. These lessons had included drawing and mapping the built environment and finished with the pupils constructing a city from recycled materials as a collaborative project.

Team-teaching was a well-established teaching methodology in this school prior to the research and occurred in all classrooms on an almost daily basis. Some teachers also referred to this approach when reflecting on their practice – '*I incorporated the school building into my teaching when teaching lines and angles as part of team-teaching for maths. The children enjoyed this'* (Ciara, reflective journal). Although not directly related to ESD, this example shows how the building was used as a resource for teaching maths. This has the potential to increase the children's awareness of the built environment and subsequently their appreciation of connecting their mathematical knowledge to their immediate environment. Also, developing team teaching as a methodology within ESD would be very beneficial as research has shown that '*knowledge about sustainability issues is distributed among participants in and around projects; not all the relevant knowledge is 'in the head' of any one participant*' (Kemmis and Mutton, 2012, p. 195).

As well as being clear about the subject content to be explored with pupils, teachers also focused on skill development through their lessons. Words such as 'identifying', 'recording', 'estimating', 'measuring' and 'observing' regularly appeared in the reflective journals and are identified in the Primary Curriculum (Department of Education and Science, 1999c) as skills to be developed. Proponents of ESD regularly cite the need to develop 'knowledge, skills and attitudes/values' to move towards sustainable societies (Department of Education and Skills, 2014a; Kanyimba *et al.*, 2014) and although research has shown that these traits do not necessarily result in behavioural change (Grodzinska-Jurczak *et al.*, 2003), they are certainly among the preconditions for the move towards action competence and improved environmental behaviours (Jensen, 2002).

Curriculum planning.

Within their curriculum organizing system, Taylor and Enggass (2009, p. 91) describe three key components for connecting the built and natural environment to teaching and learning – the context, the content and the learning processes. During this case study, when the teachers were reflecting on the EMS process, they consistently reflected on these three aspects of their practice. The teachers regularly referred to the 'context' for learning – the classroom, the vegetable garden, the yard, etc. (these are coded under *Place* section 8.4). They also discussed the subject 'content' and the methodologies or 'learning processes' that were being utilised. Although Taylor's framework was not used to structure the approach to the curricular aspect of the EMS or to structure the teachers' written reflections, it appears that the teachers automatically focused on these three critical aspects when trying to align their teaching with the school's physical environment. This is important because Taylor and Enggass come from architectural backgrounds and have lengthy experience in understanding the built environment and how design can impact upon building occupants. When these teachers began to improve their understanding of the built and natural environment, they instinctively knew the aspects to focus on to align pedagogy and environment, their experience being connecting pupils with the subject content to be explored. As mentioned above, these teachers always began with the curriculum when creating the EMS for their school. When reflecting on their practice, they referenced the curriculum – '*I referenced objectives from both Science and Geography curriculum. This worked well for integration and also topic more immersive over the fortnight*' (Jennifer, reflective journal), and also thought ahead to future planning – '*Just planning my SPHE lesson and the objective we're working on is based around taking responsibility for their own actions and belongings. This will tie in nicely with them taking responsibility for their area/desk in school, the yard, etc*.' (Deirdre, reflective journal). The EMS also aided planning, particularly from a long-term, whole-school perspective;

> *'I think that the EMS grids are a really practical way to move this project forward. With an overloaded curriculum the really valuable things such as looking at and examining hedgerows and potting plants can be left out. Having them set out in a yearly plan for*

each class is a way to ensure that valuable, hands on learning experiences incorporating nature and the school environment happen.' (Ciara, reflective journal).

When discussing the Teaching Green Building, Cole (2014) argues that the building's features must be aligned with the school's curriculum. While this process has begun within the EMS framework (e.g. the new monitors have been incorporated into teaching about energy and the new vegetable garden has been linked to the school's cookery programme), it is important that it continues as additional projects are carried out in the school (e.g. the installation of new solar tubes in corridor two). Continuing to develop the building and grounds and connecting these developments to curriculum planning will help this school to develop their capacity for experiential ESD.

8.2.2 Resourcing Lessons.

Resourcing lessons was identified as an important aspect of teaching and learning within ESD (Green and Somerville, 2015) and each teacher was provided with a bank of resources on a USB key that I had compiled as I was preparing for the case study. These resources included useful websites and online resources that I had come across as well as resources specifically pertaining to their school such as the Revit model, maps of the building and grounds, results of the audits, an identification key for the plant life on site, etc. Teachers referenced these resources when writing in their journals; '*We used the Éanna Ní Lamhna book as a guide for the plants and trees to teach the infants*' (Deirdre, reflective journal); '*We are going to learn about the bee, use your plant ID powerpoint and head out to identify the flowers in school*' (Jennifer, reflective journal). However, locating resources for supporting lessons on sustainability still remained somewhat of a difficulty. When asked if there were areas we could address going forward, Mairéad answered

> '*As teachers we love to have a book or resources. It's difficult to get to brass tacks when it is all in your head. It can be difficult to get started. It would be nice to have some pointers like a list of resources to add to EMS - even websites – like the SEAI website*.' (Mairéad, focus group).

At this point, the resources had been organised by topic (such as 'energy' or 'waste') so we reorganised them by class also to aid the location of resources when needed. This made connecting resources to the EMS grid easier as teachers could search by topic or class level, thereby saving time – a barrier to both ESD and EMS that was identified in the literature (Hillary, 2004 in Kanyimba *et al.*, 2014; Madsen, 2013). The participants also referred to their own resources that they used to engage pupils and enhance lessons. These came in numerous forms – websites, videos, books, online games, etc. They referenced interesting resources they came across and shared these with their colleagues.

> '*Saw a programme on TV last night (RTE 2) called "10 Things to know about Bioenergy". Thought it was very interesting and would be good for 5th and 6th class. Could be implemented in the 'closing the loop' lessons with them.*' (Deirdre, reflective journal).

By sharing these resources and adding them to their USBs, the teachers continued to build a bank of resources that will facilitate ESD teaching going forward.

These teachers also began to view the building and grounds as a teaching resource over the course of the case study. Anne Taylor, a leading academic in linking architecture and education, states that educators and students need to broaden their awareness of the built environment and its potential as a learning tool (Taylor and Enggass, 2009). There were a number of examples whereby the teachers used the school building or grounds as a learning resource. Following a lesson on water conservation, Deirdre recorded in her journal

> '*We went outside to look for water related things for example, gutters, drains, pipes, shores. I emphasised the importance of conserving water in this lesson and how all living things need water to grow*' (Deirdre, reflective journal).

Rather than stay in the classroom, she took her pupils on a walk around the school so that they could identify the features that connect water management to the built environment. When teachers use the built and natural environments of the school to teach about topics such as harvesting rainwater, sustainable food production or energy efficiency, they are moving away from studying static situations in textbooks or on the IWB to an experiential and active pedagogy. This reflects a pragmatic philosophy of education that is based on practical, experiential learning.

8.2.3 A cross-curricular approach.

ESD is not a static discipline that can be approached through the application of memorised facts and formulas. Rather it is interdisciplinary and dynamic and requires the application of knowledge from numerous subjects or fields (Schiller, 2012). Over the course of the year, Geography and Science were the main entry points to ESD for the teachers in this research. Science is a widely used subject within which to approach topics of sustainability (Birdsall, 2015; Dyment, 2005). Science-oriented lessons over the year included plant and animal life, energy, materials and waste and habitat study (the hedgerow). Geography lessons included planting, studying the built and natural features of their environment and mapping activities. From a planning perspective, the teachers felt that S.E.S.E. (Social, environmental and scientific education) was where ESD was most at home – '*We are doing it now as part of our SESE. It's part of our curriculum. It seems to be more integrated now*' (Deirdre, focus group).

However, many other subjects were used as avenues to explore sustainability, albeit, not as frequently. In the new EMS documentation, the following subjects are identified – Science, Geography, Mathematics, Art, History, S.P.H.E., English and an Ghaeilge. Mathematics is used mainly within the audit cycles for collecting, recording and analysing data. The infant teacher also uses 'sorting' when looking at materials during waste audits. Art was a widely used subject within their sustainability education which is a positive outcome as many researchers advocate a move away from a solely scientific/technical approach to a more holistic approach that includes humanities and the arts (Clark and Button, 2011; McNaughton, 2010). Art was used both as an activity within lessons and as standalone lessons to create posters or creations from waste material to draw attention to sustainability issues. As art was identified as a waste source during the audit, teachers decided to focus on waste-free art lessons. For example, Áine did an outdoor art lesson where pupils, in groups, found natural materials on the school grounds (twigs, leaves, stones, etc.) and created large mandalas. Here, Áine had a clear focus on Art outcomes through exploring pattern, colour and texture but she was also able to get the pupils to think about waste practices and discuss the aspect of 'refuse' or not creating waste in the first place. Through History, the teachers used the building and grounds to look at change and continuity. In particular, their 'sustainability project' drew attention to school life in the past and is an avenue for exploring the intergenerational aspect of SD in a very concrete way. S.P.H.E. (Social, personal and health education) was used to look at issues of responsibility and also health related aspects of ESD. The infant teacher used the strand oral language to plan discussion aspects of lessons while in older classes report writing was used to engage with sustainability topics. Books were also used as a stimulus for lessons such as ‘A Drop around the World’ by Barbara Shaw McKinney for water conservation and ‘The Lorax’ by Dr. Seuss as an introduction to ‘Tree Week’.

When looking at the classification of trees and wildflowers on the school grounds, the teachers decided to do this in both languages (English and Irish) from 3rd to 6th class. This is an interesting development for a number of reasons. Firstly, the New Primary Language Curriculum (Department of Education and Skills, 2014c, p. 20) puts emphasis on the integrated nature of languages and the transfer of skills from one language to another and dual language activities are an important part of teaching for transfer. Second, authors, such as Orr (2002, pp. 54-58), speak of ‘verbicide’ and the devaluation of language. He argues that we cannot think clearly about what we cannot say clearly. Language is central to how and what we learn (Department of Education and Skills, 2014c, p. 18), therefore if we want to teach children to think critically, we must give them the language to do this first. A third point here, and one that is very pertinent to the Irish language, is that there is cultural information embedded into native languages. Orr (2002, p57) argues that the problem of language is a global one, stating that of the approximately 5 000 languages now spoken on Earth, only 150 are expected to survive the next 100 years. He writes that

> ‘*Language everywhere is being whittled down to the dimensions of the global economy and homogenized to accord with the imperatives of the information age. This represents a huge loss of cultural information and a blurring of our capacity to understand the world and our place in it’* (Orr, 2002, p57).

Stated like this, native language becomes both an issue for ESD and a means to engage with it. The Yupik people of Alaska have numerous words to describe ice, giving detail and information to those whose livelihoods depend on traversing over large expanses of ice. Like many indigenous languages, certain words are born of the landscape. The Irish language is inextricably linked to the Irish landscape and there are Irish words that describe aspects of the Irish landscape for which there are no English equivalents. There are words in Irish that have multiple interconnected meanings. For example, Irish author Manchán Magan wrote

'*Cáithnín is another fine example of how a single word can unlock the hidden richness in our lives and landscape. It means a speck of dust, a husk of corn, a snowflake, a subatomic particle and a miniscule smidge of butter, or anything tiny that gets into the eye and irritates it. But, most evocatively of all, it also means the goosebumps you feel in moments when you contemplate how everything is interrelated and how tiny we are in relation to the whole, like that feeling when you realise, or, maybe, remember, that we are all one – all unified*' (Magan, 2018).

When identifying and learning about the native species on site, using a bilingual approach gives opportunity for language development and transfer while also connecting the trees and plants to native language, heritage and even folklore, for each native tree and wildflower has its place in Irish mythology also.

The four remaining subjects on the Irish Primary School Curriculum that are not identified on the EMS are Music, Drama, P.E. and Religion. Three of these subjects – Drama, P.E. and Religion, were referenced by teachers in other data sources. In fact, Religion was used by the two teachers in the younger classes as a basis for exploring environmental issues.

'*In communion preparation, as focus is on becoming better Christians, I am placing strong focus not only on care of other people but also care of the environment/animals to help the children build a stronger relationship with God*' (Áine, reflective journal).

References to P.E. and drama were made mostly in relation to taking the children outdoors for curricular activities which again reflects literature findings that P.E. is one of the main lessons to occur on the school grounds (Dyment, 2005).

It is important that teachers are aware of the web of connections of which we are a part and the interrelationships that exist between various concepts (Quinn *et al.*, 2015). The teachers were more aware of interconnections between topics and subject content.

'*We have been looking at sustainable development goals and relating all subjects and topics back to link with these goals. The children were fascinated that pretty much everything we learn in other subjects relates back to these*.' (Claire, reflective journal).

At times, teachers also referenced using the built and natural environment to support learning, but not necessarily in lessons with a sustainability focus. For example, teachers used both the building and grounds to teach measuring skills in maths and they used spaces on the school grounds to bring the children outside to read. As these teachers continue to learn about the school's physical environment they will very likely identify further opportunities for engaging pupils with the built and natural environments to support learning.

8.3 School EMS.

Participants regularly referred to the new EMS as a tool that they were using to support both curriculum and management of the building and grounds. They referred to the four themes within the EMS, the key role of monitoring, and the fact that they felt there was now an increased focus on the whole-school approach. They also mentioned some of the challenges they were still facing and made some comparisons between their new approach and the Green School approach. They spoke about the role that our meetings played in keeping them focused and the value of having the time to discuss the progress of the EMS.

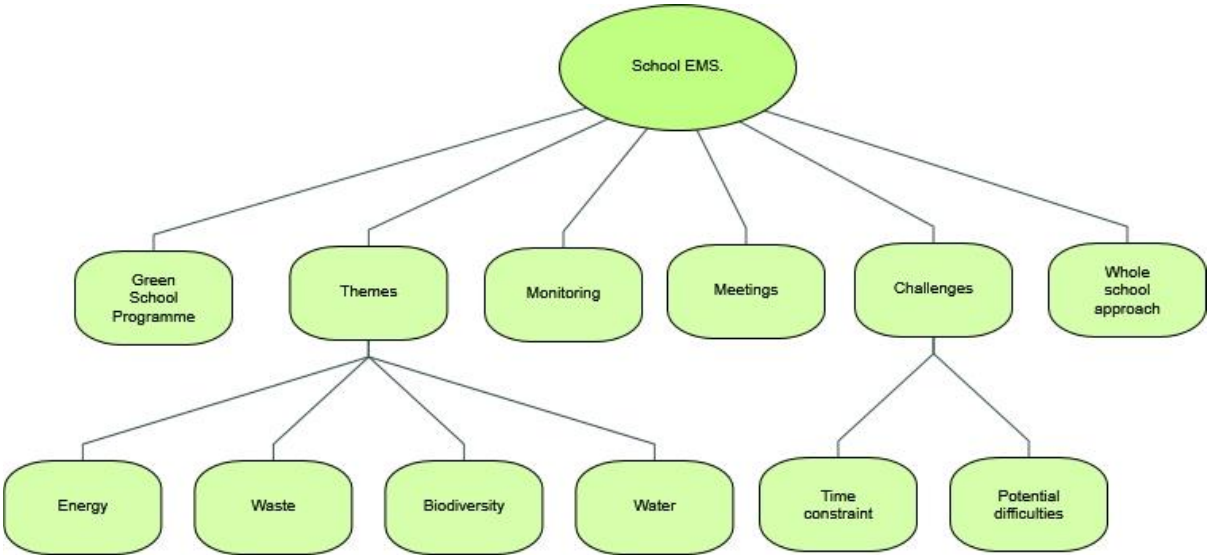

Figure 8.2 School EMS

8.3.1 The EMS framework.

The EMS framework, as shown in Chapter 7 (7.5.1), became a central artefact during the case study and played a number of roles within the research. It became a curriculum planning tool, a management tool, a tool to support curriculum integration, a tool to coordinate activities between the school and HEI actors as well as a support framework for the EMS itself. As Mairéad noted during the focus group '*it has helped us to focus*'. Essentially, it was the key document over the course of the case study. Importantly, it was not viewed as a static framework where each item was to be ticked off when completed, but rather a fluid system that teachers could adapt as they moved through the year. '*I think that the EMS grids are a really practical way to move this project forward*' (Ciara, reflective journal).

Research by Raath *et al.* (2018) which looks at Namibian and South African teachers' participation in an EMS stress that intervention workshops alone are not enough to empower teachers to embrace a new ecological paradigm, but that regular follow ups and discussion are needed. This would suggest that in this research, the regular meetings over the course of the year played a role in supporting teachers' practice.

> '*Even having the meetings with you (Mary) at our Croke park hour, we all had to be more involved. And without those meetings we wouldn't even know where to start – it's too big a project for a staff with very little knowledge*' (Mairéad, focus group).

The meetings also gave the teachers time and space to reflect on the EMS implementation as well as their own practice. Following the meeting in April, Áine recorded her thoughts in her journal,

> '*I feel EMS should become a huge part of Irish school life. It is an ideal tool for schools, teachers, students, parents, communities to use to make a positive impact upon our environment… EMS assists teachers in helping children foster individual/community responsibility for the environment'* (Áine, reflective journal).

The concept of the whole school approach came across strongly in the focus group – '*Main theme: everyone is now involved/ full participation. Lots of enthusiasm evident among the whole group'* (non-participant observer's notes, focus group). During the focus group, they compared their new approach to the Green School approach.

> '*If you were to compare it to doing the Green School flag, it was often left to that one teacher who was in charge – and you knew it was being done and you did what you were told to do. Then as a teacher, you're not really taking ownership of it. Really it was all about getting the flag….*' (Mairéad, focus group).

The teachers felt supported within this more inclusive approach and were motivated by it. The impetus appears to have moved away from 'getting the flag' to a more internal source of motivation towards becoming a more sustainable school.

> '*And you do hear the story of some poor teacher doing it for ten years and then can't get out of it! [Everyone laughs]. It's too big for one person. But now we're all increasing our knowledge and that motivates you – the more you know the more you want to do it'* (Jennifer, focus group).

These feelings have been reflected in other research with teachers finding the whole-school aspect of Eco-schools difficult and a single, enthusiastic teacher carrying the programme (Rosenberg, 2008). The teachers' focus on and awareness of this more inclusive approach is important as it encourages all teachers to take responsibility rather than the onus being on one or two interested staff members. Leading sustainability in schools must be shared among colleagues (Pepper, 2014) and not driven by top-level management (Kanyimba *et al.*, 2014). As one teacher in this study put it *'the whole school approach is the way forward'* (Mairéad, focus group). Although this research was based on working with teachers to improve their practice, it appears that all pupils are accessing the EMS – '*And the children are all getting it now, not just the kids who were on the green team*' (Amy, focus group). The post-surveys also showed that the teachers perceive that the pupils are more involved now and that they are choosing more topics for exploration within the EMS as identified in section 7.5.6.

Children's experience of space is very different from adults (Wheeler and Malekzadeh, 2015) and as the majority of school building occupants are children, it is imperative that their voices are central to decisions being made regarding building upgrades and other sustainability projects. In this case study, the focus was on working with the teachers to help them to develop their own capacities for teaching ESD and engaging an EMS. This school has an already established ethos of appreciating and accepting student voice (as explained in section 7.1.3) and it is very probable that as the teaching staff become more confident in their own abilities in this area, they will create more avenues for student involvement and participation. However, it is reasonable to believe that performing actions in a school context, such as through the EMS, helps to develop action competence (Jensen and Schnack, 2006) and the pupils' increased involvement this year would be a first step towards this development.

8.3.2 Themes of the EMS.

The teachers also made reference to the individual themes within the EMS. Waste was the most referenced theme, particularly in the journals. The water theme was referred to the least.

Energy.

Energy awareness of teachers and pupils is very important when upgrading the energy performance of schools (Katafygiotou and Serghides, 2014a) and the EMS can align learning about new technologies as they are installed in the building. This constant alignment of curriculum and campus was given a mandate through the written EMS whereby teachers could teach about and use the new technologies/upgrades to the building and grounds as an authentic means of curriculum engagement. This has often been identified as a difficulty in other researches whereby teachers felt they did not have authorisation from school management to engage with sustainability topics in the curriculum or that planning for ESD was seen as something 'to get around' (Madsen, 2013).

Real-time monitoring of electricity usage became a critical step in the energy management plan for this school. Identifying consumption patterns and the energy requirements of different systems led to an increased understanding of energy use in the school. Lourenço *et al.* (2014) found that most school leaders were unaware of their school's energy consumption patterns, but that they expressed interest in this data, including benchmarks for schools. The results were similar in this school and the staff were glad to move from using the bills as a monitoring tool to using a more detailed, real-time system. Buildings that aim to teach need to make changes in performance visible so that students can see how the building functions and how their behaviour can impact upon these functions (Schiller, 2012). The Owl-Eyes electricity monitors did just this and simple activities such as watching the monitor and turning on and off different systems (such as the classroom lights) allowed teachers and pupils to immediately see the result of their action.

Waste.

Waste separation was identified as a difficulty that this school was encountering during the course of the audits. During the initial audit, separation improved on the second count and this was put down to the new signs that the principal had put on the bins. These signs were text-only signs and separations habits reverted by the time the third audit came around. As part of their new EMS, it was decided that new signs should be made for the bins and this time pictures showing what items were allowed in each bin were added. In a study on a recycling programme by Ward *et al.* (2014), waste separation improved dramatically when the bin function was emphasised by more than just a colour. In this study, it appears that adding text *and* pictures to the 'green' bin and waste bin had some impact on improving waste separation.

The waste audit identified the children's lunches as the main source of waste. Jørgensen *et al.* (2018, p. 812) propose that '*waste is a material which becomes entangled in everyday practices of social relations linking schools with homes…*' One time when waste came up in discussion as a connection between home and school was during an EMS meeting in November 2018.

> '*During this discussion, Claire also said that in her old school, which was a large, urban school, there were no bins in the classroom so pupils had to take home all of their rubbish. This is similar to a school that I worked in, where pupils were not allowed to throw rubbish from their lunchboxes into the bin – something I had issue with. I didn't voice my opinion but Mairéad immediately said that that was wrong as 'how were they learning from that' and that they could be throwing the rubbish into the incorrect bins at home. At this point I agreed with her. And again, it shows her commitment to ESD and leading the school towards being a 'sustainable' school*' (Mary, fieldnote joural).

Pupils taking their lunch rubbish home is an option for schools who wish to alleviate waste management at school and reduce the cost of their waste bill and, as noted in Chapter 4, cost is a significant driver for sustainability initiatives in schools. But at this meeting, the principal could not even consider the idea of this action as it had no educational benefit. The audit drew their awareness to their largest waste source and they could now address this through the curriculum and in consultation with parents. The idea of a waste-free lunch week did come up at a meeting prior to finalising the EMS, but the teachers just used the idea of a waste free art week. Perhaps as they become more experienced with the new EMS and continue to involve parents and the community, they will look at this idea again.

Another source of waste was art lessons which produced waste in the form of empty paint bottles and waste material from lessons including cut-offs of paper, plastic, card and other materials. Presumably, some art work taken home by pupils eventually ends up as waste also. So once again we have the materiality of waste as well as its connection to the home environment. Waste is a very tactile element within the EMS, particularly when compared to energy and water management where the teachers had to find ways of making concepts concrete for the pupils (e.g. Deirdre's example of comparing water use when taking a bath or shower in section 8.2.1). The children handle waste and physically dispose of it in the correct (or incorrect) bin. The teachers tapped into this and used waste for art projects or construction projects such as Claire's city construction in geo-literacy. Indeed, some pupils engaged in craft activities at home using waste materials, again bringing attention to the material connection it makes between school and home. '*Today a student brought in a piece of recycled art she made at home. A jewellery box made out of an egg carton. Shows how constant reminder of Reduce, Reuse, Recycle really works and resonates*' (Áine, reflective journal).

Water

Within all aspects of the EMS, monitoring is essential (Hens *et al.*, 2010b) and this was a limitation when it came to water management at this school. Although a comprehensive EMS was developed for water management, looking at the qualitative data, it appears it was the theme that teachers interacted with the least.

As the teachers were trying to develop a more holistic approach to their EMS and were aiming to develop a healthy, sustainable school (as opposed to a green, environmentally-friendly one), one aspect of water management that they addressed was drinking water. Ensuring that water is a ready part of pupil's daily environments is one important strategy of overall child health strategies (Patel *et al.*, 2014). The importance of pupil water intake was identified during the literature and these teachers took this on board when developing their water EMS.

Biodiversity

From the outset, the teachers readily embraced the idea of developing the school grounds and were always very engaged when discussing potential ideas. Similar to the theme of waste, biodiversity has a tangible materiality to it whereby teachers can easily demonstrate concepts to pupils through concrete, hands-on experiences. Habitats are the basic building blocks of the environment (Fossitt, 2000) and a very definite outcome this year was the development of two new habitats on site. All habitats were enhanced by a variety of actions including the installation of bug hotels and the cessation of herbicide use. Teachers regularly used the grounds to teach about biodiversity and there were many references made to these lessons in their journals;'

> *'We are learning about summer flowers so I emphasised the importance of wildflowers for insects and bees and how we are creating a wildflower garden to help. We looked for different flowers outside on the grounds and tried to spot any bees/insects nearby!'* (Deirdre, reflective journal)

Áine wrote about lessons on bees, Jennifer wrote about tree identification and using the 'Pollinator Plan' website and Claire also reflected on a lesson on tree structure and identification. Placing bug hotels close to both the vegetable garden and wildflower garden gave the teachers a tangible resource to teach about pollination and the interconnections between the various habitats on site.

While there is an increasing body of research on designing sustainable school buildings where the architecture is conducive to teaching about ecology and sustainability principles (e.g. Cole, 2014; Orr 1993/1997; Schiller 2012), the fact remains that the majority of our schools were not built with these principles in mind and there is '*a miscalibration between what is taught in classes and the way buildings actually work*' (Orr, 2002, p. 128). However, through the EMS, small changes occurred in terms of installations to the building – a water butt, bug hotels, monitoring screens. These small changes helped to make aspects of the building more transparent and helped to align the building's story with what the teachers were aiming to teach. A deeper understanding of the built and natural environment has also enabled the staff to engage in productive discussions around school planning and has led to plans for sustainable school development such as the construction of a polytunnel in the school garden and the installation of solar tubes in corridor two to introduce natural daylighting. Making plans for further developments such as these will help ensure the continued engagement with ESD and the EMS in the school.

8.4 Place.

Places, are spaces, with the addition of meaning and experience (Tuan, 1977 in Rose and Cachelin, 2013). The theme of place that emerged from this data echoes the situatedness of learning as encapsulated in CoPs theory. A focus of this research was to enable teachers to harness the built and natural environments of their school for pedagogical purposes, thereby adding meaning and experience to this space. The school building and grounds are perhaps the most visible within the broader system of factors that define 'place' on a school campus

(Cole, 2014) and Gruenewald (2003b, p. 621) famously postulated that '*places are profoundly pedagogical*'.

Although references to place were coded as built or natural environment for ease of analysis, in reality, the physical school site and all that it entails should be viewed as one entity. As Taylor and Enggass (2009, p. 327) articulate, '*both man-made and natural environments are crucial to learning and should not be isolated from each other*'.

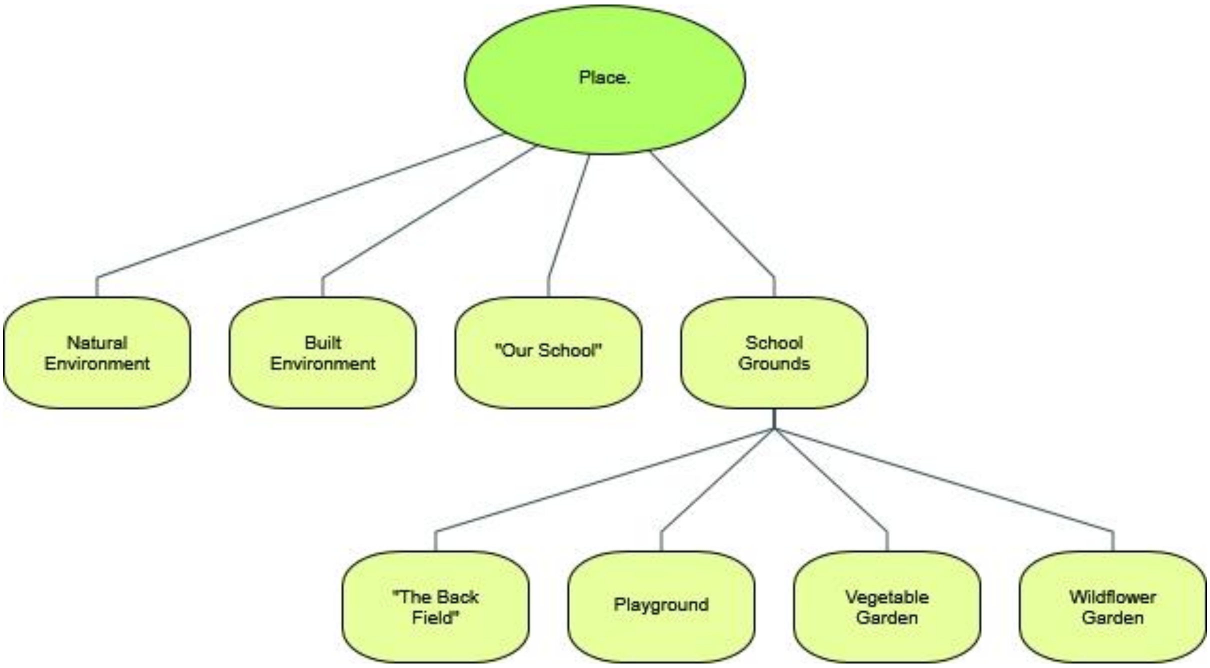

Figure 8.3 Place

8.4.1 A sense of place.

The teachers and pupils at this school would have had a sense of place ever before this project began. They had a repertoire of experiences and memories that were formed in the building and on the grounds and would have developed feelings towards the school during their time there. As this school was already recognised for their inclusivity and positive relationships (Department of Education and Skills, 2016b), undoubtedly the majority of these were positive experiences that elicited positive emotions. Also, as identified in section 7.2.5, the teachers generally had positive opinions about the built environment of the school and they commented on spaces and attributes of the school's environment that they liked. However, there were aspects of the environment that caused them anguish. For example, my first contact with Mairéad was due to the fact that she was having difficulty with her energy management, a negative experience she was having with the school space.

> ‘*Our electricity bill is huge each two months, reaching up to 700 euro in winter. I watch the energy carefully but can't seem to bring it down at all. Before the extension it would've been around 400 or less. Our school simply can't afford to pay this most of the time… I'd really love some advice as to how we can more carefully monitor things here’* (Mairéad, personal correspondence).

There were other aspects of the school that made them uncomfortable, such as poor natural lighting or difficulty managing thermal comfort. Ignoring such qualities in a building, however small they may be, tells pupils a certain story. And Orr (1993, p. 226) summarizes the storyline when he writes that

> ‘… *building design is merely technical and is thus best left to people with technical competence. It follows that ethical, ecological or aesthetic aspects of buildings don’t matter nearly as much as technique and technology. In deference to expertise then, we learn passivity towards the built environment’*.

This passivity is worrying as it *‘impoverishes human experience’* Gruenewald (2003b, p. 645). By becoming conscious of their own sense of place, the teachers at this school could identify the stories and experiences that were being encountered by all building occupants and engage pupils, through the EMS framework, in engaging in positive interactions with their school environment thereby challenging the current stories (such as energy management is difficult), and improving occupants’ experiences.

Warner and Elser (2015) maintain that for the next generation to be equipped to solve complex environmental problems, they will need to understand the relationships between the built and natural environments. In this case study, the teachers explored both the built and natural environments of their school, but there are few examples of how they looked at the connections between both. Ideally, the school site should be viewed as one continuous entity, the built and natural simply components of the whole. It would appear that this is the way children view their school and Titman (1994) in her study ‘The Hidden Curriculum of School Grounds’ found that the pupils perceived the school – the buildings and grounds- as a continuous entity. Small adjustments to the school, such as the installation of the water butt, can help tie into this holistic view of environment that children seem to already hold. Also, using the IEQ monitors to understand when and why the windows should be opened, and understanding that the fresh air from outside improves the internal IAQ, also helps connect the built with the natural. Identifying more such opportunities (e.g. natural daylighting in corridor two with the installation of solar tubes) and adding them to the EMS will help to ensure a more complete view of the school environment going forward.

A broad objective of the geography curriculum is to '*develop a sense of place: an understanding and appreciation of the major characteristics of different places'* (Department of Education and Science, 1999b, p. 15). Although this is an important objective, it is possibly more important that pupils engage extensively with their own place first. Over-concentrating on 'the major characteristics of *different* places' [my emphasis], may lead to teachers remaining in the classroom to 'look at' different places through books, the internet, photographs etc., while ignoring the landscapes outside the classroom window. Managing the geographical experiences of pupils like this could inhibit their development, as it contributes to this passivity and a lack of appreciation for place (Gruenewald, 2003b). The 17th century philosopher Comenius alluded to the importance of local places when he said '*Knowledge of the nearest things should be acquired first, then that of those farther and farther off'* (as quoted in Sobel, 2004). Using the school building and grounds to learn about energy, waste, water and biodiversity has the potential to lead pupils towards a deeper understanding of these issues, to see the interconnections between them and to experience place-making in a real and tangible way. Engaging with these issues year on year and observing the changes through continued experience can lead to a love of place and a knowledge of how to care for it (Somerville, 2011). Even though this case study was over the course of one year, teachers tried to tap into this idea of continuity and constant change by engaging pupils with elements on the school grounds through the seasons; '*We went out and revisited our trees from autumn/winter, observing differences, identifying tree shape and ivy, sketch and make notes*' (Jennifer, reflective journal). Also, by monitoring and recording energy use, the pupils can see the effects that their conservation efforts are having and can identify how the energy story of their building is changing.

The teachers were aware of the historical context of the school and had engaged their pupils in previous local history projects. They were also aware of the history of the school site and used aspects of this for pedagogy; *'History – mapping the old school'* (Claire, post-survey); *'History: school long ago (show fire places, etc)'* (Deirdre, pre-survey); *'I've used the actual* *building to show the development of different parts of the school over the years'* (Mairéad, pre-survey). Engaging with local or place-based histories enables pupils to care more deeply about their school and local community (Gruenewald, 2003b). Their sustainability project of using the space where the old school stood to create their wildflower garden also linked into this concept of change and continuity. It looked to both the past (to life in the old school and the design of the old school) and to the future (stewardship of the grounds for future generations). Engaging in projects such as this leads to a deepened sense of place, connecting pupils to those who attended the school before them and those who will attend in the future.

At times, there was a sense of ownership when the teachers talked about 'their' school – '*I use our large back field for PE and science and nature*' (Mairéad, pre-survey); '*Identifying trees in our school environment*' (Jennifer, reflective journal); '*There is a need to foster an attitude of collective responsibility for the care of our own school'* (Ciara, reflective journal); '*We are very lucky to have the space that we have…*' (Deirdre, reflective journal). Through deeper engagement with 'place', both the school building and grounds, these teachers and pupils should develop a deeper, more rooted, sense of 'their' place. Developing a sense of place leads to love and stewardship of the planet and each other (Taylor and Enggass, 2009, p. 64) and thus is a necessary component of ESD.

8.4.2 Adapting the built and natural environments of the school.

The school and its grounds are the most immediate of local places and the most readily available pedagogically (Green and Somerville, 2015), therefore it makes sense to ensure that teachers can identify the pedagogical opportunities and adapt the school environment to support the quality of these opportunities. As authors have identified that both the school building and grounds are a type of '*crystalized pedagogy with their own hidden curriculum*' (Orr, 1993, p. 226), it is important for teachers to begin to understand what types of stories the school is presently telling (Orr, 1997) and what aspects of these stories need to be changed. By working to improve the buildings 'energy story' or the grounds 'biodiversity story', pupils become engaged in a meaningful, place-based education where they directly engage with their surroundings and question what works and what could be improved.

While the teachers did engage pupils with the built environment of the school in numerous ways prior to the research (see pre-survey results in section 7.2.5), there were many aspects of the built environment that could be enhanced to further support learning and engagement with the building, particularly from a sustainability standpoint. From the beginning, teachers knew what they did and did not like about the building and what they would like to change; *'There are skylights in the classroom. It's a lovely, bright room'* (Ciara, pre-survey)*; 'I hate the lights and fittings we have in all rooms. I dislike that the corridor needs this artificial light on all day as it has no natural light'* (Mairéad, pre-survey). While retrofitting all of the lighting was investigated, it was not financially feasible for the school at the moment. But there were many low-cost or no-cost opportunities available to them and a number of small changes were made to aspects of the built environment to both support environmental management and to help engage pupils with how the building and its support services work. The monitors became visual tools that helped teachers and pupils to 'see' how their environment was operating and what outcomes their actions had on it. Visual signs were placed in locations to give information and prompt certain behaviours. A water butt was attached to the gutters close to the vegetable garden to improve water management. And the teachers continued to use architectural aspects of the building to enable the children to see how the school had changed over time. With classrooms built at four different points in time, it was a wonderful opportunity to explore material and structural changes in classroom design.

The school developed two significant projects on the school grounds over the course of the year. The potentialities that the school grounds offered for education excited the teachers and they appeared to be willing to take more chances and be more adventurous with these outdoor projects. The vegetable garden was developed early in the year with the involvement of the pupils and some parents, and the teachers ensured that it would be used for pedagogical purposes by enshrining its use in both their own curriculum planning and the EMS. The wildflower garden took much longer to plan/design and this project continued to develop over the course of the year. The teachers had wanted to develop a wildflower garden from the outset and this became their key sustainability project for the year. While the obvious environmental advantages were there, including improved biodiversity, they wanted to ensure that pedagogically, it provided as many opportunities as possible. When they decided that it would need a pathway around it, for ease of access and to mark the original foundations of the old school, they decided to create a sensory path which could be used to support education. Each class in the school is taking responsibility for designing and creating a number of 'steps' in the sensory path. As the project grew and more people became involved, they brought new ideas with them it was decided to expose the original foundations of the school and place the path around the foundations instead. So, although wildflowers had been sown in the Autumn of 2018, due to the expansion of the project, the ground was rotivated again and the pupils began work in earnest on their sustainability project in June 2019. The excitement in the school was palpable when this work began and the following entry from my fieldnote journal from June 2019 demonstrates this;

> '*The first thing I saw was the area for the wildflower garden all dug up. Mary came out to meet me and walked straight towards this area. She told me that over the past two days, all pupils in the school have brought in old clothes and wellies and have been digging this area in an attempt to expose the original walls/foundations of the old school. When they found the foundations, they then used brushes to expose the stone. One pupil even brought in a metal detector. She showed me piles of items they had found as they were 'excavating' – broken pieces of porcelain and glass, an old pencil with "made in the Republic of Ireland" stamped on it, old coins, slates, etc. She repeatedly said that the level of engagement by the pupils was amazing – she had some lovely photos and short videos of the pupils working on it. It is amazing to see the old school exposed in this way. She also said the infant classes were enthralled with the earthworms and were continually bringing her earthworms to show her! Also, she said parents have shown huge interest and that there were lots of parents in, having a look, on both evenings. It's unfortunate that they only started now – so close to the summer break but she said that the pupils will be looking forward to continuing with the project in September*' (Mary, fieldwork journal).

So, while this was the intended 'sustainability project' for 2018/2019, the school have decided to carry it forward and work on it next year. This demonstrates the flexibility that is required within the EMS. The school identified their project, but did not view the end of the year as a completion deadline. As more people became involved, the project was allowed to grow and will be a much better and more interesting endeavour for it. In the National Biodiversity Plan (Department of Arts Heritage and the Gaeltacht, 2011, p. 17) we are told that '*locally led action is crucial in protecting biodiversity*' and that '*biodiversity at the local level should be encouraged*'. By initiating this project and encouraging other community members to get involved, the school have created a place-based project that is extending ESD into the wider community and connecting the community with past and future pupils of the school.

8.4.3 Engaging 'place' for pedagogy.

Place becomes infused with meaning through the interactions that people have with it (Hill, 2013) and as teachers and pupils made changes to the school building and grounds, opportunities for teaching and learning increased. As identified in section 7.5.6, opportunities on the school grounds in particular increased across a wide range of subjects, thereby expanding the interactions and experiences of the pupils' with place. Place provided the context for learning and often influenced the methodologies, skills and activities used. For example, talk and discussions was almost always carried out indoors, in the classroom, where the space could contribute to the intimacy of the discussion, allowing pupils to share their opinions and ideas. The expanse of the school grounds, however, appears to have complimented more open-ended lessons with more pupil autonomy as can be seen by the language used in the following examples;

> *'I love bringing the children outdoors in the grass for buddy reading'* (Mairéad, pre-survey).
>
> *'Theme of the month was Ireland. I brought the children outside and allowed them to adventure around the yard to really take in the environment'* (Áine, reflective journal).
>
> *'We learned about the different trees that are to be seen around our school and locality. We looked at the leaf, flower and buds of each of the trees – Oak, Ash, Hawthorn, Sycamore. We went outside and identified the different trees we had learned about. We drew sketches of the buds, leaves and blossoms of each tree. We discussed the different types of tree and showed the others sketches when we returned to the classroom'* (Claire, reflective journal).

In a study by Green and Somerville (2015), sustainability practices in all of the eight participating primary schools were grounded in the place where the learning occurred, again reaffirming the situated aspect of learning. As outlined in section 8.2.1, teachers often referred to the context or location of teaching and learning, and being outside in particular, seems to have connected pupils with the lesson content in an engaging and active manner.

Boeve-de Pauw and Van Petegem (2018) found that while the mere presence of natural elements did not affect the pupils' knowledge, values or motivation, the means by which these features were used did. Based on their findings they argue that '*a real educational impact can be achieved when the nature that is present is also used in teaching and learning'* (p1264). As the year progressed, these teachers became more aware of the opportunities provided by the school's environment - *'I think we are now more cognisant in general to look at the building and get out and use the grounds'* (Deirdre, focus group). This type of education is in line with Dewey's philosophy of education which is based on experience, participation and experimentation (Dewey, 1938). The teachers often used the outdoors to engage pupils in hands-on learning experiences that stimulated all of the senses; '*Outside, we will focus on animal/insect sounds and chat about the wildflower garden and the buzzing of bees we can expect at certain times of the year'* (Deirdre, reflective journal). Working in the garden allowed pupils to see the textures and colours, smell the flowers, hear the insects, feel the earth and taste their produce;

> *'Amy came in during the conversation and told me that during the week her class picked lettuce from the garden (they have planted a number of lettuce varieties) and then made salad dressings to try with the lettuce. She said it was a very successful activity and she felt a number of pupils tried the lettuce that would not normally eat salad'* (Mary, fieldnote journal).

At times, teachers even felt that by simply moving a lesson outdoors, participation and engagement increased; '*Length. Estimation and measuring the yard and back field. Children were so engaged, much better than measuring items in the classroom'* (Áine, reflective journal).

Using the EMS as a framework, teachers, with their pupils, developed aspects of the school's environment which they then used to support teaching and learning both within ESD and within isolated subjects. These activities were both influenced by place and then influenced place in return. Gruenewald (2003) tells us that '*place makes us'*, but Gough (2008) counteracts with '*places are what people make them'*. There is truth in both of these statements and remember, for the pragmatic philosopher James (1907, p. 149), truth is '*what gives us the maximum possible sum of satisfactions*'. By accepting that place deeply influences us and that our actions can have profound effects on place, we can begin to understand our place in both the ecological and the socio-cultural worlds.

8.5 School IEQ.

Prior to this research, the teachers in this school were not aware of IEQ and its impact upon themselves and their pupils. Monitoring started almost a year before the case study phase and teachers expressed an interest in this data and what it meant for their classrooms. Our young people deserve the best infrastructure for their education and this includes a healthy physical environment. As outlined in the literature review (section 2.2.5) poor IEQ can affect pupils' health and academic performance (Griffiths and Eftekhari, 2008; Haverinen-Shaughnessy *et al.*, 2015). During this research, the teachers' awareness of IEQ increased and they tried to take measures to maintain a healthy indoor environment. While this theme did not emerge as strongly as those more related to education and curriculum, teachers did make references to IEQ parameters over the case study and the codes that created this theme can be seen in Figure 8.4.

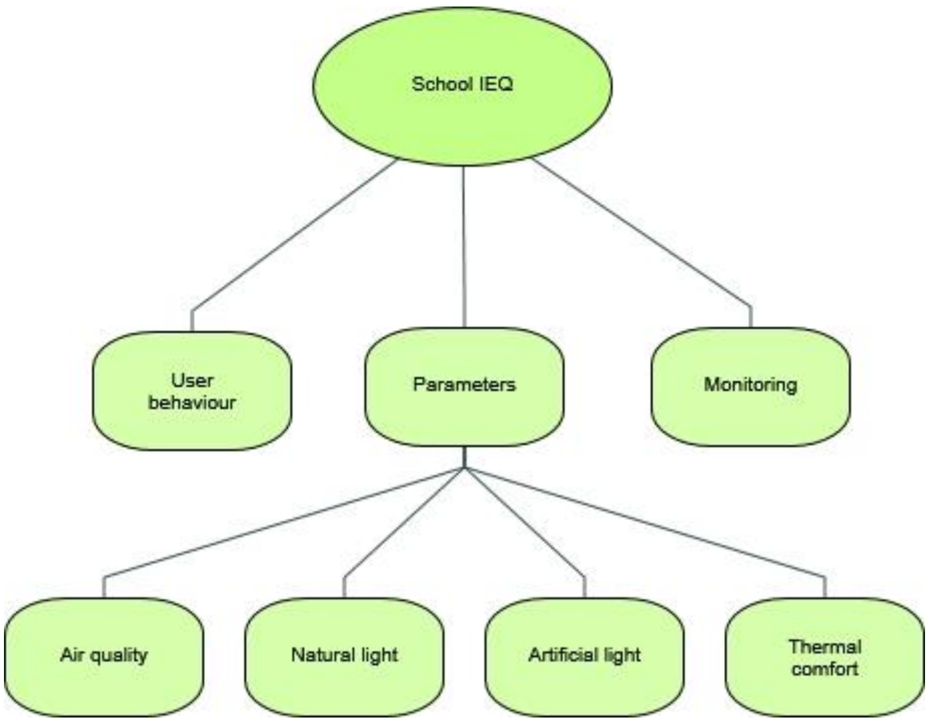

Figure 8.4 School IEQ

Thomas (2012, p. 216) tells us that in order to make the most effective use of space, users need to know how their environment affects them and vice versa. As IEQ was identified as an important part of holistic energy management during the literature review, it was incorporated into the initial workshop on energy management. The IEQ monitors were in three classrooms at this stage and the teachers were interested in the data they were providing.

> ‘*Today's session was on Energy. I tried to break it into two sections - Energy management in their school specifically and approaching energy in a broader sense in the curriculum. Again, I felt the teachers were very engaged and interested. They are showing particular interest in the IEQ data, specifically the CO_2 levels*’ (Mary, fieldnote journal).

The CO_2 levels in a building are used as the reference parameter for IAQ as high CO_2 levels indicate poor ventilation conditions and the possible accumulation of other indoor air pollutants (Salthammer *et al.*, 2016). Although the majority of teachers felt that the air quality in their classrooms was good prior to the case study, the monitors in all three rooms showed that CO_2 concentrations were reaching high levels during occupancy periods. Research has shown that in non-mechanically ventilated buildings, CO_2 concentrations follow the pattern of a saw tooth curve due to the sudden increase when people are present and the drop when manual ventilation occurs (Salthammer *et al.*, 2016). This pattern was evident in this building as seen in the following example.

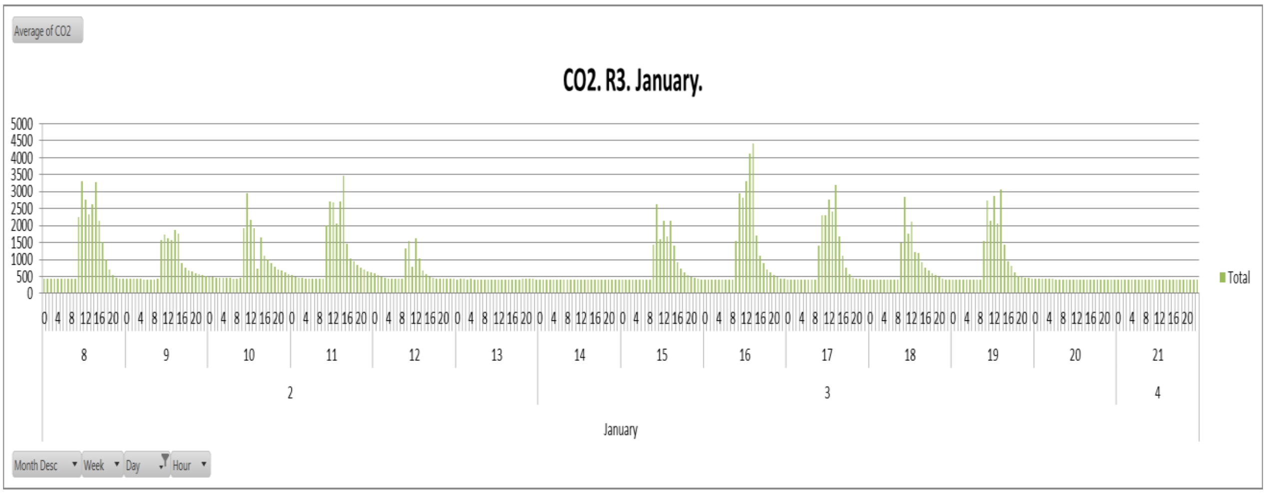

Figure 8.5: A sample of CO2 data from 08/01/18 to 21/01/18

Overall, the CO_2 levels did improve the following year in this classroom due to behavioural actions taken by the teachers, namely opening windows when the reading on the monitor went higher than 1500ppm. The teachers made the children aware of the monitor and its function and this helped teachers to manage IAQ in that pupils would notify the teacher if the levels were high. '*The pupils are aware of the monitors in the classroom. One or two in particular really watch them and ask to open up a window if the levels get too high*' (Claire, focus group). The monitors also helped the children to understand their actions. '*The thing for the children is seeing the monitor and seeing the figure. It draws their attention to it and now they know why we are opening the window*' (Mairéad, focus group). A further action that may have had an impact on average CO_2 levels was that the teachers were conducting more classes out of doors thereby giving more opportunity during the day for CO_2 levels to dissipate.

Improved manual ventilation was most likely the reason for the improvements seen in RH levels also. Ideal RH levels are between 40% - 60% as mould begins to grow from 65% onwards (Salthammer *et al.*, 2016). Classroom 3 had a mould problem before this research and the principal was focused on correcting this problem when she understood its causes and consequences. She had mechanisms installed so that the upper windows on these walls could be opened manually by the teachers and she had the walls cleaned and repainted during the summer of 2018. The teachers in these classrooms appreciated these alterations and Jennifer commented '*they* [the windows] *are ideally placed as you don't get a draught but there is the feeling of constant fresh air*' (Mary, fieldnote journal). Although this has resulted in improvements, the average monthly readings were still slightly above 60%. It will be important to continue to monitor RH levels over the coming year as well as noting classroom occupancy patterns and manual ventilation behaviours. If there is no further improvement following improved occupancy behaviour, the school will have to consider mechanical ventilation or the installation of a dehumidifier to rectify the problem.

Barr *et al.* (2014) wrote that successful schools are the ones who understand that their main purpose is to create a healthy environment that is conducive to learning. They argue that if this is the purpose of school operations, then healthy, sustainable practices will follow. This year, when the focus within energy management moved from solely being 'green' to being healthy also, the teachers' behaviours changed. They no longer shut doors and windows during break-times to conserve heat energy, but left them open if CO_2 levels were high, to ensure pupils returned to a room with more favourable IAQ. However, this may have been a factor in the increase in the volume of oil that was purchased during the case study phase. And even though more oil was purchased, the temperatures in classroom 3 were slightly lower than the previous year. There is still room for improvement in managing the thermal comfort of this building. The principal had the thermostats set to come on at 08:30 and again after lunch at around 13:30. If she felt the school required further heat she put the heating on manually during the day also. However, the data shows that the afternoons are by far the warmest times in these classrooms with some of the warmest temperatures recorded after 15:00. Therefore, in the coming academic year the staff can focus on behaviours that will improve thermal comfort also. Each teacher has a thermostat in their room and can turn off the heat if their class is too warm, which they often do. Changing the times that the heating comes on automatically, particularly in the afternoon, may have positive impacts on thermal comfort as this is the time of day that IEQ can be at its poorest. '*It's difficult to regulate temperature in my room. Can be cold in mornings and too warm in the evenings'* (Áine, post-survey).

During this case study, the teachers referred to ways that they interacted with the building to alter aspects of their environment with which they were dissatisfied. They also showed an increased awareness of IEQ parameters, particularly CO_2. One evening in March 2019, when I arrived at the school to download data from these monitors, Jennifer said '*The CO_2 is going to be bad because I only opened the windows there around half 2 – the day has been so cold*' (Mary, fieldnote journal). We can see here that she made an informed choice – she knew both the temperature and CO_2 levels in her room. She chose to keep the windows closed – she chose to have a warmer classroom and higher CO_2 level rather than a colder classroom and low CO_2 level. This reflects occupancy behaviour in other schools where ventilation is controlled based on thermal comfort rather than air quality (Griffiths and Eftekhari, 2008).

Maintaining comfortable, healthy indoor environment conditions is problematic even in more contemporary school buildings (Stringer *et al*., 2012 in Wheeler and Malekzadeh, 2015) but these teachers did their best to manage the aspects that were within their control. This case study highlighted issues with IEQ that many primary schools are faced with but also showed that the use of monitoring combined with behavioural changes can result in some improvements in IEQ.

8.6 Pupils.

Another theme to clearly emerge from the data was *Pupils*. Although this research involved working with teachers in their professional development, in their journals, the teachers consistently reflected on how pupils were being affected by the new EMS. They spoke about the various ways in which lesson content impacted upon their pupils, different actions the pupils took, how the pupils made links with their homes, misconceptions the pupils held and pupil responsibility.

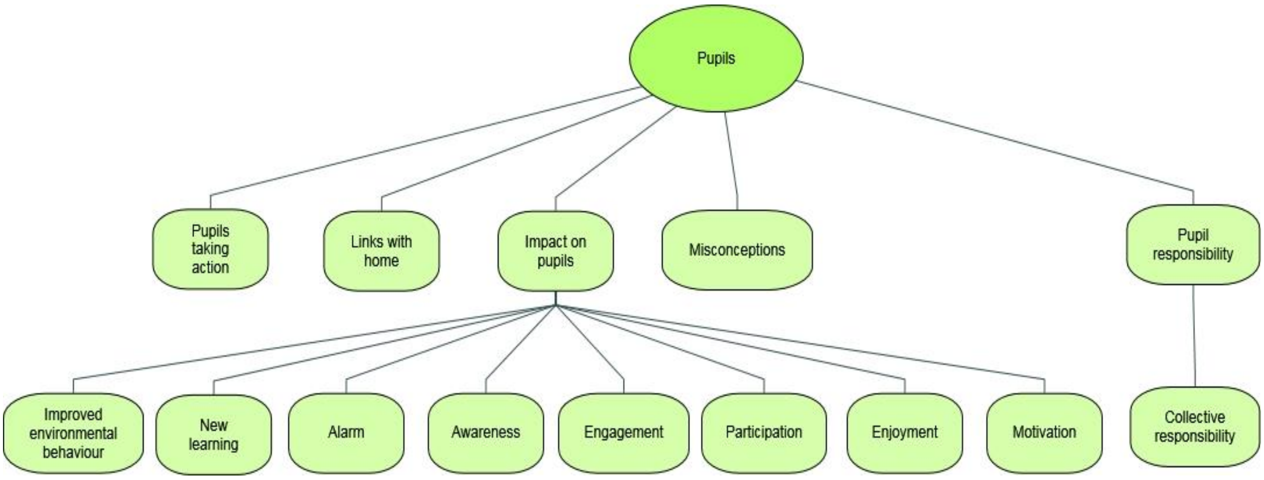

Figure 8.6 Pupils

8.6.1 Pupil participation.

At the end of the case study, the teachers perceived that student participation had increased in the EMS. The mean average in response to the statements '*The children fully participate in the Green School Programme in our School/The children fully participated in the implementation of the new EMS this year*' increased from 3.5 to 4.4 on a 5-point Likert scale (section 7.5.6). Each class within the school had responsibility for monitoring their own classroom waste within the new EMS and classes from First class up had responsibility for at least one audit. Furthermore, teachers commented on increased participation and engagement in class. Following a lesson on plastics, Jennifer recorded

> '*We again talked about choice and how our choices influence others and how 9 and 10 year olds can have power to make change. They loved that! We talked about motivation and inspiration and [I was] really impressed with their engagement*' (Jennifer, reflective journal).

Following a lesson on the 'story of plastic' Áine commented that the '*children were engaged and have been mindful of separating bins since*' and after an outdoor maths lesson she wrote '*children were so observant of the outdoors and nature. Made great connections between shape and space and our theme of the month – Autumn'* (Áine, reflective journal). In fact, teachers often commented on pupil engagement when lessons were taken outside; '*The children showed great enthusiasm and high energy when outside*' (Jennifer, reflective journal); '*This week we were examining tessellations and the children were fascinated when we examined examples of tessellations in nature… Highlighting the wonders of nature to the children made them more excited about the maths lesson*' (Ciara, reflective journal); '*Kids <u>loved</u> being outside. Student A "I can't believe that was school work!" They enjoyed getting their hands dirty outside in the muck of the back field to analyse the materials found in the school yard*' (Áine, reflective journal). Research has consistently shown that pupil engagement increases when lessons occur outdoors or in nature (Dillon and Dickie, 2012; Skamp and Bergmann, 2001) and this has been reflected again in this case study.

As well as being engaged, it is evident that pupils really enjoyed the outdoor lessons also.

> '*Whole class: Trail around school, observations, bark, buds, shape, branches, leaves if present, seasonal. Chose own tree and sheet from tree council pack to focus observations and record information. Really enjoyable being out, children really enjoyed it. Lots of discussion among them. Autonomy to choose own tree very effective as created motivation and excitement for each child. Feeling of independence'* (Jennifer, reflective journal).

And enjoyment wasn't limited to the outdoors. Pupils enjoyed the meaningful class discussions, hands-on activities and the open-ended learning scenarios that these teachers created; '*Kids really enjoyed these lessons, especially the construction lessons!*' (Claire, reflective journal). Teachers encouraged pupils to discuss what aspects of lessons that they enjoyed.

> '*During a discussion on what we enjoyed/learned, one point that came up was how children brought in bowls and plates that were not being used at home. This meant not buying these things, not being consumers and reusing. The children had the vocabulary and we discussed this, all chatting and a class realisation of how we could do this more often when looking for resources'* (Jennifer, reflective journal).

Although the teachers overwhelmingly felt that their pupils enjoyed their ESD/EMS based lessons, they also encountered moments during lessons when they realised the misconceptions that pupils were holding and had to think about ways to get pupils to face these misunderstandings.

> *'We spoke about how God wanted us to care for the world (Grow in Love). The children had to think of ways we can care for the world, most ideas were about picking up rubbish. In infants, they don't really think of the bigger picture. I must try to broaden their horizons in relation to this'* (Deirdre, reflective journal).

Keeping the school clean and picking up rubbish have been identified as being a common action when schools begin to engage with programmes such as Eco Schools (Pirrie *et al.*, 2006). Recycling is often an action that is conflated with good waste management and the teachers themselves were very surprised when we discussed this issue during one of our workshops. Seeing how far down the waste hierarchy recycling is was a lightbulb moment for some of them.

> '*One point that the teachers did comment on in particular, was the role of recycling in waste management. We went over the waste management hierarchy and I pointed out specifically that within the current system recycling is viewed as a measure of how successful schools are with their waste management and yet how low down it is in the waste management hierarchy (I used the example that cans can only be recycled up to an average of ten times and therefore recycling is only prolonging the road to landfill but not eliminating it). Jennifer commented that this was particularly interesting and spoke about the need to address consumption*' (Mary, fieldnote journal).

Another point that a teacher came across in relation to waste management was that when pupils thought about waste produced, they only thought about the waste that they themselves produced, either at home or at school.

> '*They hadn't given that much thought to the fact that there are other kinds of waste (apart from what they produce) such as waste produced by industry, medical waste and agricultural waste, electrical waste and construction waste*' (Claire, reflective journal).

They were also unaware about some of the pathways that waste takes, particularly waste that is discarded illegally; '*I think they were unaware of how much waste goes in to the rivers* *and waterways in Ireland*' (Claire, reflective journal). One teacher tried to engage her pupils with this idea by creating a lesson around "*the 4 stories of a plastic bottle*" (Jennifer, reflective journal). Each group was given a scenario of a person with a plastic bottle and had to research what happened to the bottle and create a poster illustrating the pathway it took. For example, one person threw their bottle away and one of the four placed it in the recycling bin. Reflecting on the pupils' misconceptions and underlying assumptions will help teachers to plan future lessons that can challenge these and enable children to see the broader picture and make wider connections.

Pupils held misconceptions in relation to other themes also and another difficulty that teachers noted was that pupils did not actually relate using energy in school (such as lighting) with the burning of fossil fuels. They knew they were to turn off the lights to save energy but they were unclear about how saving this energy was related to fossil fuel consumption and climate change. Following a lesson on renewable and non-renewable energy, Jennifer reflected;

> *'Identify how energy we use comes from mostly fossil fuels. This link was great as the realisation for the children re. interconnected nature of our world. Also turning off lights now more meaningful'* (Jennifer, reflective journal).

This shows that pupils will do what they are told – turn off lights, recycle their rubbish, etc. – but rarely question the underlying assumptions of these actions unless encouraged to do so. If actions are focused only at the school level (turn off the lights, segregate your rubbish) we risk teaching children a naive, individualistic approach to environmental problems, their causes and their effects (Jensen and Schnack, 2006). By creating lessons with critical discussion as a central methodology, pupils can begin to consider other actions or, as Jennifer said in her lesson on packaging in supermarkets, ask the question – *Could it be better?*

Another issue that teachers were faced with, at times, was when pupils became shocked or alarmed about topics they were exploring. Most of the time, this was surprise at learning something they didn't know before; '*Children shocked by all the energy needed for one bar of chocolate*' (Áine, reflective journal); '*Children were shocked to see the amounts of waste produced in one day… They could not believe that one million nappies went to the dump every day'* (Claire, reflective journal). But sometimes this was a deeper concern – '*I gave a very basic* *explanation about global warming and climate change and they seemed very concerned for animals in the Polar Regions*' (Deirdre, reflective journal). While we need to engage our pupils with these critical issues, it is also important that we are aware that a deep or possibly worrying concern may be one of the outcomes. In order to counteract this, '*Education for sustainability must be a hopeful project, a series of questions about human intentions and actions, but framed by possibilities…*' (Webster and Johnson, 2009, p. 20). While children will encounter information or facts that worry them, as teachers we must focus on the positive – the action we can take, those we can influence, the improvements we can see we have already made in our own school. The EMS framework can ensure that pupils can both take action within their school/community and see the results of those actions, thereby counteracting any feelings of helplessness.

8.6.2 Responsibility.

The teachers in this study regularly spoke about the need to encourage the children to be responsible for taking action. '*There is a need to foster an attitude of collective responsibility for the care of our own school where everyone plays a part and effort is acknowledged and valued'* (Ciara, reflective journal). It appears there were two main ways in which the teachers tried to encourage this responsibility. The first was through praise and encouragement.

> '*The importance of the school grounds is highlighted to the children regularly. Their role in keeping it, as it is, is highlighted regularly also. We are very lucky to have the space that we have and the infants are very keen to look after it'* (Deirdre, reflective journal).

> '*Students are doing an excellent job in their responsibility of minding the nine different plants. They are constantly talking about their growth'* (Áine, reflective journal).

The second way in which these teachers tried to foster responsibility was through the allocation of jobs.

> '*She [Claire] was showing me the various things they have planted and telling me that her class prepared all the beds and look after the weeding and watering*' (Mary, fieldnote journal).

> '*Planted fresh fruit and veg in classroom. Students job to water the plants'* (Áine, reflective journal).

> *'We have put bin monitors in place. The children in my class take their job very seriously!! The bins are definitely being sorted much better in my room as a result of the signs and monitors'* (Deirdre, reflective journal).

At the end of June, Deirdre wrote '*The bin monitors in class are still going strong. The infants want to save the planet*!' (Deirdre, reflective journal). Allocating particular jobs to pupils, particularly on a rotating basis, does appear to have a role in encouraging participation and responsibility when implemented along with other approaches. At times, it was the pupils' idea to give responsibilities to individuals in their classrooms.

> '*Bin monitor and light monitor in operation for the month of December as children decided it would be a great way to help the environment!*' (Áine, reflective journal).

However, having appointed monitors or wardens can sometimes mean that other pupils do not take action as they know it is being done by someone else. '*If there is litter in the yard it tends to be left for the litter pickers to collect rather than being picked up by any passer-by*' (Ciara, reflective journal). While the teachers of the younger classes felt that their pupils took their jobs seriously and were happy to take action and see the improvements, the teachers in the senior classes appear to have had a more difficult time getting pupils on board.

> '*One issue that did arise today when doing the waste EMS – and it has arisen a number of times before – is that pupils, particularly in the senior classes, are not putting their waste into the correct bins. Claire said she has showed them what happens to plastic that is thrown out (plastic islands in the Pacific, etc) and the pupils debated the issue, but she still feels they don't 'act' on their knowledge'* (Mary, fieldnote journal).

It has been found that engaging in EMS type programmes, such as Eco Schools, increases students' environmental knowledge but has very little effect on attitudes or behaviours and increased knowledge, particularly theoretical knowledge, does not lead to environmental action or improved environmental behaviour (Boeve-de Pauw and Van Petegem, 2018). Taking action appears to come from a combination of factors – knowledge, skills, attitudes, values and others. One factor that has been identified as having positive effects is the pupils' perceived level of participation (Cincera and Krajhanzl, 2013; Katsenou *et al.*, 2013). While the teachers here perceive that pupil participation has begun to improve, the pupils may have a different opinion on this, or possibly participation levels have yet to reach critical mass.

Perhaps next year when they do the audits themselves at the beginning of the year and make plans to take action, their participation levels will further increase thereby encouraging more pro-environmental actions among the older pupils.

There are examples, however, of pupils taking significant action on issues over the course of this case study, including pupils in the senior classes. Claire looked at the issue of homelessness with her class and her pupils took a number of actions including writing letters to *an Taoiseach's* office and raising money for a homeless charity. Although this is not within the framework of the EMS, it is clearly an issue of social justice and ESD.

> '*[Claire spoke about] the letters her class wrote to the government about homelessness in Ireland. Says that they received a reply from the Taoiseach's secretary stating that they are doing their best to 'fix the problem'. [She] felt that it was written in a simplistic style in order to address the children'* (non-participant observer's notes, focus group).

Unfortunately, Claire felt that the response from the Taoiseach's office was poor and responses such as this could potentially dampen the pupils' enthusiasm for taking action, especially if they feel that those in power are not listening to their case. There were other examples of the teachers reflecting on choices the pupils made or actions they took. It was the children in Áine's class, and not the teacher, who decided that they should take turns monitoring the bins and making sure that the lights were being turned off. Also, students in both Áine's and Jennifer's classes made art pieces at home from waste materials and brought them in to show their classmates. In Jennifer's class, pupils also shared stories about how they either re-used bags when shopping or didn't use them at all.

The most noted aspect of the pupils' improved behaviour was in respect of waste management; '*The children are generally very good and put litter back into their lunch bags on the yard'* (Ciara, reflective journal); '*The children are constantly coming in from the yard with rubbish in their hands that they found outside. They are proud of helping to keep the yard clean*' (Áine, reflective journal); *'The bins are definitely being sorted much better in my room as a result of the signs and monitors'* (Deirdre, reflective journal). The teacher's felt that the children were good to make suggestions as to how their behaviour could improve and were good to discuss these with their peers;

'*They all said that afterwards they would make changes to try to reduce the amount of waste they produce. They suggested using reusable water bottles, using reusable bags for fruit and vegetables in the supermarket and making sure that waste is put in correct bins'* (Claire, reflective journal).

'*Children great for saying how their behaviour changed and sharing with the class'* (Jennifer, reflective journal).

As noted in the literature review, pupils often take their newfound knowledge and skills into the home (Grodzinska-Jurczak *et al.*, 2003; Rada *et al.*, 2016) and there was some evidence of this occurring during the case study. The teachers were aware of the potential for this also.

'*And the children are all getting it now, not just the kids who were on the green team. And they could be talking about it at home – we need to do this more…*' (Amy, focus group)

Áine also reflected on a biodiversity lesson where there was evidence of pupils bringing their home learning into school;

'In a "What we know" chat introduction, lots of children in the class were learning from home how leaving the grass grow and planting flowers for the bees is something we can all do. This is a great starting point' (Áine, reflective journal).

The teachers tried to enhance their home-school links through their EMS work. They informed parents of work taking place, including the development of the vegetable garden and the wildflower garden. Parents with an interest in gardening came in to help out with lessons and parents showed an interest in the work taking place in the school. When the pupils began excavating the old school foundations, '[Máiread] *said the parents have shown huge interest and that there were lots of parents in having a look on both evenings'* (Mary, fieldwork journal). Cultivating relationships with parents through the EMS will help ensure that the EMS is strongly rooted in community and will benefit pupils and their families through a deeper understanding of sustainability issues.

8.7 Teachers.

A final theme that emerged from the qualitative data was that of the teachers themselves and their own personal journeys during the year. Codes under this theme refer to impacts that their participation had on their own practice, including increased enthusiasm for sustainability education, new learning that occurred, increased awareness of sustainability issues and references to impacts and changes in their own personal lives. A further code under this theme was the aspirations that these teachers had for their pupils and the final code, commitment, emerged in my journal only and refers to observations of the teachers' dedication to their school and their practice.

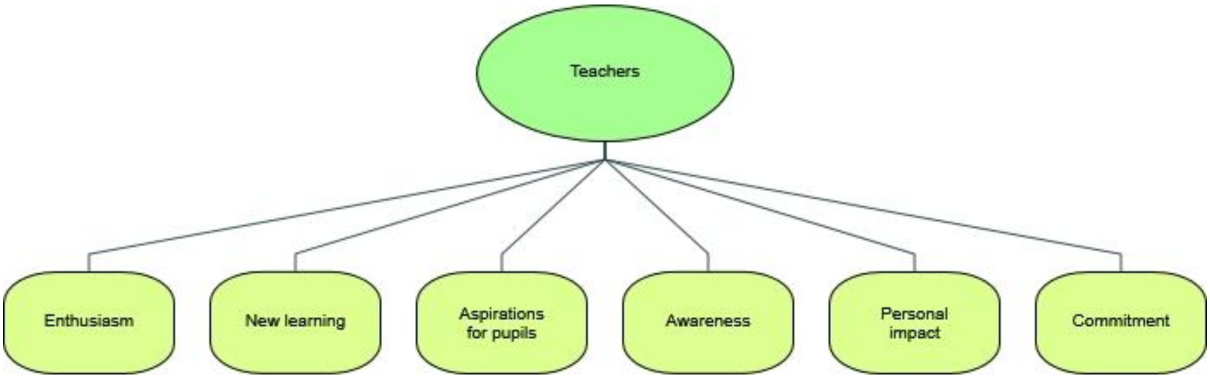

Figure 8.7 Teachers.

The participants regularly spoke about all that they were learning over the course of the year. They also reflected on their experiences and thought about ways that they could improve going forward;

> '*When running again, I would ensure to get out earlier, e.g. September to ensure more seasonal observations as had missed full effect of autumnal changes. I would also ensure more time for the children to report back to the class re observations*' (Jennifer, reflective journal).

While much of their reflection referred to what they were learning through the workshops, meetings and their own practice, they also spoke about other sources of new learning.

> '*I had read some articles recently adding <u>Refuse</u> to this Reduce, Reuse, Recycle mantra'* (Jennifer, reflective journal).

> '*Saw a programme on TV last night (RTE 2) called "10 Things to know about Bioenergy"*' (Deirdre, reflective journal).

> '*Claire also told me that she is signed up to do a gardening summer course this year and that she is really looking forward to it. Once again this shows how invested the*

> *teachers are in the various sustainability activities in their school*' (Mary, fieldnote journal).

Along with recognizing their increased knowledge, teachers also referred to the fact that they were more aware – '*As a result of my heightened awareness, it has rubbed off on the children too*' (Deirdre, reflective journal); '*I have become more and more aware of repercussions of an individual's choices*' (Áine, reflective journal). Increased enthusiasm was also noted among the teachers and was also a feature of the focus group – *'Lots of enthusiasm evident among the whole group'* (non-participant observer's notes, focus group). However this increased awareness, enthusiasm and new learning did not necessarily spill over into increased confidence. Perceived self-confidence levels did increase marginally (section 7.5.6), yet only one teacher agreed and one strongly agreed with the statement '*I am confident in engaging an ESD approach to teaching and learning*'. This case study took place over one academic year and it would be expected that more experience with these approaches would be required for confidence levels to increase significantly. Lack of teacher confidence is continually cited in the literature as a barrier to ESD (Kadji-Beltran *et al.*, 2013; Kennelly *et al.*, 2012; Skamp and Bergmann, 2001) but there is also evidence that engaging in CPD such as this case study can have positive effects on teachers (UNESCO, 2016).

Two teachers in this study made very direct statements in their journals about personal changes they have made due to their increasing knowledge and awareness of sustainability;

> '*Having read up on the cost of producing meat on the environment I have turned vegan. Since the beginning of September I have become more and more aware of repercussions of an individual's choices. Will now teach children how to cook vegetarian dishes every third Friday'* (Áine, reflective journal).

> '*As a result of Mary's work in the school, I feel I am trying to make changes in my home life in relation to being green. Definitely re-using plastics more, choosing bio-degradable bags for fruit and veg while shopping. Conserving energy and water…*' (Deirdre, reflective journal).

Áine has clearly researched a topic of interest to her and made a significant lifestyle change in response. Deirdre is also looking at aspects of her home-behaviour and considering the environment when making certain choices. Other teachers spoke about personal changes during meetings.

> *'Mairéad said that it's great that the caretaker is no longer using herbicide and that she really notices the increase in daisies and buttercups close to the hedgerows. She said this is the same in her own garden at home because when I spoke to her (over a year ago) about the dangers of using pesticides for pollinators, etc., she stopped using it in her own garden also.'* (Mary, fieldnote journal).

Undergoing a personal change towards sustainability is important. Kennelly *et al.* (2012), in a study on ESD and primary teachers, found that an important aspect of developing ESD practice was the teachers experiencing a personal shift towards sustainability and Izadpanahi and Tucker (2015) found that one of the best ways to improve pupil's environmental attitudes is to improve the environmental attitudes of teachers. In this case study, the teachers at S.N. an Bhaile Nua reflected on both personal and professional learning, and presumably both impacted on each other – their increased knowledge in their professional development led them to look at their personal activities in a new light while the personal changes then impacted upon how they thought about their teaching. For example, following her reflection on becoming vegan, Áine links this new thought process to her cookery lessons.

'*Education is done in many ways, the most powerful of which is by example'* (Orr, 2002, p. 149). Teachers as role models has been shown to be an effective method of encouraging pupils to engage in pro-environmental behaviours (Higgs and McMillan, 2006) and these teachers were modelling sustainable behaviours in both their personal and professional lives. While teachers engaging in sustainable behaviours themselves is an essential requirement for effective sustainability role modelling, close student-teacher relations appear to improve the outcome of this role modelling (Higgs and McMillan, 2006). As can be seen from the previous theme *Pupils*, these teachers deeply cared about the children in their care and were committed to providing a quality education for them. An inspectors report from 2015 also commended the staff at this school for their care of pupils stating '*the quality of support for pupils' well-being is very good. The school is characterised by a spirit of inclusiveness and respect*' (Department of Education and Skills, 2016b). Such support and respect is essential if pupils are to look at their teachers as role models. The teachers in this study often spoke about their aspirations for their pupils, wanting them to engage with sustainability and to do their best; '*We want the children to feel a sense of pride in their school and in the environment*' (Ciara, reflective journal). '*It is this type of meaningful, real education that will promote a sense of pride in the environment and a love of lifelong learning'* (Ciara, reflective journal). This second comment links directly with the normative reference point to promote lifelong learning, and many of the skills that these teachers were developing through gardening, cookery, electricity and water management, etc., were skills that would stand to these children throughout their lives and can only be developed through hands-on engagement.

Teachers are key to the necessary change required for embedding sustainability in schools (Sahlberg and Oldroyd, 2010) so it is fitting that the role of the teacher emerged as a theme from this case study. One component within this theme, teacher commitment, emerged only in my fieldwork journal but is an important code nonetheless. Without the commitment of teachers, sustainability would have very little chance on an already overloaded curriculum. One of the parameters for choosing a case study school, as outlined in section 3.2.4, was that the school was committed to working on sustainability, and the teachers continuously proved that they fulfilled this requirement before and during the case study. From the very beginning, the principal was committed to the project – '*I returned to the school after 2pm as I had a meeting with Mairéad at 14:15 to discuss the timeline of the project. She is very interested in the project and feels her school will benefit greatly from being involved'* (Mary, fieldnote journal). Many later entries, following meetings or workshops with the staff, refer to their enthusiasm, interest and commitment and the following entries were made after three different meetings with the staff;

> '*Today's session was on Energy. I tried to break it into two sections - Energy management in their school specifically and approaching energy in a broader sense in the curriculum. Again, I felt the teachers were very engaged and interested. They are showing particular interest in the IEQ data, specifically the CO2 levels. When we were discussing energy in the school, I mentioned that I was thinking of creating a Revit model of the building as it might be interesting/useful and again I got a very positive response. The 5th/6th class teacher and the principal were particularly interested, commenting on how it would be a good visual when teaching and planning energy management with the pupils'*

'Overall, I was very happy with today's session. I feel the staff are really buying into the idea of 'sustainability' and ESD. They are a dedicated staff anyway, which is very apparent in their teacher-presence and their engaging classrooms and I feel if they bring this level of engagement to this project, the outcomes for both the school and the research should be very interesting'.

'*We finalised the waste and biodiversity ones [EMSs] – although when I say 'we' I should really say 'they' as they pretty much did it on their own. They are so dedicated to it. Their commitment is really evident – in the questions they ask, in the way they discuss issues that arise, etc'*.

Teacher commitment has been found to be a strong influencing factor across ESD (Kadji-Beltran *et al.*, 2013; Sund and Wickman, 2008) and EMS (Conde and Sánchez, 2010; Raath *et al.*, 2018) and studies have also found teacher commitment to be influential within themes of the EMS. For example, Rada *et al*. (2016) found the active and ongoing role of teachers to be a key factor in achieving positive results in waste management. While these teachers did not directly refer to their commitment in their journals or other data sources, it was implicit in the way they engaged with this research and in the progress they made over the year.

8.8 Summary.

David Orr (1997, p. 599) stated that '*ideas and ideals need to be rendered into models and examples that make them visible, comprehensible, and compelling'* and asks the question '*who will do this?*' Our schools, and in particular our teachers, are in an ideal position to embed ESD into all aspects of school life and an EMS is a tool that can support them in embedding sustainability into all levels of 'school' – curriculum, campus and community. However, given the vast nature of sustainability, teachers need to be supported in their own professional development, in access to resources and in developing the school building and grounds. When the teachers in this case study were given this support through the extended CoPs model, they grabbed all opportunities with enthusiasm and, in the space of one year, created and implemented a new EMS that resulted in many positive changes across numerous levels of school and community.

The emergent story from this school is that when teachers are supported within their own practice and place, they use their expertise to develop meaningful educational experiences for their pupils. When they are enabled to understand their environment, they can use it as a pedagogical tool and can improve its environmental performance. It appears that the participants engaged with this model to a much greater extent than the Green School approach, a factor that may be contributed to the regular interactions with a HEI actor and the consequent allocation of time that was dedicated to discussing the EMS implementation.

Working on sustainability in schools is a continuous journey. There will always be more to do and there will always be areas for improvement, as '*it is an evolving journey and a dynamic destination*' (Birney *et al.*, 2011). Analysing the data from this case study has revealed some interesting themes and illuminated various roles, relationships and processes that have the potential to aid the work of sustainable schools and further develop the Extended CoPs model. These ideas are explored in the next chapter.

9. Viewing the Case Study through a Communities of Practice Lens.

The empirical case study detailed in Chapter 7 and discussed in Chapter 8 was analysed again using the lens of situated learning theory. The data gathered through the case study was used to further theorize the Extended CoPs model. Although CoPs theory was used intensively at this point, its limitations were recognised and are discussed in this chapter. The components of the embedded case study design were used to structure this analysis – people, place and process. However, these components were not isolated from each other. Rather, they interacted on many levels and it was at the collective level where knowledge creation occurred.

9.1 The Extended CoPs Model.

The Extended CoPs Model was explored via an embedded case study. The components of the case study were chosen in order to help focus the research observations and analysis. The people or social actors were grouped according to the model – actors from the sustainable school, the HEI and industry. Although the overall research took place across three physical sites (S.N. an Bhaile Nua, Waterford Institute of Technology Campus and B+L Waterford Campus), the case study focused on the implementation of the new EMS at the school site and this was the 'place' that emerged as a theme in the previous chapter. While it was anticipated that certain processes would be used within the model, such as teaching and learning (see figure 3.3 Embedded Case Study Components), it was also expected that other processes would emerge. Due to the importance placed on tools and artefacts in CoPs theory, particular emphasis was placed on identifying the tools used during the case study and the roles they played.

9.1.1 People: the emergent roles of social actors.

'Social actors' emerged as a theme in the fieldnote journal only and referenced the various participants in the research. The social actors, the people in this research, and their relationships were the driving force behind the model's actualisation. Every participant played a role and it was the development of trust and understanding between parties that allowed this to happen.

Sustainable School actors.

Prior to this research, it can be said that the teachers at S.N. an Bhaile Nua fit the description of a community of practice – they were a self-organised group focused on a particular practice (primary education) and were increasing their learning through regular interaction (Borzillo *et al.*, 2011). Although it was not the sole focus of their CoP, they were working on sustainability, using the Green School Programme as a framework. On entering into this research, the teachers agreed to regularly come together to focus on ESD and EMS with a view to improving their practice in this area. This was not a new CoP, but rather a new focus for their existing CoP, i.e. ESD practice was embedded within the wider picture of what it meant to be a teacher for these participants. Therefore, the domain was their shared understanding of sustainability and EMS, the community was their collegial relationships with each other and the practice was the development of knowledge over the year, including their experiences, ideas and the documents they created (Wenger *et al.*, 2002).

Legitimate peripheral participation (LPP) describes the two-way workings of a CoP, creating 'people' through the development of knowledge, skill and identity and creating the actual CoP through the production and reproduction of practice (Lave and Wenger, 1991). 'Newcomers' become 'old timers' through centripetal LPP and eventually old timers are replaced and the practice continues and develops (Lave and Wenger, 1991). This CoP consisted of teachers at various stages of participation with the most experienced member having over 30 years' experience and the newest member, Áine, in her first year of practice. This 'newcomer' was therefore at the edge of the CoP and was becoming a member through LPP. The other participants had, on average, over ten years of experience each. However, when it came to ESD, the levels of experience changed. Many of the more experienced teachers had no direct training in ESD prior to this research and the youngest teacher was the only one who had experienced ESD in her initial teacher training. Therefore, the youngest, least experienced teacher was the most confident in engaging with ESD as identified on both the pre- and post-surveys (section 7.2.5 and 7.5.6). The more experienced teachers' engagement with Áine, discussing ideas with her and listening to her led to increased learning about sustainability. Research by Fuller *et al.* (2005) also found that experienced workers increase their learning through engagement with newcomers and this highlights the importance of the newcomer for instilling new methods and ideas into the CoP. On the other hand, when it came to situating ESD within the broader curriculum and social milieu of the school, the experience of the 'old-timers' meant that they understood the curriculum in practice and therefore could predict potential difficulties that may arise and potential areas that could be explored within the context of their own school. When talking about trying to create meaningful change, Mairéad commented '*Time can be difficult. Especially with the new language curriculum and the child protection last year. Change in the curriculum can take a long time to come to grips with. There are always so many priorities*' (Mairéad, focus group). The more experienced teachers also had more 'stories' to draw on during discussions and could recall past experiences when certain approaches, methodologies or resources were successful '*Mairéad said that she has used the SEAI energy lessons when she was in the classroom. She said she found them very good'* (Mary, fieldnote journal). They also had experience with the Green School programme and could therefore make comparisons with the new EMS.

Each teacher creates an identity that is situated within the workplace of the school (Uline *et al.*, 2009). In CoPs theory, Wenger (Wenger, 2010b; 2000) identifies three modes of identification – engagement, imagination and alignment. Each of the seven participating teachers engaged with ESD practice, albeit, at varying levels and in different ways. Each teacher worked at creating and engaging with the new EMS and participated in the creation of other artefacts also. As teachers engage in their practice, they construct an image of that practice that helps them to understand how they belong (Wenger, 2010a, p. 184). These teachers imagined how their ESD practice might fit into the wider landscape of teaching. They connected their work into the established curriculum framework – '*I referenced objectives from both Science and Geography curriculum. This worked well for integration'* (Jennifer, reflective journal) – and they also talked about ESD in the wider practice of primary education - '*I wouldn't be surprised if more about sustainability comes forward from the department because recently it seems to be everywhere'* (Jennifer, focus group). Finally, to engage in practice, we must align ourselves with the context (Wenger, 2010a, p. 184). Alignment occurred through the teachers negotiating the new EMS and through the production of documents that connected this new work with the established curriculum (such as the curriculum links in the EMS grid).

Each participant has their own experience of practice, and when they wish to bring something new that they feel is important into the CoP, learning becomes a process of realignment where the socially defined competence of the CoP now has to be aligned with the participant's personal experience (Wenger, 2010a, p. 181). As discussed in section 8.7, a number of teachers made significant changes in their personal lives also, demonstrating how identity is '*a complex relationship between the social and the personal'* (Wenger, 2010a, p. 182) and how these are fluid and influence each other. Scott and Reid (2001, in Scott and Gough, 2008) suggest that significant personal transformation occurs when individuals begin to think about their lives in relation to sustainability thereby moving it from being an abstract concept to a tangible event in everyday life. These personal transformations caused the teachers to reconsider aspects of their practice in alignment with their new 'sustainability' beliefs; '*Having read up on the cost of producing meat on the environment I have turned vegan. Since the beginning of September I have become more and more aware of repercussions of an individual's choices. I will now teach children how to cook vegetarian dishes every third Friday'* (Áine, reflective journal). As the teachers increased their own learning about sustainability, they became further motivated to embed sustainability principles in their practice '*We're all increasing our knowledge and that motivates you – the more you know the more you want to do it'* (Jennifer, focus group). The personal and the social became entwined in their practice. Lave and Wenger (1991, p. 65) argued that the development of identity within the CoP motivates and shapes the process of becoming 'knowledgeably skilful' and the personal learning that occurred in this case study was an intrinsic motivator for engaging with ESD practice.

In order to sustain a CoP over the longer term, movement in and out of the core is an important aspect of LPP (Cundill *et al.*, 2015). This links to the notion of distributed leadership, an idea that has been deemed important in the ESD literature (Carr, 2016; Kanyimba *et al.*, 2014; Pepper, 2014). While Mairéad, the principal, was the leader in terms of managing the overall project in the school and her LPP was at the centre of the CoP, she consistently worked to develop capacity in the other teachers and ensured they had the time and space to engage with the work of the CoP. Her positive leadership skills had been identified in a previous Whole School Inspection - '*The principal has created a very positive and collaborative school environment and she provides effective leadership'* (Department of Education and Skills, 2016b) and they were a driving force in ensuring the success of the new EMS at the school. Principals play a key role in creating cultures of change in schools (Warner and Elser, 2015) and this was reflected in this research whereby Mairéad encouraged the teachers to question current practices (such as the practice of pupils taking their lunch waste home) and to try new approaches and methodologies, in particular, outdoor learning.

One aspect of situated professional learning that is not addressed within CoPs theory is that of potential power influences. Lave and Wenger (1991) do recognise that CoPs will entail relations of power but Cundill *et al.* (2015) rightly caution that power asymmetries that may be present between experts and non-experts (or newcomers and old-timers) could be concealed within a CoP. In this research, there was no evidence of any inequality within the CoP. Indeed, the theme of full participation was noted across data sources (including the non-participant observer in the focus group) and the staff were led by a principal that was actively inclusive and encouraging of all teachers. However, within this model, it is recognised that this is a potential difficulty, particularly as there are so many social actors involved with widely varying types and levels of expertise. As the role of the principal was so influential in research by Warner and Elser (2015) and Zachariou *et al.* (2013) it can be assumed that poor leadership styles would negatively impact upon the LPP of other actors. In an interview with Farnsworth *et al.* (2016), Wenger stated that his theory does recognise power relations but does not try to theorise them. However, as education can be a powerful tool in reproducing social norms, including power structures, it is essential that power roles are identified within the extended CoPs model. Learning within a CoP gives the community the power to define competence in that context (Farnsworth *et al.*, 2016), therefore shared learning through LPP and shared negotiation of meaning are important to ensure equitable development of the practice.

'*Socially defined competence is always in interplay with our experience'* (Wenger, 2000, p. 226). As the teachers became accustomed to an ESD approach they questioned their current approaches to their EMS and to the ways they approach topics like environmental awareness within the curriculum. As their experiences grew, so did the definition of competence within the CoP. It was no longer enough to reduce waste production without questioning the ways in which waste is produced, used and disposed of. Within the EMS, it was now essential to manage the building in a way that supported learning and offered opportunities for learning. Over the course of the year, the teachers' experience with ESD and the new EMS progressed as they worked on this new practice individually with their classes and collectively in whole-school projects and reflective discussions. Takahashi (2011) found that teachers co-construct their efficacy beliefs in shared, situated practice. Therefore, the development of teacher confidence is also a social phenomenon and one that can be supported within a CoP. The more teachers believe they can effect positive future outcomes, the more motivated they become to work towards these outcomes (Takahashi, 2011) and this was reflected within this case study. During the focus group, the teachers expressed their opinion that it was the full-participation of all staff that was ensuring the success of the EMS – '*This is something we would never have managed by ourselves. It's very motivating… The whole school approach is the way forward'* (Mairéad, focus group). Furthermore, a moderate increase in teacher confidence was noted on the survey questionnaires with the mean increasing from 2.6 to 3.6 on the 5-point scale (section 7.5.6).

Although this case study focused on working with teachers to develop their professional practice in EMS implementation at the school, the engagement was much wider. Very importantly, pupil participation improved over the course of the year. The pupils, in turn, created school links with their parents and homes as discussed in section 8.6 and this has also been reflected in a number of researches whereby pupils took their new sustainability learning into their homes (e.g. Grodzinska-Jurczak *et al.*, 2003; Wheeler *et al.*, 2018). Parents also became involved in more direct ways, such as helping out with gardening activities. Although this research highlighted that managing external relationships is an area of difficulty for principals (Chapter 4), during the case study, this was an area that developed with relative ease and facilitated and enhanced the work that took place on the school grounds. Leaders of sustainable schools need to cultivate these wider school-community relationships (Kadji-Beltran *et al.*, 2013) and in this study, it was Mairéad who initiated these interactions. The community is increasingly being viewed as an essential resource for learning (Alexander, 2010) and all of the teachers acknowledged the need to tap into expertise in the community. This need to identify and harness external expertise has been highlighted in other research on ESD (Kadji-Beltran *et al.*, 2013). Successfully engaging actors from the community for ESD does not just happen at the beginning but is a gradual process that extends along the collaboration (Espinet and Zachariou, 2014). With regards to the wildflower garden and sensory path, the number of collaborators increased over the year and as collaboration grew, so did the project itself. Therefore knowledge required for the project and ownership of the project became distributed across the wider school community.

HEI actors.

I, as the Ph.D. researcher, was the main HEI actor within the exploration of the model in this study. My background experience was influential in how this role developed across the study (see section 1.2.2). As predicted by the model, one of my key roles was to broker knowledge from the FM team to the school. Brokering is described in many ways in the literature, including the sharing of knowledge at boundaries (Carlile, 2004) and the aligning of perspectives between members of different CoPs (Kuhn, 2002). An early definition by Wenger (2000) describes the process as introducing elements of one practice into another, which portrays some of the processes that occurred in this research. However, the discussion on brokering in the original CoPs theory is limited (Pawlowski and Raven, 2000) and subsequent research has looked at the concept of brokering in various situations, including transferring, translating and transforming knowledge (Carlile, 2004). This research adds to the discussion on boundaries as it looks at the transfer, translation and transformation of knowledge, in one direction, within the Extended CoPs model.

Two boundary sites were encountered during this research. First, there was the boundary at the HEI-Industry site and second, the boundary at the HEI-School site. At the first boundary, tacit FM knowledge was explored and captured by means of observations and interviews. According to Carlile's (2004) classification of boundaries, this site was a sematic boundary where knowledge had to be captured and translated for use in a different setting. Therefore the data from the FM interviews was interpreted in a way that could potentially benefit the management of a sustainable school. A briefing document was prepared for the school that summarised the findings and the potentials these findings may offer their school. This knowledge was then transferred to the second boundary and as it was mostly domain-specific knowledge, it had to be adapted for a different setting and purpose. Meyer (2010) argue that brokering knowledge is never simply a case of moving knowledge but rather a complex process of transforming knowledge through '*the identification and localization of knowledge, the redistribution and dissemination of knowledge and the rescaling and transformation of this knowledge*' (p120). At this boundary, the knowledge had to be translated so that it could be utilised for new, novel purposes, such as using the built and natural environment for pedagogy. This translation of knowledge was done in conjunction with the teachers as it had to be meaningful to their site and situation, and through this process the SFM knowledge was transformed into a pedagogy for ESD. Therefore, this second boundary was a pragmatic boundary (Carlile, 2004). Over the course of the year, both boundaries were regularly traversed as issues arose in the school and further knowledge was sought from the FM team.

Carlile (2002) found that the more 'distance' that exists between the two practices, the more difficult it is to communicate the embedded knowledge they use. As this research was looking at transferring knowledge between to disparate practices, having a broker eased the process of transferring this knowledge. The CoPs literature had identified that the role of broker can be a difficult one (Kuhn, 2002; Wenger, 2000), therefore within the Extended CoPs Model it was proposed that this role be played by social actors from a HEI. As HEIs have already established networks with both industry and schools, it was expected that the difficulties often encountered by brokers, such as not fully belonging to either CoP, would be offset. On analysis of three years of field notes and one year of reflective journal entries, there is no evidence to suggest that as broker, I was marginalised by either CoP at any time. Indeed, the qualitative data from meetings with any of the social actors included themes of commitment and support;

> '*Today I had a meeting with David and Trevor in B+L. I gave them the key findings of the literature review and told them my idea regarding including them in a partnership model with WIT and some case study schools. They liked the idea and they both expressed their commitment to the project and their willingness to give of their time*' (Mary, fieldnote journal).

> '*I was out in the school today getting IEQ data from the monitors. I expected to fly in and out but I was there for almost an hour! On the way in I was speaking to Áine about her class … Mairéad came in to see me and I was speaking with her for about 20 minutes about different things – their approach to maths, a recent visit by the DES inspector, etc. And I was also talking to Amy about Christmas, class plays… It just reminded me how kind and friendly the staff are here and how much they welcome me on every visit'* (Mary, fieldnote journal).

Furthermore, in WIT, I had access to a multitude of expertise which supported my role as broker. Over the course of the case study, I discussed issues that arose with lecturers in the Department of the Built Environment, lecturers in Architecture, lecturers with specialisation in ecology and BIM specialists. Having the collegial support within the college of professionals with varying expertise ensured that the collected data was interpreted in a more rounded manner and not only from the point of view of\ an educator or teacher.

As well as being a knowledge broker, an important role that emerged for me during the case study was that of being a supportive friend to the teaching staff who encouraged them to develop their ESD practice. This role is termed a 'critical friend'. The role originally emerged in action research, and is a person who assists the practitioner in reflection (Cebrián, 2016) and is an agent for teacher development (Kember *et al.*, 1997). Reflection was key to the learning process for both myself and the teachers. As Dewey articulates in Education and Experience (1938, p. 87) '*To reflect is to look back over what has been done so as to extract the net meanings which are the capital stock for intelligent dealing with further experiences*.' Through our regular meetings, we could collectively reflect upon our experiences to date and question and discuss why things were working effectively or not and how we could improve going forward. Creating this time to reflect is an important role of the critical friend (Cebrián, 2016). Individually, teachers also reflected on their lessons and on how they may approach things differently in the future. Reflection led to learning and during the meetings I had the opportunity to ask critical questions and to encourage the teachers to really think about the way they were doing things and to examine the currently accepted norms. During these meetings, the teachers questioned the emphasis they were putting on certain actions such as recycling or turning off lights and discussed how they could engage pupils more critically with issues such as waste management or energy management. They also discussed these issues from a wider, societal perspective and topics such as consumerism and mental health arose in these conversations;

> *'While talking about how much children love being outdoors, [Jennifer] made a very interesting comment regarding mental health (it is mental health week this week and there's a lot in the media at the moment). She was saying that while she feels strategies such as introducing mindfulness are good, it is just as good if possibly not better, to engage pupils in outdoor projects where they naturally become immersed and 'mindful'. I really think this is a valuable point. When there is a focus on process, pupils really become engaged and enter into a 'flow'…'* (Mary, fieldnote journal).

As sustainability issues require teachers to comprehend the theoretical and practical frameworks for promoting sustainability (McFarlane and Ogazon, 2011) and it has been found that teachers engaging with ESD rarely question the underlying assumptions (Madsen, 2013), there is much potential for a critical friend to support teachers in deeply inquiring into their own practice. Cebrián (2016) explored the potential of the critical friend in supporting teachers' engagement with sustainability and found many benefits to this approach including helping teachers to approach their programme more strategically and enabling them to create a shared vision. Having an external but supportive friend to aid the process of engaging with sustainability appears to have promoted reflection and learning in this research also.

The critical friend should also strive to maintain the teachers' autonomy in constructing knowledge in relation to their own practice (Kember *et al.*, 1997) and this process was respected as the HEI actor's role was to facilitate the design and implementation of the EMS, allowing the teachers to ensure it fit to their school and curriculum. Furthermore, the critical friend takes the time to fully grasp the context of the work and the outcomes that the practitioners are striving for (Costa and Kallick, 1993) and the prolonged involvement in auditing the school prior to the case study and regularly meeting throughout the case study helped me to fully comprehend the context of this school. This full understanding of the teachers' situation benefited the research. Bouchamma *et al.* (2018) found in a HEI – school CoP collaboration, that the teachers really appreciated the availability of the university team, particularly outside the established times of meetings and that the principals felt that they understood just how busy their schedules were. This appreciation was reflected in this research and the teachers, in particular the principal, were very grateful for the support they were receiving – '*Thanks for all the work you're doing on our behalf, Mary. I honestly appreciate everything and I know you have enough of your own stuff to do!*' (Mairéad, email correspondence). It is the culmination of these processes – listening, enabling reflection, supporting, being available – that ensures the success of the critical friend.

Reflexivity was the second code that emerged in my journal only. As a researcher in this case study and a primary school teacher in practice, reflexivity played a very important part of this research as it was crucial to identify how my background and beliefs would potentially impact upon the research findings. Akkerman *et al.* (2006) state that not only do brokers have to converse with the actors of each CoP, but that they also have to have inner conversations between the different perspectives they are able to adopt. Therefore, reflexivity was part of both roles – being a researcher and being a broker. Ahern (1999 in Robson, 2007) outlines a ten point checklist to identify areas of bias. In consideration of these questions, I could identify that as a teacher, I was conscious of the potential impact groups outside of education may try to have on the system and on what is taught in classrooms. I was also conscious of my belief that the teacher's voice is often omitted from programmes that teachers are expected to implement in schools. This issue has been echoed in the literature by Stevenson (2007) showing that it is a genuine concern to have. Overall, I was very aware of being on the 'teachers' side' and had to be conscious of ensuring that the expertise of the FM staff and others could filter through to the school in an unbiased manner.

To engage with the reflexive process, I entered 'personal reflections' into my fieldnote journal where I would reflect on issues as they arose in the research. As part of the qualitative analysis, any reflections that clearly demonstrated the influence of my teaching background were coded again under 'reflexivity'. One such issue was my concern over the impact of 'outside' groups (as mentioned above) when I first came up with the idea for a partnership model;

> *'I'm trying to think of a way to bring local schools, B+L and WIT together in partnership for sustainable school practice. I think it's a good idea but I'm a little concerned about how it will be received within education. Will it be viewed as a positive thing to be bringing industry influence into schools/education? Definitely, it wouldn't be looked on favourably if industry were dictating what was to be taught but surely if they are there in a supporting role, this wouldn't be an issue….*
>
> *My own background as a teacher is really coming into play here... I really need to be sure that I document how this is being done and that the partnership is a supportive one with teachers leading teaching and learning in their own schools but with access to this external expertise. I don't think it's a huge deal but it's definitely something I need to be aware of….'* (Mary, fieldnote journal).

Had I not recognised my preconceived beliefs on this subject, it is possible that the partnership idea would have been disregarded. However, through regular dialogue with the FM actors, I could clearly see the value of bringing their expertise into the model. Indeed, it was their role as my mentor that gave rise to the idea for the CoPs model in the first place – initially I felt 'outside' the group, I did not have their knowledge, and their language and practices were foreign to me. But through regular interaction and their constant support of both me and the project, I became more comfortable and learned much from them. So the question became 'how can I scale up the learning that I have benefitted from?' Also, discussing this idea with others and presenting an earlier version of the model at an education conference helped me to confront my beliefs and approach the development of the model with more clarity and less bias.

The combined reflexivity codes reveal that the main impact of my background on my actions was to show understanding when teachers couldn't commit to an aspect of the research or when meetings had to be cancelled. For example;

> *'The third workshop with staff was supposed to take place today but the principal asked me if we could postpone it as a number of circulars have come through that she has to address with her staff, and therefore needs today's Croke Park hour. I understand how busy school life is and how reactive school principals end up being to these types of situations. As she needs to address new Child Protection guidelines, I imagine she is going to need quite some time – time that she did not schedule and this is going to impact on my work – well on the timeline anyway. However, I am not concerned – we will make it up later'* (Mary, fieldnote journal).

This does raise the question that if someone with a different background was carrying out this research, would they have motivated the teachers to do more during the case study rather than just accept when challenges arose, such as aspects of the timeline being changed? Would they have insisted on rescheduling meetings as soon as possible? The answer to this question is probably yes, but in really understanding the full workload that teachers deal with and the unpredictability of the teaching day, I was able to connect with these teachers in a way that a person with a different professional background would not have been able to. My background and understanding of the working environment of teachers helped me to be easily accepted into this CoP. Brokers who aim to transfer external knowledge or practices into a CoP encounter difficulties '*owing to the homogeneity of internal CoPs'* (Ishiyama, 2016) but as these teachers felt that I understood the circumstances into which I was transferring this new knowledge, they were not resistant to incorporating new or novel ideas into their established practice. One evening as I was leaving the school, I met Áine on the way out –

> *'On my way out of the school, Áine was leaving at the same time so we were chatting on the way out. She said she has made a few entries in her reflective journal already. I*

was obviously delighted to hear this and said she was very good to be doing this already. I also mentioned that I am very aware of their busy days and don't want any of this work to become a burden to which she replied that it isn't as I understand teaching as a profession and am therefore the best person to be carrying out this research. I was really happy to hear her say this – to know that she feels I understand the challenges they face daily and that I am aware of the business of the school day' (Mary, fieldnote journal).

This encounter explicitly demonstrated that one of the main reasons that the teachers engaged with the project to the level that they did was because of my teaching background.

The predicted role of HEI as broker was realised through the case study. In this research, knowledge transfer and translation occurred at the first HEI-industry boundary and knowledge translation and transformation occurred at the second HEI-Sustainable school boundary (discussed in greater detail in section 9.2.2). The difficulties associated with the role of broker were alleviated due to two key factors. The first, as predicted by the conceptual model (Chapter 5), was that HEIs have pre-established relationships with both industry and schools. Although the individual HEI actor may not be directly involved with both parties, within the college or university, they have colleagues who are engaged with either schools or industry. This eased the difficulty of engaging with knowledge and processes that were unfamiliar, as the collegial support was available within the HEI actor's own work environment. A second factor that came into play during the case study was my background in teaching. This enabled me to take on the role of critical friend, ensuring that reflection both improved the teachers' practice and was available as research data. My teaching experience was also an influential factor in getting the teachers to consider, explore and incorporate knowledge that was not traditionally associated with their profession. This suggests that the previous experience of HEI actors doing brokering work needs to be taken into consideration to maximise the probability of external knowledge being accepted.

FM actors.

Although they did not directly connect with the school personnel during the case study, the role of the FM actors was crucial to the success of this project and there is scope to further develop it over longer term engagement. The initial interviews resulted in identifying some of the key aspects of successful SFM which were then transferred to the school setting via the

HEI actor. This adaption and transfer of existing procedural knowledge was a crucial process within the Extended CoPs model and it occurred at the boundaries where innovation and creativity are most abundant (Wenger, 2000). Each CoP has different knowledge, skills and practices that are based on tacit knowledge (Ishiyama, 2016) and it was the FM CoP that had knowledge and expertise that had the potential to support EMS implementation in schools.

The initial role that the FM participants took on was mentor. Members of the FM team offered me advice in the areas of waste, water and energy management and trained me in conducting energy audits. This role had been identified early in the research prior to the development of the model. However, two members, both David and John, remained in a mentoring role following the new direction of the research – the establishment of a partnership model. Through meetings and email conversations, both men offered advice and support and were available to discuss concerns (such as the cause of the high electricity base load). Having this support strengthened my position as broker as it extended the expertise that I had access to. While there were lecturers at WIT with expertise in FM, the participants at B+L were practitioners and therefore had a tacit knowledge in the development and implementation of EMS.

The literature on ESD, as discussed in Chapter 2, identified the lack of knowledge and skills amongst teachers about sustainability (Department of Education and Skills, 2014a; Rosenberg, 2008) and the need to connect with external expertise (Green and Somerville, 2015; Kennelly *et al.*, 2012). As I had experienced an increased learning in sustainability and EMS through my interactions with the FM team, the idea of connecting schools to this knowledge led to the development of the model;

> *'[ESD] is the central thread running through everything else. It also calls for partnerships which is a perfect way to link in the B+L knowledge/expertise. Actually, I wonder if I could develop this into something – the partnership idea…. Rather than me just using the B+L knowledge, I wonder if [FM actors] would become active participants in the research …'* (Mary, fieldnote journal).

To be effective, Kimble *et al.* (2010) argues that brokers need to have authority within all of the groups with which they are working. However, I did not belong to the FM CoP, and while I engaged with them through the research, I did not legitimately participate in their CoP. This may have been an influencing factor on the fact that the FM actors did not engage in a more direct manner with the school. As I was more comfortable on the 'Sustainable School' side of the model, I may have, unknowingly, missed opportunities for involving the FM actors more. As my role as teacher was so influential in transferring knowledge into the Sustainable School CoP, it is reasonable to suggest that a HEI broker with a background in FM, may be better positioned to ensure that feedback loops occur and that ESD knowledge is transferred successfully back to the FM CoP. One example of feedback that did occur was that of the potential for biodiversity on the grounds as discussed in 7.5.5, but there is an identified need to align CSR with ESD (Manteaw, 2008) and while not explored in this research, there is potential within the model to support this. There is also criticism in the literature of companies using CSR to align themselves with sustainability initiatives, suggesting that global corporations have tried to counter the gains of the environmental movement and ensure that their worldview is reproduced (Huckle, 2013). Huckle (2013) argues that through sponsorship of programmes, such as Eco Schools, guidance materials and resources are produced that '*fail to promote ethical and political debate*'. However, within this model, relevant know-how from industry is transferred to where it is needed and the teachers are given the space to discuss and question this before using it to engage their pupils in ESD. This is essential in engaging with ESD from an action competence approach, whereby guidance and advice from experts is taken seriously but also questioned critically (Mogensen and Schnack, 2010). Therefore, companies still get the benefit of improved CSR and schools get access to a much needed expertise but in a way that a critical pedagogy can still be utilised. If we assess the pedagogical imperatives of school-industry partnerships (Manteaw, 2008) schools can ensure that their partnership is transparent with benefit to all involved. Webster (2007) suggests that innovative businesses that are looking at new, sustainable modes of production are the '*new allies for sustainability*' as they provide meaningful cases for students to study and also because they will be the ones that will thrive in a carbon-constrained world. This research was the outcome of B+L's CSR framework and it involved working with professionals who were passionate about sustainability, innovative in how they were managing their environmental impacts and forward thinking in that they wanted to support schools in engaging pupils with these topics.

Over the course of the project, only one meeting occurred between a member of the sustainable school CoP and the FM CoP. This was when David met Mairéad at the school during an energy audit. Even though this was a brief meeting, the different perspectives of both actors was interesting;

> *'When we were talking during the audit, David was talking about energy management in B+L and about how they are looking at huge savings and but here [at the school] we are looking at very small amounts. He was just commenting on the difference but it's interesting that he sees it that way. Mairéad would be happy with any small saving but at B+L savings are always big – like the CHP saving €1000s a year. At the end of the audit, David said that 'the low-hanging fruit had already been picked' which again confirms that the school are managing energy appropriately and to the best of their ability – especially seeing as they are not trained in energy management!!'* (Mary, fieldnote journal).

David was used to identifying sources for large cost savings, but in schools, the small savings really matter and can impact the budget. This raised the question that if industry personnel were conducting audits, would they overlook the actions that would result in small financial savings? While the support and expertise at B+L was hugely beneficial to this school, the importance of teachers receiving training in all areas of environmental management is essential, as they could identify the importance and potential of all actions, for both cost savings and for curriculum impact.

Although it was identified early on in the research that it would not be feasible to have regular meetings with both the teachers and FM personnel, it was hoped that they would meet on occasion and that this would provide new interpretations of the brokered knowledge. For example, it had been arranged for David to attend the meeting when the teachers were finalising the EMS but unfortunately due to an unforeseen incident, he was unable to leave work to join us at the school;

> *'I am just back from another workshop with the teachers at Newtown… I had asked David from B+L to join us today. He had said he would but he didn't turn up – something must have come up. I just feel it would have been very interesting to get him together with the school staff when we were putting the finishing touches to the EMS – I thought*

> *he might have some insight or might say something that would trigger some discussion/idea with the teachers… '* (Mary, fieldnote journal).

It was also hoped that the teachers would bring their classes to the B+L plant to meet some of the engineers and take a tour to see how the company operates their EMS. When devising the school EMS, the teachers had thought that this was a great idea and it was written up as part of their plan. However, due to the newness of much of the work that was taking place this year, the teachers did not get around to this. The main purpose of these visits was to offer 'a contrast case' to aid knowledge transfer and deeper understanding (Schiller, 2012) so to benefit from the visit, the children would really need to understand their own school situation first. They hope to carry out these visits during the year 2019/2020 when they are more familiar with environmental management at their own school site. It is expected that such an experience would greatly benefit teaching and learning in ESD and EMS as it would provide the opportunity to see alternative approaches on a much greater scale (such as the CHP).

Although not physically active at the school site during the case study, the role of the FM actors was central in that they provided the required knowledge and expertise. Furthermore, two of the FM actors took on the role of mentor for the researcher thereby bolstering the role of the broker.

Overall, the social actors in this case study and their relationships fuelled the other aspects of the project, such as professional development, the creation of artefacts and the development of knowledge. The role of identity in CoPs theory explained the teachers' personal and social learning journeys and highlights the importance of social learning in teacher CPD, particularly in the area of ESD where knowledge is extensive and ever-changing. While there was minimal direct contact between the teachers and FM engineers, they were both driven by the same aim – to generate an effective EMS that could be used for ESD. In essence, this implies that all actors worked together in a transdisciplinary CoP.

9.1.2 Place: situating learning in social and environmental contexts.

The interconnectivity of people and place, which is a core tenet of an ESD approach and a key focus of FM as identified in the interviews in Chapter 6, also emerged as an important aspect of the model in terms of the teachers' learning for sustainability. Their ESD work was situated in the places of the school and there emerged a reciprocal relationship of teachers and pupils influencing place and place influencing teaching and learning as discussed in section 8.4. While place was discussed in depth as a theme that arose in the qualitative data, from a CoPs point of view it is the notion of place within situated cognition that is of interest. In Japanese philosophy, the concept of 'ba' (roughly translated as the word place) links the concepts of place and knowledge; '*knowledge is embedded in ba where it is then acquired through one's own experience or reflections on the experiences of others*' (Nonaka and Konno, 1998, p. 40). Knowledge separated from ba is simply information (Nonaka and Konno, 1998). Through the case study, the teachers developed their ESD knowledge by engaging in hands on and reflective experiences that were directly connected to place.

The teachers' learning, and indeed much of my learning, was situated in the environment of the school – the physical setting, the community, the culture and the activities/processes that we engaged in. In order to learn how to take action, participation in the life of the community is essential where 'community' includes both the natural and human environment (Chawla, 2008). In order to learn how to take action, in their own classrooms through teaching and learning and in the school through school and community projects, these teachers extended their participation in many ways. They collectively participated in the regular meetings and discussions and in the development of the EMS. They produced and used artefacts to support their learning and they physically engaged with the outdoors to learn about their school site and to discuss potential development on the grounds. They participated with their pupils and with others in the community in developing these projects. At each stage, their learning was situated in the community and in the environment and a sense of place pervaded much of what they did and what they wanted to accomplish.

If '*places produce and teach particular ways of thinking about and being in the world'* (Gruenewald, 2003b, p. 627), what are our schools teaching when energy consumption is too high and too difficult to manage or pupils turn off the lights but get no feedback into what this action produces in terms of CO_2 savings? In order to challenge these stories and manage the building in a way that it could teach new lessons with positive feedback, teachers had to look outside of their school to find the expertise that could support them. In the summary of the previous chapter, we were reminded that Orr (1997) tells us that ideals must be fashioned into visible, compelling models and examples. In this study, place became the vehicle for this to happen. When the teachers increased their understanding of 'their' place and when they connected with others in the community, the school grounds became a canvas on which to create a representation of their new ESD learning and outlook. Understanding the technical aspects of the grounds, such as soil pH and habitat location, combined with a more tacit understanding of pedagogy and curriculum to enable these teachers develop successful, usable learning spaces outdoors. The building changed less over the course of the case study but small introductions were made in an effort to promote the building as a teaching tool. Cole (2014) believes that the concept of the teaching green school building (TGB) fits well within the construct of place based education, although it has not been explicitly addressed in the research yet. 'Place' has been used to address human-environment connections and disconnections (Cole, 2014; Gruenewald, 2003b) and ESD needs to be situated in place to enable teachers and pupils to connect to their immediate environments (including the people in their community) and then to their national and global environments. Cole (2014) also believes that the TGB aligns with situated learning as the environment is used in an active, hands-on manner. In this study, the teachers physically engaged with their surroundings in an attempt to improve their understanding of it and then developed activities and experiences for their pupils to do the same. Situated cognition tells us that the activity and the environment in which learning occurs is a part of the learning itself (Brown *et al.*, 1989), so teachers need to connect with and understand place in order to ensure the activity and environment are conducive to providing meaningful experiences for the child. Dewey (1938) believed that teachers '*should know how to utilize the surroundings, physical and social, that exist so as to extract from them all that they have to contribute to building up experiences that are worthwhile'* (p40). This statement captures the integration of place and situation, emphasising the teachers need to deeply understand the community and 'place' within which the learning is occurring and to situate the children in that place. Others, such as Hill (2013), have stressed the importance of experience (in the Deweyan sense) and place in ESD and this research suggests that engaging teachers in their own school place has benefits for CPD in this area.

Schools often become a '*repository of the history of people who had worked and learned there'* (Uline *et al.*, 2009, p. 43). School, as place, is important in the lives of children and becomes a part of the store of childhood memories. When Mairéad contacted groups in the community to share the teachers' idea to mark the original school site, there was a huge response and it brought locals to the school, some of whom had not been there since their own school days. Their connection to place was likely one of the factors that drew them back and peaked their interest in this project. From a learning point of view, and particularly within an ESD approach, this becomes a tangible connection for current teachers and pupils to connect with the intergenerational aspect of SD, a concept that can appear quite abstract. As pupils hear stories from the school's past, they can question how the same place has evolved over the years and how it will continue to evolve into the future. What type of place will future pupils experience? This is an example of an activity that Stagell *et al.* (2014, p. 108) terms '*causes and effects in a history-future time scale'*, a crucial component of an action competence approach to ESD – questioning how actions of the past influence the present and how present day actions will affect the future.

From a research perspective, the case study method and transdisciplinary approach allowed the '*particularities of context'* (Spaapen *et al*., 2007 in Klein, 2008) to be explored. This allowed space and place to come to the fore in terms of the building and grounds and the teachers' connections to them. As a phenomenon being investigated cannot be separated from its context (Scholz *et al.*, 2006), the case study method supported a clear focus on 'the case' and on how each person and process was situated in the case. In fact, looking back at the embedded case study design (section 3.2.3) that saw people and place encompassed in the processes that were occurring, the focus was on how people and place were interacting and affecting each other. On analysis however, a more suitable design may have been to look at people and process as being embedded in place as this reflects more closely the way relationships emerged between the three.

Similar to the Green and Somerville (2015) three year study on teachers' professional learning for sustainability, this study was also very much framed by the concept of place. Place emerged as a theme in the teachers' journals, it was the '*constituent meeting point for the three pillars of sustainability*' (Green and Somerville, 2015, p. 834) and it influenced the situated activity. People engaged in processes that affected and adapted place and place very much influenced the processes in which the people engaged.

9.1.3 Process; working towards sustainable school practice.

The third aspect of the embedded case study was process. CoPs theory guided the identification of key processes in which the social actors were engaged.

Establishing relationships.

According to Dewey (1958), within a situated approach, individual learning is inseparable from change in the social relationships in which the learner participates, therefore establishing positive relationships among the various social actors was of utmost importance. As mentioned above, I consciously worked on establishing positive relationships with the teachers early on in the research through many informal conversations and listening to their thoughts on the proposed work. It appears that my background in primary school teaching was an influencing factor in building relationships of trust with these teachers as they felt I understood the environment in which they worked and in particular the time pressures and workload they encountered.

O' Dell and Jackson (1998 in Hildreth and Kimble, 2002) identified the development of relationships as a prerequisite for knowledge sharing to occur. It was noted that discussions during the initial workshops increased in depth and meaning as the case study progressed (see section 7.4; Workshop 3). While this could be due in part to the fact that the teachers were becoming more confident in the language and practice of ESD, it could also be due to an increase in trust and confidence in their relationship with me. This increase in dialogue was important for two reasons. First, within the community, reflection and dialogue must be encouraged as this is what enables learning to occur (Merriam, 2008). Second, it allowed the teachers to discuss and critique different interpretations of sustainability and establish their own understanding of the concept, a factor that is very important when engaging an ESD approach (Smyth, 1995). CoPs theory puts the negotiation of meaning at the centre of the human learning experience (Farnsworth *et al.*, 2016) and opportunities for critical discussions increased across the study as the teachers became more familiar with both me and the ESD concept.

Communication has been identified as a strong determinant as to whether ESD collaborations will be successful (Espinet and Zachariou, 2014). Mairéad and I communicated regularly via email for over two years. I communicated regularly with the teachers at informal encounters when I was in the school but also during the scheduled workshops and meetings. The teachers deemed the regular meetings to be a key component of the project.

'Even having the meetings with you (Mary) at our Croke park hour… we all had to be more involved. And without those meetings we wouldn't even know where to start – it's too big a project for a staff with very little knowledge' (Mairéad, focus group).

The teachers also developed working relationships with others in their community through ESD related projects. Mairéad met with the Tidy Towns committee who got involved with the wildflower garden project and all teachers connected with parents to help them with gardening activities. The various relationships that were established across the case study drove the project and facilitated its success.

Artefacts

In a community of practice, participation should be balanced by reification (Wenger, 1998). Reification is the process of making concepts, ideas or thoughts into an object. This may occur through various processes including '*making, designing, representing, naming, encoding, and describing as well as perceiving, interpreting, using, reusing, decoding and recasting*' (Wenger, 1998, p. 59). These objects then become artefacts or tools in the CoP. Within CoPs theory, artefacts are cultural tools. They are the objects or things that result from human activity and become incorporated into social practices (Fenker, 2008). Looking at the data, it is evident that a number of artefacts emerged as helpful tools across the case study – the resource folders, the EMS documents, the teachers' journals, the monitors and data, the building and grounds and the language used throughout.

Participation and reification go hand in hand because artefacts without participation carry no meaning and participation without reification is uncoordinated and detached (Wenger, 2010a). Many of the artefacts in this case study were co-created as part of the process of learning within the CoP. The EMS grids, for example, were working documents that developed and changed as the teachers' learning and confidence increased. The teachers' journals were products of their reflection and they informed future actions and planning. FM knowledge can be transferred using artefacts such as written specifications or guidelines (Jensen, 2012) and in this research written audits, data bases and reports were used to aid the teachers' understanding of the school building from an FM point of view. Other artefacts, such as the data reports from the monitoring or resources such as the Revit model, were produced by me to help transfer a particular concept (usually a FM concept) to the teachers. These artefacts often informed practices (such as opening windows) or influenced the school's development plan (such as installing solar tubing in corridor 2). Data are intermediary between a given property and the artefacts we eventually create (Garrison, 2009). The electricity data, for example, was the mediator between the actual electricity performance of the building and the written energy management plan. The biodiversity audit was the link between the current number of habitats on site and the development of the school garden.

The school buildings and grounds became an artefact within the study as they were adapted to suit the new learning that was occurring in the CoP. Gruenewald (2003b, p. 627) states that '*places are a primary artefact of human culture'* and the development of the building and grounds as an artefact was very much linked to the concept of place (see section 8.4.3). The places that we inhabit reflect what is important to us. As sustainability became a more important issue to these teachers and pupils over the year, this was reflected in adaptions to the school site. Therefore, reification occurred through the building and grounds with developments that embodied the work of the sustainable CoP.

The importance of language emerged at many levels throughout this case study. Language is defined as a tool in CoPs theory and Dewey called language '*the tool of tools*' (Dewey, 1958, p. 146). Language is the tool of communication (Kivinen and Ristela, 2003) including the spoken and written word. It was the medium through which all artefacts were created and used in the study. The social environment infiltrates the inner self as language and the inner self reflects the social environment in language and meaning (McDonald, 2003, p. 79). As these teachers engaged with sustainability, their language reflected their new learning and outlook. Although the word *children* was the most used word in the teachers' journals and the words *lesson, class* and *learning* were in the top twenty words used, other words in the top twenty included *waste*, *environment*, *recycling*, *tree*, *nature* and *bees*. Throughout the journals the language of ESD can be seen (reflecting teaching and sustainability). Interestingly, the language changed in the focus group and had less of a sustainability focus and more of a focus on the process that the teachers were engaging in. This time, the most used words were *school*, *helpful*, *participant*, *teacher*, *everyone*, *focus* and *knowledge*. While individually, the teachers reflected on what was happening in their own classes and lessons, collectively they focused more on the project as a whole. On both occasions, language was the tool by which they formulated, reflected upon and shared their ideas and was reflective of the processes occurring within the CoP. Language endowed the artefacts with meaning (Dewey, 1958, p. 146).

The various artefacts were produced in different ways, but all were connected with processes of participation and learning within the CoP. From a pragmatic perspective, tools are instrumental as they are a means for realising human ends and purposes (Garrison, 1995) and each tool or artefact contributed to the work of becoming a sustainable school.

The Environmental Management System.

A key artefact that emerged in this case study was the EMS document. Tools and artefacts facilitate interaction in a CoP (Clancey, 1995) and each aspect of the EMS furthered participation and interaction in the sustainable school CoP. The audits were used as a tool to communicate the current health and performance of the school site to the teachers and the teachers reified their new knowledge and learning in the development of an action plan. The EMS grids that were designed collectively by the teachers with support from the HEI actor, became a much used tool that allowed all teachers and classes to participate in each of the action areas and provided for the inclusion of other community actors. Brown *et al.* (1989) maintain that when tools are used actively, they lead to a richer understanding of both the situation in which they use the tool and the tool itself. This understanding '*continually changes as a result of their interaction*' (ibid. p33). The EMS was viewed as a flexible document and it was adjusted as the teachers saw fit. Meyer (2010) found that brokers not only move knowledge from one CoP to another, but that they also produce a new kind of knowledge which he terms 'brokered knowledge'. In this case study, the knowledge was transferred to the school by a HEI broker, but it was transformed in its utilisation through the EMS. The EMS was the tool that facilitated engagement with this knowledge in a different setting and the 'new' knowledge was created through both dialogue and action in situated activity.

At the beginning of this case study, when the initial energy audit was carried out, gaps in the system being used became evident. The school was using the Green School programme which is very focused on the environmental pillar of sustainability. As such, the social and financial pillars were not being strategically targeted resulting in surging electricity costs and poor IEQ. Blom and Solmar (2009) warned that neglecting one pillar would result in the collapse of the other two and in this research, with a more conscious approach to holistically developing the EMS using Warner and Elser's (2015) Sustainable School Framework as a guide, improvements were made in all three areas of the sustainable school – society, environment and economy, and at all three levels – curriculum, campus and community. Furthermore, the EMS was designed from the perspective of engaging an ESD approach, an approach that many studies have found lacking in other programmes (Boeve-de Pauw and Van Petegem, 2011; Olsson *et al.*, 2016; Stagell *et al.*, 2014). By focusing on ESD from the beginning, the target was not to reduce water or electricity use or increase recycling, but to identify the learning opportunities for engaging in water, energy, waste and biodiversity management. This then opened up opportunities for critical thinking and action competence. Another aspect that was to the fore in this case study was that the school had full ownership over the project. Varga (2005) looked at Eco School implementation in 13 countries and found that this is rarely the case. As sustainability issues are site specific and the theme of place emerged so strongly in this research, it would seem essential that the school has full ownership of their own sustainability work and the direction it takes. This sense of ownership and the extensive involvement of community actors in activities such as the wildflower garden would suggest that it is a motivating and supporting factor in seeing projects to completion. Overall, the teachers found this model more flexible than the Green School programme. Pirrie *et al.* (2006) found that in Eco Schools in Scotland, pupils were raising a wider range of issues than those covered by the themes of the programme. Using a more flexible framework and giving the teachers more freedom in engaging with the themes of the EMS led to many interesting topics arising in this case study including consumption and homelessness. Overall, the findings from the literature review, the surveys in Chapter 4 and this case study concur with Huckle's (2013) summation that the Eco Schools programme has engineered a 'light greening' of schools.

Through each of the four themes, the teachers have begun to harness the built and natural environments of the school to support pedagogy. As cited in the literature review, Cole (2014) identified four design patterns for the Teaching Green Building – factual information, physical engagement, social interaction and social norms (section 2.6.1). The first and most basic step is factual information. Over the course of the year, signage was added to building features to both give information (what materials can be recycled) and to act as a behaviour prompt (remembering to turn off the lights). These types of interventions appear to have only a modest effect (Katzev and Johnson, 1987 in Cole, 2014), and certainly in this case more is required to improve waste separation. Over the year, advances were also made with step two

– physical engagement. Cole (2014) reasons that features such as gardens, compost systems and energy monitors will consciously engage pupils over long periods and each of these examples have been developed this year. The final two steps are arguably the more difficult and really need to be considered at the design phase of a building. However, certain developments within the school this year could be considered to be advantageous for both social interaction and social norms. Social interaction requires '*physical spaces in which student groups can self-organise for ongoing environmental action both inside and outside of the school building*' (Cole, 2014, p. 848). While developing these spaces within a building such as this one would be challenging, developing social outdoor spaces are well within their capabilities. Indeed, the new vegetable garden could be viewed as such as space as groups work together to tend their plants and work alongside teachers and parents in doing so. Similarly, developments such as the vegetable garden and wildflower garden become a part of the school's hidden curriculum and deliver messages to those who attend or visit the school.

An interesting observation from this case study is that within the EMS, health and health education (HE) seemed to go hand in hand with ESD. Issues such as IAQ, hydration and water intake, mental health and mindfulness all arose in discussions on becoming a sustainable school. From a SFM perspective, health is very much taken into account when managing the environment of the workplace. Looking at sustainable school initiatives, Rauch (2000) believes that it is the underlying philosophy of the programme that determines whether health and the environment are viewed as interrelated. As one of the underlying principles of this EMS was to focus on core business, i.e. the business of education, the teachers had to think about factors that made the classroom environment conducive to learning. Also, as Warner and Elser's (2015) sustainable school framework was used to ensure inclusion of all three pillars of sustainability, there was a focus on developing a healthy environment and population wellness. Other approaches to sustainable school practice include a specific focus on health and the AuSSI-WA initiative in Australia positions student wellbeing at the heart of their programme (Pepper, 2014). Also, some researchers such as Schnack (2008) and Mogensen and Schnack (2010) study both EE and HE and look at the action competence approach in both. In health education, just as in ESD, there is the need for the individual to '*critically make value judgements about the different alternative ways to act*' (Hedefalk *et al.*, 2014). As a healthy environment and population wellness are focus points for ESD and activities such as gardening link directly to issues of diet, food production and food waste, there is significant potential here to look deeper into the interdisciplinary aspect of EE and HE.

A key aspect within the EMS this year was the role of monitoring. While the Green Schools Handbook does state that monitoring is vital (An Taisce), it is the process of monitoring that presents the difficulty. S.N. an Bhaile Nua, like many schools, were using their electricity bills to monitor electricity use. A step up from this would be to regularly read the electricity meter, but in the survey in Chapter 4, only a fifth of schools were doing this on a monthly basis. During the case study, a more detailed system was used for monitoring electricity use and IEQ parameters were monitored for the first time. The quality of facility decisions is only as good as the information on which they are based (Lavy and Bilbo, 2009) and more detailed data in these areas gave the teachers increased confidence in making decisions regarding energy management and allowed the principal and BOM to make informed decisions regarding building upgrades. Although not investigated in this study, it is probable that using a more detailed monitoring system to track water usage would improve water management as it is evident that improved monitoring leads to improved data which leads to improved decisions. Monitoring was one of the key findings from the FM interviews. In Chapter 6, each of the key findings was translated into a potential implication for schools. Table 9.1 identifies some of the ways in which these potential implications manifested over the course of the year.

Potential implication for Schools.	**Examples of how these implications manifested during the case study.**
A SFM strategy must support education – i.e. teaching and learning.	• The EMS was securely rooted in the curriculum and was developed with an ESD approach in mind. • Adaptions that were made to the buildings/grounds were aligned with curriculum planning. • Teaching and learning were taken into account when exploring any potential projects/upgrades, etc.
A more detailed monitoring system would provide better data and therefore inform better decisions.	• The Owl Eyes electricity monitor helped this school to identify a long-standing issue in energy management. • The real time monitor gave instant feedback to teachers and pupils on their actions. • The IEQ monitors provided detailed data that helped the staff to manage the very difficult area of classroom IEQ.

Explore all opportunities regardless of seeming impracticality. Engage pupils in this process to encourage creativity and innovative thinking. Make short and long term plans based on potential opportunities.	• The development of the outdoors seemed like a very big undertaking at the beginning. However, by discussing all ideas, innovative projects ensued that would have perhaps seemed unlikely before. The school now have a good sized vegetable garden with plans to extend it in 2019/2020 with extra beds and a polytunnel. • Short term plans include the installation of a poly tunnel and the installation of solar tubes in corridor 2. Retrofitting the lighting system is an expensive task but has been noted as a longer term project that will take place on a phased basis. • There was no evidence of pupils engaging in planning opportunities over the case study. However, the potential for this remains and using the maps of the school to engage pupils in potential planning opportunities for the school building and grounds would create meaningful learning experiences.
Potentially, one stand alone, key project could get a school started as a sustainable school, act as motivation for further projects and get the attention of all stakeholders in the community.	• The sustainability project for the year – the development of a wildflower garden with surrounding pathway to mark the original school – was a huge success, even though it was still in progress at the end of the case study. It brought the community together, engaged pupils in deep learning, and offered a tangible means of exploring the intergenerational aspect of SD.
Management systems provide a framework to pursue environmental management but these frameworks must be fluid and provide the opportunity to adapt to the needs of the school. (perhaps the Green Schools system currently in use in over 95% of Irish Primary schools is too rigid in structure to allow this at present)	• The EMS was viewed as a flexible tool and was adapted as needed throughout the year, with some activities put forward to the next school year. • The teachers could comfortably explore all four topics throughout the year whereas before they were focusing on one topic only. Similarly, the school could put more of an emphasis on one project at any given time (such as the grounds project) to suit the time of year, available resources or a topic that the pupils found particularly engaging.
Finance and *Teaching and Learning* emerged as top drivers in the schools' surveys while almost 40% did not rank *environment* or *school image* as a driver at all. Having a broader outlook on sustainability initiatives and understanding the multiple potential benefits may result in higher motivation towards ESD.	• While teaching and learning emerged as the strongest theme during the case study, other drivers developed also. • One of the top benefits, as identified by the teachers during the focus group, was full participation. They felt that this was the first time that this was achieved in EMS implementation. • The teachers' own learning was also identified as a key motivator over the course of the year.
All staff and pupils, as building occupants, need to be	• Teachers used the data provided by the IEQ monitors to manage the indoor environment of their classrooms

involved in managing the building and understand the reasons behind any changes taking place or any technologies being introduced.	• Using the real time readings on the IEQ monitors, teachers could explain to pupils why windows were being opened during the day. • Using the real time readings on the electricity monitor, pupils could see how their actions (such as turning off classroom lights) affected the energy use of the building.
While management systems may encourage reductions in energy use, waste produced, etc. a broader view of building management must take into account the building's impact on pupils and teachers. (e.g. if pupils are encouraged to turn off the lights, are the lux levels at an optimal level for classwork? or if windows and doors are being closed to conserve heat energy, is the IAQ being consequently affected?)	• Using the IEQ monitors, teachers could judge when windows needed to be opened to improve IAQ. • Pupils' water intake was targeted as part of water management.
A dedicated team including both staff and pupils could spearhead ideas/initiatives while still ensuring full participation by all students. This group could ensure that sustainability stays to the forefront of a school's agenda.	• This year, it was the teachers who spear-headed the EMS. This was positive in that all teachers were active and therefore all classes were exposed to the programme. • Getting interested parents to help out aided the progress of projects on the grounds. In particular, parents with gardening know-how gave advice on planning the vegetable garden. • Perhaps going forward and as the teachers become more experienced in this area, they can expand on the opportunities for pupils to become more involved.

Table 9.1 Examples of how FM findings translated to the School EMS.

Boundary Objects

Some of the artefacts that emerged over the case study developed further to become boundary objects. Boundary objects are artefacts that aid the transfer of knowledge across boundaries and act as translation devices between CoPs (Star and Griesemer, 1989). Star and Griesemer (1989) were the first to extensively theorise boundary objects, describing them as objects that are '*both plastic enough to adapt to local needs and the constraints of the several parties employing them, yet robust enough to maintain a common identity across sites*' (p46). Within CoPs theory, they are defined as '*forms of reification around which CoPs can organize their interconnections … They enable coordination, but they can do so without actually creating a bridge between the perspectives and the meanings of various constituencies*' (Wenger, 1998, p. 107). A number of artefacts in this study enabled coordination at each of the boundary sites within the Extended CoPs model.

At the HEI–Sustainable school boundary, the EMS was the key artefact around which the work was coordinated. It was a boundary object that translated meaning and intention between myself (HEI actor) and the teachers (sustainable school actors). First, through the production of the audit reports, dialogue ensued regarding the current situation on the school site and the teachers' opinions of the building and grounds. Then, through the development of an action plan and the creation of the EMS grids, dialogue continued around learning opportunities and the potential development opportunities in the building and on the grounds. Also, as I knew the direction the teachers wished to take in each theme and with each aspect of the sustainable school framework (curriculum, campus and community), I could further support them in offering advice, locating resources and even identifying grant opportunities. The EMS documentation was 'plastic enough' to provide the framework for the school's work plan and provide me with relevant research data and 'robust enough' to maintain its structure in both CoPs. Boundary objects are also valuable in establishing shared understanding at boundaries (Abraham *et al.*, 2015) and through the development of the EMS, the teachers developed their understanding of SFM and ESD while I increased my learning about how these disciplines could be integrated at a specific school site.

Boundary objects can act as anchors or bridges (Star and Griesemer, 1989). While the EMS anchored the work at the sustainable school CoP and provided for coordination between the HEI and school, the IEQ data, electricity data and Revit model acted as bridges which supported the transfer of required knowledge from the FM CoP into the school CoP. There were a number of instances over the course of the case study where a challenging situation arose that neither the teachers nor I could solve. When these situations occurred, I would bring them up in my mentor meetings or conversations with David and John, and at these times, I found myself bringing along objects to show them or to help me explain the situation. The first occasion where this occurred was when I analysed the first full month of electricity data from December 2017. I could see that the base load was too high and there was a sustained increase in electricity use from the Monday through to the Friday when the pupils were on their Christmas holidays, but as I had already identified all of the energy users during the audit, I was unsure of how to go about identifying the extra usage. When I showed the graph to John, he said that the trending suggested a timer function, possibly a heating pump for the boiler control. He drew my attention to a similar trend on each Monday of the month.

When I told him that the principal had assured me that she had turned off the system for the holidays, he asked me to ask Mairéad how she turned off the boiler, because if it was from the timer control, a number of timers will initiate at the next “on” signal. I went back to the school, spoke to Mairéad and photographed the timer mechanism and from this John could tell me how to correct the setting on the timer. For John, this was an easily identifiable problem but for the school, it had been hampering their energy management for almost four years.

The IEQ charts were used in a similar way to discuss with the FM team what was causing the high RH levels and the mould on the walls of classroom three. In an effort to explain why the mould was occurring in this particular area of the classroom, I found myself then using the Revit model to show the teachers how the upper external walls were north facing and therefore colder than the other walls in the classroom. Visual tools, such as this model, have proved important in aiding the transfer of knowledge between designers and building users Jensen (2010) and being able to show the teachers the orientation of their classrooms, the position of the internal walls in relation to the exterior walls, and the solar pathways through the building all facilitated their understanding of how the building worked and how it was influenced by orientation and the external environment. Boundary objects can be perceived or used differently over time (Akkerman and Bakker, 2011) and the senior teachers plan on using the Revit model as a teaching tool in the coming year. This will aid the further translation of the FM knowledge into curriculum.

Transdisciplinarity

A transdisciplinary approach was engaged through the methodological framework with a view to enhancing the CoP model and encouraging participation from all social actors. The first aspect of a transdisciplinary approach is using knowledge from more than one discipline to solve a problem. Individual disciplines provide crucial knowledge, methodologies and tools for transdisciplinary research (Klein, 2008) and in this research, the disciplines of SFM and ESD were used to engage a school in sustainable school practice, whereby the EMS became the tool that drew the two disciplines together. Wickson *et al.* (2006) advise that rather than combining two bodies of knowledge, one must look at each subject in light of the other. When creating the new EMS, myself and the teachers considered the management of the building and grounds from an ESD perspective and considered teaching and learning for sustainability from a SFM viewpoint. This helped to move the EMS away from a 'turn off the lights – how much electricity did we save this month?' attitude to asking questions such as 'is turning off the lights impacting upon the children's knowledge and values?' and 'are there better ways of engaging pupils in the energy management of the building?' Similarly, by looking at education from a SFM angle, teachers began to question how their physical classroom environment affected pupil learning and what opportunities were available in the management of the school site that could promote teaching and learning. This helped them to see the potential of the building and grounds as a teaching tool. Engaging in this reflective process, reflecting on each discipline from the stand point of the other, ensured that SFM and ESD were integrated throughout the EMS.

This model also allowed actors from various backgrounds and disciplines to co-ordinate and use their disciplinary knowledge to work on collective problem solving. This has been identified as one of the key factors that moves interdisciplinary research to transdisciplinary research (see section 3.2.2). Participatory research designs have been found to afford better frameworks for understanding effective community partnerships for SD (Espinet and Zachariou, 2014) and the transdisciplinary element of this research design put a clear emphasis on facilitating participation. While it was originally hoped that the teachers and FM team would work more closely together, each actor did contribute to the work of sustainable school practice. The FM team participated in interviews to share their experience of SFM and were readily available to answer technical questions when FM issues arose in the school. The HEI actor, with support from others in the college, brokered this knowledge between the two CoPs and the teachers used their knowledge of teaching and curriculum to transform this knowledge into meaningful learning experiences for their pupils. There are two main roles that participants can play in transdisciplinary work – consulting and participating (Mobjörk, 2010). Although a participating role is preferable to ensure that actors' voices are heard, the FM team played more of a consulting role as they did not engage with the problem/research question at the school site where the knowledge was being applied. However, they were in regular contact with me throughout and were aware of the ways in which their knowledge was being used. The teachers did play a participating role as they were actively involved at all stages of the case study – setting the normative reference point, writing the EMS, deciding what projects to take on and reading the final reports (findings and discussion) to say whether they felt it was an accurate description of the work that took place. While a participating role may be viewed as more desirable, in this model both the participating and consulting actors worked in a way that was suitable to them and was effective in addressing the research problem.

Another key factor for transdisciplinary research is that it is application oriented (Van den Besselaar and Heimeriks, 2001). In this research, the school had control over the direction of the case study and the focus was to create a brokered knowledge that could be applied to the three levels of a sustainable school – curriculum, campus and community. From a pragmatic perspective, freedom of inquiry is essential whereby social actors can define the issues that are most important to them (Morgan, 2014) and the teachers identified the curriculum topics and the various projects that they wished to pursue. In transdisciplinary research, a constant interplay occurs between abstract and case-specific knowledge (Pohl and Hadorn, 2008) and the findings from the FM interviews, although translated by the HEI actor, then had to be connected to the place-based, discipline-specific knowledge of the teachers. Through reflection and dialogue, the social actors considered how their new FM and ESD learning could be applied to their specific school and through this process they used the knowledge to enhance the curriculum, campus and community.

Language arose at every level of this research – issues of language and meaning are essential to pragmatism (Morgan, 2007), language is a key artefact in CoPs theory and variations in language among the social actors and the two disciplines arose in the transdisciplinary approach. As noted in Chapter 8, Teaching and Learning emerged as a strong theme and this theme was particularly evident in the teachers' reflective journals. Indeed, it was in these journals that we could really see the 'language' of education being used, and teachers regularly referred to the teaching methodologies they were using, the subject content they were exploring and how the lesson was resourced. Similarly, the FM actors used the language of their trade in the interviews in Chapter 6. They regularly spoke about the procedures they engage in, the technologies they use and areas of focus within their EMS. As this research was engaging a transdisciplinary approach, it was important that, in some way, the language of both sides could be heard.

From a research perspective, this led to an issue when writing the research. In academic writing research, it has been identified that for those new to a particular social context, such as being exposed to competencies from other disciplines, considerable challenges are encountered, including the exposure to new discourses and practices that may not support their own identities (Barton and Hamilton, 1998 in Hyland, 2002). As our identities are socially constructed in practice (Wenger, 2010a), the issue of language arises as particularly pertinent within transdisciplinary research, where researchers are exposed to discourses and practices outside of their own discipline. As our professional identities are socially constructed in our CoP, as an academic writer we then employ the discourses of that community and discipline (Hyland, 2002). Therefore, as a researcher who engages in an interdisciplinary approach, a decision must be made as to which disciplinary language and protocol will be used. Research from engineering disciplines avoids using the first person while the first person is often more accepted within educational research. While this is a transdisciplinary research, looking at disciplines within both engineering and education, it was decided to use the first person when writing. As social learning is at the core of the work and in order to convey the various roles, and in particular my role, the use of pronouns was important. Using first person pronouns helped to explicitly identify my role within the research while also establishing my commitment to the writing (Hyland, 2002). As a case study methodology was used and naturalistic generalization was the intended outcome, it was felt that the use of the first person also strengthened conveyance from writer to reader.

Overall, the transdisciplinary aspect of the model was much more pronounced in practice than originally expected and was a key component in approaching and addressing ESD issues. This impacted on the development of the model and the model is reconceptualised as a *Transdisciplinary CoP for ESD*, as discussed in section 9.2. The fusion of ideas from different disciplines (SFM and ESD) and different professions (FM, primary education and tertiary education) led to a new approach to the EMS and encouraged engagement with different actors on ESD that may not have happened otherwise.

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The Extended CoPs model was designed to support teachers in developing and implementing an EMS and in alleviating some of the many challenges that are associated with this process. Three groups of social actors engaged in transdisciplinary work to transfer knowledge to a school site in order to facilitate EMS creation and implementation. Participation levels were high at the school site and each teacher engaged in LPP. Áine's role demonstrated the importance of 'newcomers' while other teachers confirmed the importance of experience. Positive leadership enhanced the work of this CoP and facilitated community involvement. The role of the broker emerged as a critical component and was supported by the range of expertise at WIT and also the mentoring role that some of the FM team took on. The FM actors provided the much needed source of SFM knowledge and helped the school when they encountered technical challenges. Strong relationships facilitated knowledge sharing and learning and activity became focused around key artefacts such as the EMS. It is accepted in the KM (knowledge management) literature that innovation occurs through knowledge sharing at CoPs boundaries (Kimble *et al.*, 2010) and it was through the transfer of knowledge from the FM CoP to the sustainable school CoP that lead to innovative practices being adopted by these teachers.

9.2 Reconceptualising the Extended CoPs Model; a transdisciplinary CoP for ESD.

This model was explored through a transdisciplinary, case study methodology to examine its feasibility and to further develop its potential. CoPs theory was extremely helpful in explaining the various phenomena that occurred within the model; the role of social actors, the importance of situation and the artefacts that were produced through processes of participation and reification. However, certain singularities could not be fully explained using CoPs theory and this led to the development of the theory itself, albeit in small ways. Research on the role of broker is quite limited when compared with the volume of work available on CoPs theory. Here, the broker encountered two different types of boundary within the model and two different types of participant (consulting and participating) as reflected in transdisciplinary research. Also, the background expertise of the broker was very influential in the process of knowledge transfer. These findings open up new avenues of development for the model. Using the empirical evidence from the case study, this section explores further potentialities for the Extended CoPs model.

9.2.1 Boundary Locations.

Originally, the model was developed with the view to having FM personnel and teachers working directly together to enhance sustainable school practice. The boundary was conceptualised as existing between these two groups and the role of the HEI was to work at this boundary to broker the knowledge. However, in practice, this approach was not feasible, mainly due to the busy timetables of both parties and the time constraints that this placed upon them. Therefore, it was too difficult to timetable meetings with both groups together and the approach changed, with the broker working separately with both CoPs.

The first boundary site was at the HEI – FM border (although there was no order in which the boundaries were encountered). At this site, the FM actors engaged in a consulting role (Mobjörk, 2010) and their knowledge was accessed through observation, interviews and mentoring sessions. While they were very much aware of what we were trying to accomplish, they did not engage directly with the research framework nor did they apply their knowledge at the physical school site. Therefore it cannot be said that a CRP was established here. At a syntactic boundary, knowledge is transferred from one CoP to another. However, at this boundary site, knowledge had to be translated also so that the FM perspective could be understood by the teachers. Therefore, a semantic boundary was encountered here.

The second boundary site was at the HEI – Sustainable school border. At this site, the teachers engaged in a participatory role where they engaged directly with the research and actively applied the brokered knowledge on site. As this was a dynamic and active relationship between research and practice, where research and practice were not incongruent (Cheek *et al.*, 2009), it can be said that a CRP was established at this boundary. Here, the knowledge was transformed for new purposes in a new setting, therefore this can be identified as a pragmatic boundary.

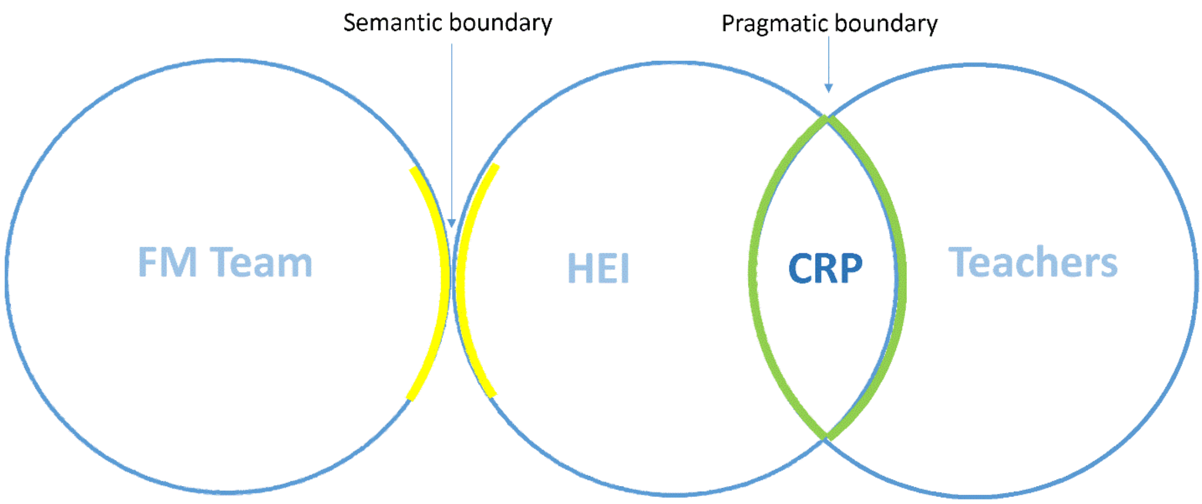

Figure 9.1 Transdisciplinary Cop for ESD with Boundaries.

As living entities, theories are modified and advanced through sound research (Silverman, 2005) and the way in which the knowledge moved in practice altered the original model. This is not to say that the original model is now obsolete. In fact, the original design may be suited to other applications within sustainability science as discussed later in section 9.3.3.

The extended model was designed to support teachers' professional practice in the area of ESD and EMS implementation, justified on the findings of a literature review (Chapter 2) and a survey questionnaire (Chapter 4). Within ESD/EMS programmes, such as Eco schools, research has found that teachers rarely take on the role of 'expert of learning' (Mayer and Mogensen, 2005) but in this case study the model supported the teachers in playing their professional role as education experts and this came through in the qualitative data explored in the previous chapter whereby *teaching and learning* emerged as the strongest theme and teachers consistently reflected on methodologies, resources and lesson planning rather than purely subject content. Through the merging of two distinct disciplines, each group seemed more aware of their area of expertise and just as it was noted in the FM interviews that the individual professionals were aware of their know-how and deferred to a colleague when an issue outside of their area arose (section 6.2.4), it appears that the teachers embraced their know-how and deferred to the FM team when something cropped up that was not within the 'education remit' -

> '*As I was doing the audit, Mairéad was talking to me about the Pureflo system. She feels it is a waste having it on over the two months of the summer as there is no one in the building so she asked me if I could ask one of the FM team if it would be okay to turn it off. I must ask them as it would be worthwhile shutting it down for the two months if it won't damage the system*' (Mary, fieldnote journal).

Therefore, when it came to transforming the FM knowledge to their school setting, they had the confidence in their own professionalism to apply the new knowledge to their curriculum and when they needed clarification or if they felt there was an issue that was outside of their expertise, they sought help through the channels that the model provided.

As the boundaries are now further conceptualised and better understood, it is worth asking the question 'Who was outside the boundary?' Although the model was designed specifically for teachers' CPD, as it is a model of social learning and it has been identified that power discrepancies can arise in such an approach, it is important to broach this question and be aware of possible exclusions. In Chapter 5 (see section 5.3.3), it was envisaged that the model would create a forum for teachers to discuss and explore issues as they were arising from a participatory process within their school. However, in this case study, the opposite occurred. The teachers were identifying the issues within the CoP and then bringing these to the students through the curriculum and the EMS. Although increased participation was noted both among staff and among pupils, the pupils will need to take on a more active role as they move forward. Pupils need to work with their teachers in identifying issues in their school and in finding projects to pursue. It may be that as the teachers become more knowledgeable of sustainability and EMS issues and as their confidence improves, they will more readily create avenues for full participation for pupils. Also, for this case study, I conducted all of the audits which means that neither the teachers nor pupils participated at this stage. However, these audits were more detailed than those produced by the school before and gave more information upon which the school could base decisions. As part of their EMS plan, each class has responsibility for various audit areas and while some classes engaged with this over the case study, it is planned for all classes to conduct audits in the following school year.

As it is learning as the production of practice that creates the boundaries (Wenger, 2010a) the model itself is predicated upon the idea that teachers working to develop their practice naturally creates the Sustainable school CoP boundary. However, as sustainable schools should be inclusive of all school and community stakeholders, the term 'teachers' is now used within the model (Figure 9.1). So, although pupils, parents and other community stakeholders may be outside of this CoP, they are not outside of the Sustainable school community which again has the potential to become a CoP if shared learning occurs within the domain. In fact, this approach has much to offer. Shallcross and Robinson (2008) argue that one positive approach to sustainability education is '*a situated, whole-school, action-focused learning'* (p299) and this is very possible by extension of the model. While the teachers may be developing their own professional knowledge and skills in relation to sustainability within the model, working on sustainable school practice in participation with pupils, parents and community members could be a direct extension of their CoP work. Although Lave and Wenger (1991, p. 40) exclude students working in school as a viable CoP as schooling itself assumes that knowledge can be decontextualized, looking at whole school approaches to ESD, Shallcross and Robinson (2008) find that the focus on community, action and context resonates very much with a CoP. Pupils engaging in meaningful, situated activity with teachers working as practitioners to solve problems can give them the experience of engaging in authentic domain activity (Brown *et al.*, 1989). In particular, the EMS can facilitate this approach as it has been created from both a SFM and ESD perspective. Brown *et al.* (1989) strongly argue that to learn a subject, rather than just learn about it, pupils need to '*be exposed to the use of a domain's conceptual tools in authentic activity – to teachers acting as practitioners and using these tools in wrestling with problems of the world*' (p34). As procedures within the audits are authentic, pupils are exposed to a situated approach of exploring, monitoring, planning and developing their school site whereby they can '*coproduce knowledge through activity*' with their teachers '*acting as practitioners*' (Brown *et al.*, 1989).

Shallcross and Robinson (2008, p. 309) contend that whole school approaches require teacher participation and are more likely to evolve when teachers intentionally intervene to promote action-focused learning. By engaging with each other and with HEI and FM actors through this model, the teachers worked on developing their synergistic teaching methods which increased the chance of pupil participation. Therefore, it is very likely that as the teachers continue to develop their practice and increase their confidence in this area, they will become more comfortable in giving greater scope to students to engage in sustainability issues at their school. By continuing to use the EMS, which is embedded in sound SFM and ESD principles, the potential for authentic situated activity for both teachers and pupils is maximised.

9.2.2 The movement of knowledge.

In order to develop sustainable school practice, many authors call for schools to develop their buildings as teaching tools (Cole, 2014; Izadpanahi and Tucker, 2015; Schiller, 2012) and to develop EMS to support an action-oriented approach (Kanyimba *et al.*, 2014). In order to do this, two types of key, disciplinary knowledge are required – the knowledge to manage buildings sustainably and effectively and the knowledge to engage creative pedagogies.

In order to employ both disciplines to support sustainable school practice, knowledge moved through the model differently than originally predicted. Figure 9.2 demonstrates the ways in which knowledge was transferred using the processes from Carlile (2004) integrative framework.

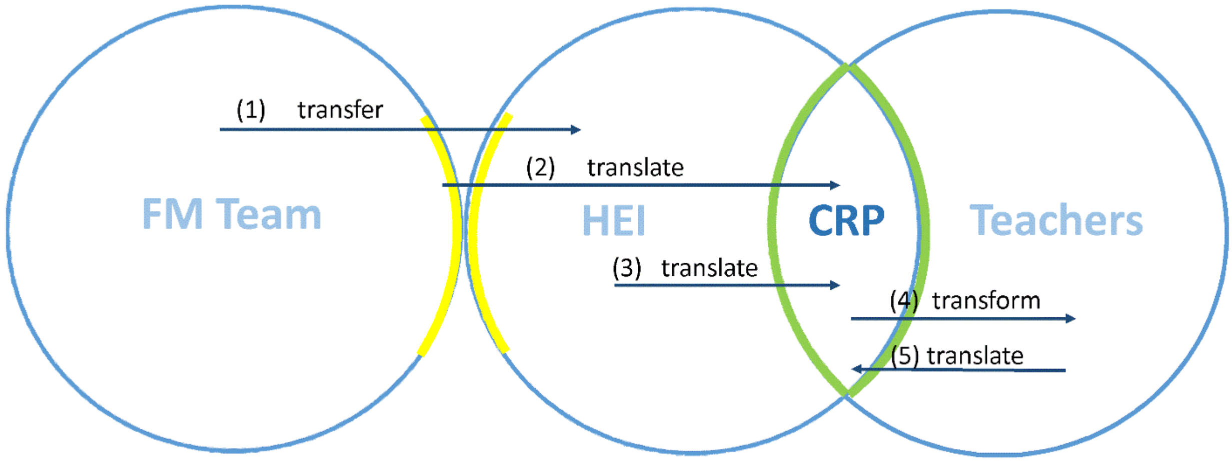

Figure 9.2 Transdisciplinary CoP for ESD with knowledge flows.

Although knowledge transfer did not occur in a linear fashion, the transfer lines are numbered to facilitate discussion. First, knowledge was transferred from the FM CoP to the HEI actors. This occurred mainly through conversations to discuss particular issues, through the direct answering of questions (such as how to change the setting on the boiler controls) and through the sharing of documents. However, this boundary was not labelled a syntactic boundary as translation also occurred here. The second arrow symbolises the work that took place close to the boundary and the translation that occurred to prepare this knowledge for use at the school setting. At a semantic boundary, even though there is a common language, it is interpretations which are often different (Carlile, 2002) and this knowledge had to be translated for use at an entirely different site for an entirely different purpose. However, not all of the required knowledge was available on the FM team. In this case, the knowledge about biodiversity and grounds management was not available and I had to look within the college to source this expertise. In the Department of Architecture, there are landscape specialists and I was able to use this know-how to identify how professional grounds audits and ecological surveys are carried out. Arrow three in Figure 9.2 represents the translation of this knowledge to the HEI/school boundary.

At this point, FM knowledge has been translated to the HEI-school CRP. In the CRP, this knowledge was negotiated by both myself and the teachers. At arrow four, the knowledge is transformed, through the structure of the EMS, to an experiential ESD that is action oriented and focused on the creation of a healthy school environment. In this space, there is a constant interplay of research and practice. Discussion and reflection occur within the CRP and the teachers apply their new knowledge to their own practice within the CoP. This application of new knowledge leads to further refinement of the brokered knowledge that was then translated back into the CRP to inform both the research and the teachers' future practice. Table 9.2 shows an example of each knowledge transfer.

Knowledge movement	**Arrow in model**	**Example**
Transfer	1	Sharing of B+L EMS documentation
Translate	2	Creating a report to share findings of FM interviews with teachers.
Translate	3	Creating a resource of plant life on the school site for teaching and learning.
Transform	4	Using knowledge of waste management and the circular economy to engage pupils in a critical discussion on waste produced from their lunches.
Translate	5	Teachers' reflections on their classroom practice informing EMS/SFM integration.

Table 9.2 Examples of knowledge movement.

As can be seen from Figure 9.2, there were no significant knowledge flows from the sustainable school or HEI back to the FM team. This was unfortunate as in the spirit of both ESD and CoPs theory, it would have been preferable to have a shared learning experience across the model. The potential for this was identified when the model was designed (section 5.3.1) but was not acted upon during the case study and remains an area that needs further development. ESD needs to permeate all levels and sectors of society and one avenue to do this is through the workforce. Policy documents on various sustainability issues call for increased public awareness (e.g. Department of Arts Heritage and the Gaeltacht, 2011) and as people spend a substantial amount of their time at work, it is a prime setting for informal and non-formal education (UNESCO, 2016). One potential reason for this lack of reverse knowledge flow could be the background of the broker, as mentioned in section 9.1.1. Only one clear example of knowledge transfer into the FM CoP occurred which was the potential of the factory grounds to support biodiversity. Although a small movement within the total knowledge flow, it is important as biodiversity depletion is a serious global issue (see section 2.4.1) and it is essential that all sectors consider biodiversity in their policies and operations (Department of Arts Heritage and the Gaeltacht, 2011).

At this point, it is also important to call attention to a key limitation of the role of broker. As knowledge was being transferred by a broker, with a specific skill set and expertise, knowledge would have been lost in translation. The identity of the broker determines what is actually transferred as they will view the knowledge through the lens of their own experience. As Law (2002) articulates (in Meyer, 2010, p. 121), '*To translate is to connect, to displace, to move, to shift from one place, one modality, one form to another while retaining something. Only something. Not everything. While therefore losing something. Betraying whatever is not carried over'.* This is further argument for a second broker when transferring knowledge in transdisciplinary work. Not only would a second broker increase the chances of knowledge flowing in both directions within the model, but it would also further develop SFM/ESD integration. While I was more likely to view information from an ESD perspective, a FM actor would look at the same information from a SFM point of view. Both an ESD actor and FM actor in the HEI CoP would create more balance in the knowledge transfer process, increasing the amount and type of knowledge that is transferred as well as the direction of transfer.

9.2.3 Future potential development.

There are three avenues for development available for this model. The first is to further develop the model, as is, for use in schools trying to use EMS within their ESD approach. The model could also be explored with secondary school teachers in the sustainable school CoP. The second is for schools who wish to develop another aspect of their practice. This model could also be used to connect schools with relevant experience in other professions. The final way that this model could be developed is within sustainability science, whereby HEIs could broker knowledge between diverse stakeholder groups in society.

Developing the sustainable schools approach.

While it was strongly felt that working with a single school (i.e. single embedded case study) was the first step in exploring this model, it would be unfeasible to work in this manner on a larger scale over the longer term. In order to engage multiple schools with this model, a more stream-lined approach would be required that would allow teachers from multiple schools to engage simultaneously.

Tillmanns *et al.* (2014) believe that in order for teachers to develop transdisciplinary understandings of sustainability for ESD, they must appreciate the perspectives of a range of sectors including HEIs, business and civil society. Engaging with this model led all of the social actors to appreciate the differing perspectives of each other and this enabled them to look at sustainability issues from new angles. Exposing more schools to SFM as a discipline and enabling them to incorporate this into their EMS would provide many benefits as seen in this case study. There would also be the added benefit of teachers meeting teachers from other schools to discuss ESD. This would widen the transdisciplinary CoP for ESD and would broaden the available experience within it as teachers from different schools will have different experiences. Birney *et al.* (2011) looked at sustainable school leaders working together in a CoP and found that it was an effective arena for knowledge sharing and mutual support. It is expected that there would be similar outcomes if teachers from multiple schools engaged with this model as they could share their experiences of taking a SFM approach to EMS development.

HEIs are in a key position to link disciplines, as was demonstrated in this research. The multiple expertise available within the HEI supported the role of broker and Schools of Education have already established links with many schools through the provision of postgraduate courses and CPD. HEIs could facilitate the gathering of teachers from a number of schools who wish to engage in this process and research by Bouchamma *et al.* (2018) highlights the importance of the role of universities as coordinators in developing school CoPs. HEIs have been identified as key enablers for EMS in schools (Hens *et al.*, 2010a) and ESD in schools (Sewilam *et al.*, 2014) and this model provides a practical framework with a sound theoretical base for developing the role of HEIs to not only support sustainable schools but to broker a new and valuable knowledge to the school.

Technology could play a role in enabling knowledge sharing between teachers from different schools and between teachers and the FM team and HEI actors. Teachers' online communities of practice have been explored by numerous authors including Hur and Brush (2009) and Duncan-Howell (2010) but Finerty (1997 in Hildreth and Kimble, 2002) emphasises that the focus must be on the sharing of knowledge rather than packaging knowledge. There are online forums already available for such knowledge sharing, such as Teachers' Research Exchange (T-REX, 2019), which could be utilised in a manner that would alleviate the issues of time that arose as a challenge in this research.

From a practical viewpoint, in order to engage more than one school, the workshops could be delivered through colleges to participating schools followed by regular meetings during the implementation phase of the EMS. The initial audits provided by the college were an important part of the process as they were more detailed than those the schools could carry out themselves and expert advice was available from both the FM team and within departments in the HEI. Individual school visits with initial audits could still occur when schools decide to take part as this detailed understanding of the school site is required (Hens *et al.*, 2010a). This would involve an increase in manpower on the part of the HEI, but could also offer material for engineering or facilities courses whereby undergraduate students could help with these audits as part of course material or end of year projects.

In order to access how the model would work with multiple participating schools, empirical testing would be required. However, the evidence from this case study suggests that there is much merit in engaging schools with an SFM approach to sustainability.

Developing the situated cognition approach

The total community of a school can be viewed as an interdisciplinary environment offering a variety of learning opportunities and educational resources (Taylor and Enggass, 2009), not only for sustainability but for all subjects across the curriculum. School – community partnerships have been touted as an important part of innovative learning and broadening school experience. Businesses often want to engage with schools but partnerships are regularly confined to donating money or resources to a school (Wheeler *et al.*, 2018) and businesses often want to do more than this (Cole, 2008 in Wheeler *et al.*, 2018). Engaging in the Extended CoPs model gives business an opportunity to do more than donate to schools or sponsor resources (which could be seen as a charitable donation from an organisation with power to one in need thereby continuing the power inequities that exist in modern capitalist societies). Through this model, business and industry can share know-how in a way that can really support students and teachers. Through the brokerage of a HEI, the knowledge can be transferred in such a way that teachers explore the knowledge and understand it in relation to pedagogy and then use their own education expertise to introduce these new concepts to curriculum.

If activity needs to be situated and teachers need to behave as practitioners (as argued for by Brown *et al.*, 1989) then teachers need access to these professions. As schools strive to prepare pupils for an increasingly globalised, technologically driven future, the argument for new curricular subjects or new extra-curricular activities arises. One such subject that has been the topic of some debate of late is computer science which has been introduced as a new Leaving Certificate subject (Department of Education and Skills, 2018a) and has seen many primary schools introduce coding as an extra-curricular activity. Coding is one example whereby if a school wants to introduce it through the formal curriculum or as an extra-curricular activity, teachers will need significant training. Using this model, IT specialists would be the social actors in the industry group (Figure 9.3). Based on the findings of this research, it is suggested that two actors from the HEI take on the role of knowledge broker. In this example, one broker would have a background in education and one in IT.

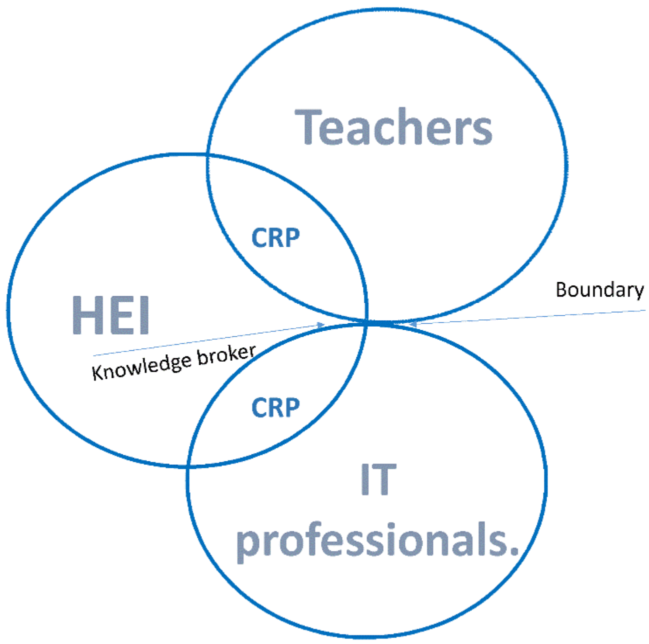

Figure 9.3 Extended CoPs model demonstrating the situated cognition approach

Brown *et al.* (1989) use Schoenfeld's teaching of maths (1985) to demonstrate how teachers can expose students to the authentic activity of mathematics practitioners using genuine tools. The goal of situated cognition is the acquisition of cognitive skills that must be developed through authentic experience (Jenlick, 2013). To engage students in situated activity and expose them to a domain's tools and practices in order for authentic learning to occur, teachers need to be exposed to the domain first. The Extended CoPs model can facilitate this exposure and the brokerage by HEI actors, with expertise in both education and the domain in question, can facilitate teachers in exploring this knowledge in a way that can result in transformation to pedagogy.

Developing the sustainable science approach.

The complexity of sustainability issues calls for an interdisciplinary approach that can employ diverse knowledge, skills and tools in the search for effective solutions (Kajikawa *et al.*, 2014). HEIs have a key role to play in moving towards sustainable futures. Regional HEIs, in particular, are obliged to engage with local stakeholders and create productive partnerships (Karatzoglou, 2013) and the education sector has also been identified as a focus area for tackling the SDGs (Government of Ireland, 2018). To achieve the SDGs, public and private sector bodies, communities and individuals will all have to work together (Government of Ireland, 2018) and this will require an approach that has the ability to maximise the expertise and knowledge from each sector. Using this model, in tandem with a transdisciplinary approach, is one method that has the potential to engage diverse stakeholders in achieving the 17 SDGs.

The various roles that social actors can play are essential to the challenges of both transdisciplinary work (Mobjörk, 2010) and sustainability work (Lang *et al.*, 2012). The knowledge required to work on the modern problems of a globalised, industrial society is located across and between disciplines. As it is at the boundaries between communities that new insights to problems often arise (Wenger, 2000), the Extended CoPs model maximises the opportunity for innovative solutions. The role of broker is thus essential in connecting the communities and disciplines that can potentially work on and solve problems together. HEIs are in a key position to play this role due to the already existing multiple knowledge sites on campus. Using a group of interdisciplinary researchers to act as knowledge brokers will increase the likelihood of knowledge transfer resulting in translation and transformation.

Many authors (e.g. Karatzoglou, 2013) and policy documents (e.g. ULSF, 1990; UNCED, 1992) have identified the need for HEIs to engage the wider public with ESD and/or work towards creating sustainable futures. This model offers a sound framework for this work to take place.

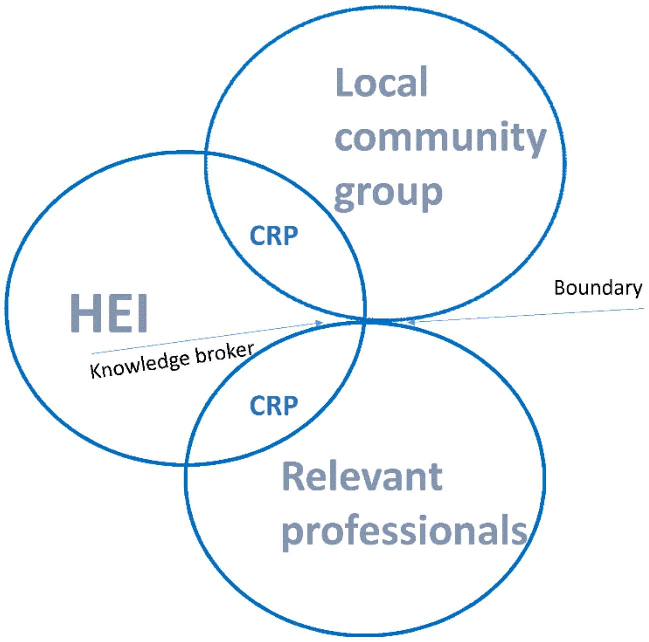

Figure 9.4 Extended CoPs model demonstrating the sustainable science approach

Another potential development of the model is to include RCEs in the HEI CoP. Regional Centres of Expertise were established to coordinate ESD work across regions and Mula *et al.* (2016) found that the creation of partnerships is noted as a key component in many RCE projects across the Asia-Pacific region. As sustainability issues continue to be a challenge across sectors, it is important that ESD permeates all forms of education, both formal and informal, and all sectors of society. This model has the potential to frame responses to such needs.

9.3 Summary.

Collaborative cultures are essential for effective ESD in schools (Shallcross and Robinson, 2008) but they need time to develop. This model gave teachers and school leaders the time and space to develop their own practice and a shared, collaborative culture. From the embedded component *People* emerged the various roles of the social actors within the model. Participating and consulting roles were observed and the transdisciplinary approach complemented the participation of all actors and the contribution of the various expertise. The transdisciplinary approach supported new ways of approaching ESD and the teachers, HEI and FM actors worked together for sustainable school practice. As pragmatism recognises the importance of the natural and physical world as well as the social world (Johnson and Onwuegbuzie, 2004), it complemented the component *place* and the embeddedness of situated experience. The sustainability work at the school was embedded in place and place was adapted to support this sustainability learning. The development of relationships was a key *process* that contributed to the success of this work. As relationships strengthened, so did participation which in turn lead to reification and the production of artefacts. These artefacts, in turn, further supported learning through their use as tools and boundary objects.

Analysing the embedded components of the case gave insights to the workings of the model in practice. The movement of knowledge altered the conceptualisation of the model and the unidirectional flow of knowledge leads to the argument for a second broker in the HEI CoP. The success of the model was heavily dependent on high participation from all social actors and effective leadership within the school. Without these two elements, the challenge of power inequity may arise and this is an issue that will critically test the model. The current case study provided empirical evidence that supported many aspects of the model, but further exploration in different schools and with different social actors will add greater depth to its underlying theory.

This model was developed with the intention of supporting the practice of sustainable schools. The participating school, S.N. an Bhaile Nua, extended their practice within all areas of a sustainable school – healthy environment, population wellness and economic efficiency (Warner and Elser, 2015), and across all levels – curriculum, campus and community. The practice of sustainable schools is a journey with no fixed destination (Birney *et al.*, 2011) and this school clearly demonstrated that they have begun this journey.

10. Conclusion.

This research set out to address the issue of sustainability in the primary school. An extensive literature review revealed challenges across all the areas of sustainability with which a school is concerned and many of these challenges were corroborated by a survey of primary school principals. The Extended CoPs model was developed to support schools in EMS implementation, both to manage the school sustainably and to bolster curricular ESD. The FM team at B+L were interviewed and the themes were used to identify characteristics of successful SFM. These findings were then transferred, via the HEI broker, to the school and were used to support the creation and implementation of a new EMS. The creation and implementation of the EMS at the school site was researched using a single embedded case study. The empirical findings from this case study demonstrated the ways in which these teachers went about incorporating an ESD approach to their curriculum and how they used the EMS to do this. The case study identified how knowledge moved through the model and what boundaries were encountered. The Extended CoPs model was reconceptualised as a Transdisciplinary CoP for ESD.

10.1 Revisiting the Research Questions.

As stated in Chapter 3, the fundamental moral value at the centre of pragmatism for Dewey is freedom of inquiry (Dewey, 1925b in Morgan, 2014), meaning individuals and communities should be able to define the issues that are most important to them and pursue these issues in meaningful ways (Morgan, 2014). In this study, while the research questions were established by the researcher, how the EMS was created and explored at the school was at the discretion of the teachers. They knew their school (the pupils, the community, the building, etc.) and they could identify the most pressing matters (such as energy management) and the most promising ways of engaging their pupils with ESD. Although the teachers defined the issues at the school site, their work provided the data that helped to explore and answer the research questions. The main conclusions based on the research findings are summarized in relation to the research questions.

10.1.1 Research Question 1.

The first research question asked "How can schools be supported, within an Industry-HEI partnership, to develop and implement an EMS?" Following a rigorous and in-depth review of the literature, many challenges were identified under each of the EMS subheadings –

energy, waste, water and biodiversity. Although it was evident from both policy documents and academic papers that teachers and school leaders see sustainability issues as important and are engaging with them at varying levels, there was a multitude of challenges cited that are hindering engagement with both EMS and ESD.

The Extended CoPs model/Transdisciplinary CoP for ESD supported the participating school in a number of ways. First, by doing an in-depth analysis of the school site and conducting detailed audits in each of the four areas, the school was provided with better data upon which to base their decisions. The expertise from both B+L and WIT supported the rigorousness of these audits and this expertise was also available throughout EMS implementation when required. This need to access external expertise to support ESD in schools was noted in the literature (Kadji-Beltran *et al.*, 2013) and in this case, it supported the sustainable school approach in many ways. For example, the long standing energy management issue would not have been identified without this external support and the idea of using a sustainability project to harness interest and support came from the FM team.

This model also facilitated and encouraged the role of teachers as education experts, a role that many sustainable school programmes fail to recognise (Mayer and Mogensen, 2005). Once the SFM knowledge was translated to the HEI-school CRP, the teachers actively transformed this knowledge, with the researcher, for application at the school site. Raath *et al.* (2018) argue that sustainability in schools begins with teachers, and this research supported teachers in developing their own ESD practice which then had knock-on effects for pupils and the wider school community.

The HEI actor, taking on the role of critical friend, also supported these teachers in their own practice. Through regular dialogue, formal meetings and personal reflection, these teachers were enabled to consider all aspects of their school – curriculum, campus and community, when developing the EMS. The teachers valued their new learning and felt that it motivated them to further develop their ESD practice.

Therefore, within a HEI-industry partnership, this school was supported on its sustainable school journey in three key ways;

- access to external expertise,

- teachers taking on the role of education expert and creating a programme that was specifically tailored to their school and
- teachers encouraged to engage in reflective practice through the support of a critical friend.

10.1.2 Research Question 2.

The second research question asked "How can teachers be facilitated in harnessing the built and natural environment of the school for effective ESD pedagogy?" The importance of the school's built and natural environments were explored in the literature review through the works of Orr (1993; 1997), Taylor and Enggass (2009) and others, but there is very little information on how to utilise the physical setting of a school for pedagogical purposes (Kong *et al.*, 2014). However, through this research, a number of avenues were identified through which the school's physical environment can be adapted for pedagogy.

First, the initial workshops helped the teachers to understand the current state of the building and grounds and to see them as potential teaching tools. As the staff discussed potential upgrades to the building (such as retrofitting the lights or inserting solar tubes on corridor 2) and grounds (development of a vegetable garden), they discussed them in terms of the curriculum as well as in terms of economic savings or improved occupant wellbeing. This continuous focus on 'core business' or education, meant that all potential upgrades would support teaching and learning.

As the teachers began to develop a deeper understanding of the school's built environment, they gained a deeper appreciation for the effects it has on them and their pupils. Small adjustments were made, such as adjusting the upper windows in classrooms 2, 3 and 4, to increase opportunities for natural ventilation and thereby create a healthier classroom environment that was more conducive to learning. Using the IEQ monitors, the teachers enabled the children to understand why they were turning down the heating or opening windows. Indeed, both the electricity and IEQ monitors gave the teachers and pupils an insight into how the building operates and they helped to connect action and consequence in relation to energy conservation measures and IAQ.

The teachers embraced the outdoors as a pedagogical tool and were excited to explore all opportunities it had to offer. The grounds were used regularly to support teaching and learning across the curriculum and new habitats were developed that supported biodiversity on site. The grounds projects that this school undertook also created opportunities to connect with the wider community. The wildflower garden on the old school site grabbed the imagination and curiosity of the whole school community and this, in turn, enhanced the project as more people came on board.

Creating learning environments '*that are living examples of sustainable design is one of the best ways to educate for a sustainable future'* (Taylor and Enggass, 2009, p. 364). One aspect of sustainable learning environments is introducing sustainable technologies but Taylor and Enggass (2009) argue that we must also incorporate aesthetics in sustainable design. Newly built primary schools in Ireland are including sustainable technologies but are still planned around linear corridors with rows of classrooms. A focus on aesthetics and a space that can support learning are just as important. At S.N. an Bhaile Nua, there was a real appreciation for the older part of the school (the 1930s and 1960s classrooms) and some teachers preferred these classrooms for their design. The grounds presented as a blank canvas upon which the school could envision their new sustainability ethos and ideas. The building and grounds became tools for both supporting ESD and for reflecting sustainability learning.

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Many schools engage in EMS implementation through programmes like the Green Schools in Ireland or Eco Schools elsewhere. Research has found that the main outcome of partaking in such programmes is an increase in pupils' knowledge (Boeve-de Pauw and Van Petegem, 2018). Research has also found that many schools lose momentum following certification and do not remain fully committed to the underlying principles of the programme (Goldman *et al.*, 2018). This was reflected in Chapter 4, whereby a number of schools identified that they do not continue with actions, such as composting, once they have attained their flag. There is evidence to suggest that S.N. an Bhaile Nua will continue on their sustainable school journey. First, they have made arrangements within their school development plan to make further adjustments to the building (solar tubing in corridor 2) and developments on the grounds (the construction of a polytunnel in the garden). Such planning adds both momentum and motivation to the work of the school. Second, the principal and teachers have remained in touch with the researcher and feel that the support remains although the formal research project has ended. This also suggests that the teachers feel that sustainable school practice is now a routine part of their own practice. As the central idea of pragmatism is that the truth of an idea lies in its consequences (Hickman, 2009), this research can be viewed as successful in terms of coming to the end of an inquiry. In this school, engagement with the Extended CoPs model has resulted in inquiry leading to satisfactory outcomes which in turn has led to further questioning of practice. The research questions were answered and yet highlighted avenues for further research/inquiry.

10.2 Research Contributions.

This research addressed the issue of sustainability in schools through a social learning lens and a communities of practice framework. As the research questions were focused on supporting and facilitating school staff, with the aim of addressing the current challenges facings schools in this area, it had a very much practice-oriented approach. This research adds to two areas within the field – contribution to content knowledge regarding ESD and EMS and contribution to methodology within sustainable school research.

10.2.1 Contributions to knowledge.

The findings of this research have added to knowledge in the field of EMS and ESD in primary schools in a number of ways. EMSs were originally designed for the industrial sector and although they are now widely used in schools, they present numerous challenges to teachers mainly due to the technical knowledge required. Using a SFM approach in the development of the school EMS opened up opportunities that had not been identified using their previous approach. The EMS became more fluid and teachers felt less restricted. For the first time at this school, all four themes of the EMS were explored simultaneously.

The key contribution of this research is the generation and exploration of the Extended CoPs model and its reconceptualization as the Transdisciplinary CoP for ESD. The Extended CoPs model offers a robust framework for knowledge sharing among different sectors and the case study provides empirical evidence for its use to support sustainable school practice. The role of the broker, in particular, is not fully conceptualised within CoPs theory and this research demonstrated how a broker’s professional background can influence the transfer of knowledge. This research also revealed how different boundary types can be encountered within one project and how knowledge traversed these boundaries. The understandings of boundary objects was also enhanced through this research, demonstrating how they can act as anchors or bridges (Star and Griesemer, 1989).

Giving full ownership to the school over the EMS appears to be vital in maximising participation amongst teachers. When given the opportunity to develop their EMS without restriction, and with HEI/industry support, the teachers took on the role of education expert. They consciously sought to identify all teaching and learning opportunities that the EMS had to offer. They readily took a more holistic approach to the EMS and this research also demonstrated that when the EMS is moved from focusing solely on environmental issues to embracing more fully the social and economic context of the school, outcomes are more positive and well-rounded. This school's previous focus on environmental outcomes meant that their heating bill was reduced through closing windows and doors but unknowingly, this was having an adverse effect on IAQ and the physical learning environment. These findings corroborate Barr *et al.* (2014) statement that a focus on a healthy environment ensures that healthy, sustainable practices will follow. A number of other critical components emerged in EMS implementation including the role of more detailed monitoring and the importance of regular meetings to discuss progress. This case study also demonstrated that small, low-cost actions had an impact on the environment, finance and wellbeing of occupants at the school as well as teaching and learning.

ESD has also been a challenge for schools to implement. Due to the extensive knowledge needed for exploring sustainability issues and the teaching methodologies required to engage pupils in this approach, schools have found that the relevant knowledge and skills are not available on staff. While the literature has cited the need for teachers to locate this external expertise (Kadji-Beltran *et al.*, 2013) and school-community partnerships are continuously advised as components of sustainable school practice (Green and Somerville, 2015), there is little practical guidance available for either endeavour. This research has created a framework that supports both the establishment of partnerships and access to expertise and it was explored to demonstrate its feasibility.

The initial workshops that were developed for these teachers also proved to be an important component of the case study as it introduced the teachers to a number of interpretations of ESD and sustainable schools. This substantiates findings by UNESCO (2016) whereby short modules for teacher training were found to have benefits for teachers' understanding of complex issues such as climate change. In this research at S.N. an Bhaile Nua, the opportunity to consider various interpretations of sustainability appear important to the teachers' ESD development as it challenged their current ideas. This in turn led them to consider a broader range of perspectives when planning the EMS.

10.2.2 Methodological Contributions.

Much of the published research that addresses ESD or EMS implementation in primary schools is implicitly embedded in a constructivist paradigm, addressing teachers' or principals' experiences with these topics (e.g. Katsenou *et al.*, 2013) or students' knowledge, attitudes and/or behaviours (e.g. Pauw and Petegem, 2013). However, this research took a pragmatic approach with a focus on action and outcomes and the case study method allowed for deep analysis showing how such outcomes came about.

This research also took a transdisciplinary approach, not only looking to integrate multiple disciplines but also academic, public and private sector perspectives. Transdisciplinary approaches have been recognised for their ability to explore issues of sustainability as there is the need to draw on various fields of knowledge and include non-academic participants. This research adds to the body of work on transdisciplinarity, showing how consulting and participatory roles can both be used to engage in problem solving. Furthermore, it demonstrated that engaging actors from different disciplines led each actor to embrace their own expertise and focus on its use to benefit the overall work.

Connecting the transdisciplinary approach to the CoPs framework and case study method within a pragmatic paradigm created a meaningful yet rigorous research design that could be adapted by others wishing to pursue ESD/EMS research in a participatory way. Furthermore, it has been demonstrated that CoPs theory has a significant role to play in addressing complex, sustainability issues across sectors through the connection of diverse social actors and the harnessing of multiple expertise.

10.3 Future Research Potential.

Dewey's pragmatism views results of research, not as final truths, but as tools for future research (Saito, 2008). Following on from the experiences gained while conducting this research, along with the research findings, the following recommendations are made for future inquiry.

Much of the research on sustainable schools focuses on whether a particular programme is successful or on the impacts of such programmes, with few questions asked about why a programme might be successful (Rickinson *et al.*, 2015). Although this research has attempted to look at both how and why the model has worked, there is scope to further investigate this through more longitudinal research with a broader range of school participants. As outlined in section 9.2.3, there is both the need and potential to investigate this model with a wider cohort of teachers participating in the Sustainable School CoP. This would allow researchers to look at how schools can support each other and in what ways knowledge moves between schools as well as between the FM team/HEI and multiple schools.

Although this research was clearly focused on working with teachers to enhance their ESD practice, there is a significant need to ensure that this filters down to pupils and that pupils' participation is maximised as a result of the model. This research showed that pupil participation did increase according to the teachers, but it is essential that this participation extends to choice in EMS topics and projects to be undertaken, so as to ensure that action competence can be developed. Also, situated cognition played a key role in engaging the teachers with the EMS and there is scope to develop this approach with pupils whereby the EMS becomes the authentic tool for situated activity. This would address Brown *et al.* (1989) call for pupils to '*be exposed to the use of a domain's conceptual tools in authentic activity – to teachers acting as practitioners and using these tools in wrestling with problems of the world*' (p34).

A number of other avenues for inquiry were also highlighted in this research. The theme of place emerged strongly in the qualitative data of the case study and it clearly influenced the teachers work and vice versa. However, it appears that the built and natural environment are still separate entities in the minds of these teachers which is in direct contrast to research on children's perceptions of their school sites where they view the building and grounds as a continuous whole (Titman, 1994). Investigating teachers' perceptions of the built and natural environment within the theme of 'place' would have interesting connotations for teaching and learning, because if they could duplicate pupils' more holistic view of environment, they could leverage this for ESD.

As discussed in section 9.1.1, reflexivity was a significant part of this research and my background in teaching influenced this research in a number of ways. The question was raised 'would knowledge have flowed in the opposite direction (i.e. into the FM CoP) had someone else played the role of broker?' Therefore, to maximise the potential of the HEI in the

Extended CoPs model, it is important to investigate this model with more than one social actor from the HEI, ideally one actor from the School of Education and one from Built Environment. This may give more balance to the situated knowledge in both CoPs and open up the opportunity for transfer in both directions.

Other potential applications for this model were outlined in the last chapter in section 9.2.3 and there is research potential in each variation outlined. Investigating these adapted models has the potential to address knowledge in the area of sustainability while simultaneously adding to CoPs theory.

10.4 Limitations.

It is recognised that there were a number of limitations to this research project. First, while the single case study was justified in Chapter 3, there were a number of issues pertinent to this school that would need to be investigated elsewhere to increase generalization. For example, this school had a particularly energetic and charismatic leader in the school principal. As the role of the principal (or key leader) emerged as such an important role, it will be very important to further investigate the impacts of differing leadership styles on the implementation of this model. This is an element that will critically test the model as more authoritarian leadership styles may lead to power inequalities that would hinder knowledge sharing.

Another aspect of this school that would have affected the implementation of the model was that the school had a relatively small staff. Although this is reflective of many Irish schools, it is possible that as staff numbers increase, full participation may become more difficult. Exploring the model with different schools would help explore this issue more fully.

A final limitation of this study is the issue of researcher bias. Although reflexivity was specifically addressed, and every attempt was made to address pre-conceived ideas that I held, it is acknowledged that my background as a teacher did affect the way in which this research was carried out. Further investigation into this model, particularly research that includes other HEI actors, would help identify the limitations this may have placed on the model.

10.5 Final Comments/Thoughts.

As outlined in the introductory chapter of this thesis, our planet faces a multitude of challenges including climate change mitigation, reversal of environmental degradation and ensuring equity across a range of social issues. A new way of thinking is required and the journey towards sustainable lifestyles begins with education.

At the beginning of the case study, '*there were needs to be satisfied; consequences to be reached. As they were reached, new needs and new possibilities opened to view and old processes were remade to satisfy them'* (Dewey, 1986b, p. 14). Embedded in a pragmatic paradigm, this research sought to answer questions in a way that would improve the practice of those involved. It was problem oriented and focused on finding solutions to the problems encountered by the participants. As solutions were found, new problems were identified and the process of inquiry began once again. This cycle of inquiry ensured meaningful experience for those involved which led to new learning.

In a vision of sustainability, communities should be well served with public, private and community services (Alexander, 2010) and local schools, being central to communities, have the moral obligation to take on the role as educators and facilitators of ESD. However, schools alone cannot drive the large scale reform that is required and a more connected approach is required (Wheeler *et al.*, 2018). Business and industry play a central role in the social and economic development countries (Brundtland, 1987; UNCED, 1992) but have also been responsible for much of the social and environmental challenges we now face. All sectors, including industry, need to be active in the move towards a sustainable future, and many businesses, such as B+L Waterford, are taking it upon themselves to eliminate waste from production activities and move towards green energy, not only for environmental and social reasons, but also because it makes good business sense. These are the companies that will thrive in a zero carbon, sustainable future and as they work towards this future, they are developing an expertise (such as SFM) that is valuable to the school sector as well as providing a case in innovation for schools to study.

HEIs have the multiple expertise on site that can facilitate the connection of these diverse communities. Partnerships are often advocated as a key to unlocking the know-how required for solutions to sustainability problems and this research presented a model that can structure and facilitate these partnerships.

The challenges we face today require a new approach to learning and living. We need to innovate in how we teach and learn. Innovation requires information and knowledge that can only be gained by crossing the boundaries between communities and sectors (Kimble *et al.*, 2010) and the innovation required for ESD will only be found by extending into the wider community. The Extended CoPs model created an effective framework for enabling HEI actors to identify and locate a knowledge source that benefitted sustainable school practice and it facilitated teachers in the transformation and utilisation of this knowledge for successful EMS and ESD.

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Appendix A

Questionnaire for Primary School Principals and Deputy Principals on Sustainable Management of Building and Grounds.

Please tick the box that you feel most suits your opinion in relation to each statement.

	Strongly disagree	Disagree	Don't know	Agree	Strongly Agree
Sustainable management of the school building and grounds is an area of high priority.					
Sustainable or 'green' upgrades/refurbishments are included in our School Development Plan. Please provide details at end of questionnaire. *					
Sustainable management of the school building and grounds receives regular attention by the BOM					
I am confident in managing the energy demands of the school building as outlined by the DES.					
Electricity usage is monitored using the electricity bills.					
The school has an energy policy.					
The electricity meter is read and recorded monthly.					
Green Public Procurement is taken into consideration when purchasing resources for our school.					
I am confident that our school's waste is managed effectively.					
Organic waste produced by the school is composted on the school premises.					
Waste generated by the school is sorted into the appropriate bins.					
I am confident that our school's water is managed effectively, in line with Circular *0046/2008*					
The water taps are regularly checked for leaks and repaired.					
The water meter is read and recorded monthly. (If your school doesn't have a meter tick here)☐					
I am confident that the school grounds are managed effectively.					
There are pollinators on the school grounds or an area designated for attracting bees and butterflies					
The majority of plants/trees on the school grounds are indigenous.					
The school grounds are conducive to outdoor learning					
The Green Schools programme is a valuable initiative in our school.					
ESD (education for sustainable development) is referred to in our Pleann Scoile.					
The Green Schools Programme is effectively implemented in our school.					

Please rank the following duties of a principal in order of importance, with one being the most important of your duties.

Key Accountabilities of the Role of Principal as taken from the report 'Defining the Role of the Primary Principal in Ireland', Drea, E. & O'Brien, J. (2003).	Ranking from 1-7 in order of importance
Administration	
External Relationships (including parents)	
Human Resource Management	
Leadership	
Policy Formation	
Resource Management	
Teaching and Learning	

Please rank the following duties of a principal in order of difficulty, with one being the most difficult of your duties and 7 being the least difficulty of your duties.

Key Accountabilities of the Role of Principal as taken from the report 'Defining the Role of the Primary Principal in Ireland', Drea, E. & O'Brien, J. (2003).	Ranking from 1-7 in order of difficulty
Administration	
External Relationships (including parents)	
Human Resource Management	
Leadership	
Policy Formation	
Resource Management	
Teaching and Learning	

Please rank the following drivers for undertaking sustainable initiatives in your school (eg. Energy saving, water saving, etc). You do not need to rank all five if you feel some of the drivers are not relevant to you.

Drivers	Ranking
Environmental – reducing carbon footprint	
Expertise on staff/BOM	
Financial – if there is a grant available to undertake the initiative	
Financial – saving money	
Image – helps develop the positive image of our school	
Regulations/Legislation	
Teaching and Learning opportunities	
Other (please state)	

Please tick the areas you would most like support in and how you would like to be supported.

	Areas requiring more support.	How would you like to receive this support.		
		Written guidelines	Policy	Outsource to a specialist agency
Energy efficiency				
Waste management				
Water management				
Upgrading of building (eg. Insulation, upgrading windows, etc)				
Managing the school grounds				
Implementing education for sustainable development (ESD) in the curriculum.				

Do you have any other comments/relevant information on this area?

____

____

____

____

* Brief explanation of any sustainable or 'green' refurbishments in your School Development Plan.

And finally…

Are you a: teaching principal administrative principal ☐ deputy principal ☐

Is your school: urban rural ☐

single-sex co-educational

How many class teachers in your school: ☐

If you know the BER rating of your school can you fill it in here: ☐

Many thanks for completing this survey. Further study will be done in this area on a case study basis. If this is something that your school would be interested in partaking in or if you would like any further information regarding the above issues, please contact me at

m.mullinsmoore@gmail.com

Appendix B

Dept. of the Built Environment

School of Engineering

Waterford Institute of Technology

Cork Road

Waterford

24/10/16

Dear Colleague,

My name is Mary Moore. I'm a primary school teacher of 14 years and I am currently conducting PhD. research with WIT and Bausch and Lomb regarding *Sustainability in Primary School Infrastructure and Practices*. This project is being supported by the Facilities Unit in Bausch and Lomb whose engineers are dedicated to running the plant sustainably and having minimal environmental impact in their production practices.

I am writing in regards to enclosed questionnaires for Principals and/or Vice Principals. I fully understand the busy life of a primary school but I would be very appreciative if you could find 5 -10 minutes to fill out these questionnaires and return them to me in the SAE. This data will help me to analyse the current situation/practice in schools and to structure the case studies that are to follow.

Also, I encourage you to note my email address (m.mullinsmoore@gmail.com) and should you wish to contact me for advice/information regarding sustainability projects in your school I will be happy to help.

Kindest regards,

Mary Moore

(B.Ed, M.Sc)

ID:________________

Appendix C

Pre-analysis of Case Study School.

Teachers' Survey.

Section One: Indoor Environmental Quality (IEQ).

On a scale of 1 to 5, (1 = most uncomfortable and 5 = most comfortable), how would you rate the following aspects of your classroom indoor-environment?

		1	2	3	4	5
Light	Natural light					
	Artificial lighting					
Sound	Sound/Acoustics					
Thermal Comfort	Temperature (general)					
	Temperature fluctuations					
	Draughts					
Air quality	Air quality					

Would you like to comment on any of the above aspects of your classroom?

Section Two: Environmental Management Systems (EMS).

On a scale of 1 to 5, (where 1 is strongly disagree and 5 strongly agree), how would you consider the following statements.

	1	2	3	4	5
The Green School Programme is a useful programme for our school					
I fully participate in the Green School Programme in our school.					
The children fully participate in the Green School Programme in our School.					
The Green School Programme is difficult to implement.					
The Green Flag is an important sign of our environmental achievements.					
I incorporate EMS topics (eg. waste, water, energy, etc.) into my teaching.					
Pupils choose topics (eg. energy, biodiversity, etc.) for exploration.					

Section 3: The Built Environment and Education.

Please tick the subjects for which you *regularly use the physical school building* or other aspects of the school's built environment in your teaching.

English		Gaeilge		Maths		History	
Geography		Science		SPHE		Music	
Art		PE		Drama		Religion	

Can you give some examples for the subjects you have ticked?

Section 4: The Natural Environment and Education.

Please tick the subjects for which you *regularly use the school's natural environment* in your teaching.

English		Gaeilge		Maths		History	
Geography		Science		SPHE		Music	
Art		PE		Drama		Religion	

Can you give some examples for the subjects you have ticked?

Section 5: Education for Sustainable Development (ESD).

On a scale of 1 to 5, (where 1 is strongly disagree and 5 strongly agree), how would you consider the following statements.

	1	2	3	4	5
ESD is an important approach to education.					
I regularly incorporate sustainability topics into my teaching.					
It is easy to access teaching resources to support ESD.					
I am confident in engaging an ESD approach to teaching and learning.					
I have the skills to engage an ESD approach to teaching and learning					

Appendix D

Institiúid Teicneolaíochta Phort Láirge   Waterford Institute *of* Technology

Port Láirge, Éire.
T: +353-51-302000
info@wit.ie

Waterford, Ireland.
T: +353-51-302000
www.wit.ie

REF: 17/BE/01

24th October, 2017.

Ms. Mary Moore,
Doon,
Rathronan,
Clonmel,
Co. Tipperary.

Dear Mary,

Thank you for submitting your amended documentation in relation to your project *'Sustainability in Education Infrastructure and Practices'* to the WIT Research Ethics Committee.

Based on the revised WIT ethical approval application form and supporting documentation, I am pleased to inform you that we now fully approve the conduct of this project.

We will convey this decision to Academic Council.

We wish you well in the work ahead.

Yours sincerely,

Prof. John Wells,
Chairperson,
WIT Research Ethics Committee

cc: Dr. Jane Russell-O'Connor
Dr. Paul O'Leary
Dr. Derek Sinnott

Appendix E

Participant Information Sheet.

Sustainability in Education Infrastructure and Practices.

Mary Moore, Ph.D Candidate,

Department of the Built Environment, Waterford Institute of Technology.

You are being invited to take part in a research project. Before you decide, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Please ask if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part. Thank you for reading this.

Research Project Title:

Sustainability in Education Infrastructure and Practices.

Researcher:

Mary Moore, Primary School Teacher and Ph.D Candidate, Waterford Institute of Technology

Research supervisors:

Dr. Jane Russell O' Connor, Department of Architecture and Department of Education, WIT

Dr. Paul O' Leary, Head of Quality Promotion and Policy Development, WIT

Dr. Derek Sinnott, Head of Department of the Built Environment, WIT.

What is the purpose of the project?

This project is being carried out in fulfilment of the requirements for a Ph.D. at Waterford Institute of Technology.

The aim of this project is to investigate sustainable school practice in a primary school that is supported in a HEI-Industry partnership, with WIT and Bausch + Lomb.

Who will be involved in the project?

Along with the researcher and research supervisors, a number of employees from Bausch and Lomb Waterford will be taking part along with teachers and principals from one or two Primary Schools in Co. Waterford.

What will be involved if you take part in this project?

For school staff:

Teachers and principals will be encouraged to engage with sustainable school practice in a Communities of Practice-approach. Prior to the research, school participants will be asked to complete an occupant satisfaction survey based on the school building in which they teach and to complete a pre-research questionnaire (please see the topic guide for details).

Following this, staff at WIT and B+L will present the results of the School Building and Grounds analysis to the school staff and support them in developing and implementing an Environmental Management System (EMS) (work already being completed as part of the Green School programme will be complemented here). EMS implementation will also be used as place based, experiential learning for Education for Sustainable Development (ESD). The B+L plant in Waterford will also be used as a resource for both learning about EMS and for curricular ESD. Teachers/Principals can decide on how best to implement ESD in their own school/classrooms and can choose the level of support they wish to receive.

For data collection and analysis, teachers will be asked to engage in short interviews with the lead researcher, engage in focus groups and keep a reflective journal through the process. Recordings will not be made of interviews and focus groups.

For B+L staff:

Staff from B+L will be encouraged to engage with researchers from WIT in supporting school staff to engage in environmental management of the school. This will include visiting the school, and hosting the school staff at the B+L plant in Waterford.

For data collection and analysis, participants will be asked to engage in short interviews with the lead researcher and to engage in focus groups during the research (see topic guide for details). These interviews will be recorded with the interviewee's permission. Recordings will be stored on a WIT password protected computer and will be held for 5 years in line with WIT's Data Protection Policy. Interviews will be transcribed using NVivo software and again these files will be stored on a password protected computer. The lead researcher and research supervisors will be the only persons with access to these recordings/files.

Do you have to take part?

You are being invited to participate as it is felt that your contribution to this research project could be particularly valuable. However, it is entirely up to you to decide whether or not to take part. Refusal to take part will involve no penalty of any sort. If you do decide to take part you will be asked to sign a consent form. If you decide to take part you are still free to withdraw at any time, without penalty, and without giving a reason.

Will your taking part in this project be kept confidential?

Every effort will be made to ensure that your identity and privacy are protected and that any data that you as the participant deem to be confidential will not be allowed into the public domain. You will not be referred to by name in any documentation related to the project, and personal details by which you could potentially be identified will not be included in any such documentation. Pseudonyms will be used on all interview notes, focus group notes and documents produced in connection with the project, including the final dissertation document and any subsequent related publications. All data will be held securely by the researcher and will not be accessible to any other person at any time.

What will happen to the results of the research project?

The data collected from you and from other participants will be analysed and the results of this analysis will be presented in the form of a dissertation that will be submitted to Waterford Institute of Technology. It is also anticipated that the research will be presented at relevant academic conferences and / or published in relevant academic journals. In all cases, both the true identity of the individual participants and any information which such participants have deemed confidential will be protected and will not at any stage be published.

Who has reviewed the project?

The project has been reviewed by the ethical review body at Waterford Institute of Technology and has been deemed to be ethically acceptable.

Contact details for further information

Should you require any further information on this project or wish to discuss any aspects of it, please feel free to contact me.

Office location: Office C28, School of Engineering, Main Campus, WIT

Phone numbers: 086 2599001

E-mail: mary.moore@postgrad.wit.ie

Appendix F

Participant Consent Form.

Thank you for agreeing to take part in the research project 'Sustainability in Education Infrastructure and Practices'.

Please complete this form, and sign and date.

Name: ______________________________

Address: ______________________________

____

____

____

Phone number: ______________________________

Email address: ______________________________

Please read the following and circle the answers that apply to you.

- Have you received a copy of the Participant Information Sheet and the Topic Guide?

  Yes No

- Have you been given the opportunity to ask questions relating to the project?

  Yes No

- Are you aware that the data you provide throughout this project will be included as part of the research findings and will be contained in the final thesis, and in any related articles and conference presentations?

  Yes No

- Are you aware that participation in this research is completely voluntary and that you can choose to end your participation and/or withdraw your information without giving any reason and without any negative repercussions?

  Yes No

- Are you aware that you will not be named or in any way identified in any of the research findings?

  Yes No

- In full awareness of the issues outlined above, do you consent to participate in this research project?

  Yes No

- Are there any other considerations you would like to highlight in relation to your consent?

- Have you been informed that you will be given the opportunity to read any work based on your contributions and approve its accuracy?

  Yes No

Name (printed in capitals): ______________________________

Signature: ______________________________

Date: ______________

Researcher signature: ______________________________

Date: ______________

To be completed by researcher:

Copies:

One copy for the participant ☐

One copy for the Researcher ☐

Description of written documentation	Date sent to participant	Date received from participant	Approved by participant

Appendix G

Energy conversion factors for Kerosene.

Values taken from https://www.seai.ie/resources/seai-statistics/conversion-factors/

Year 2016/2017

Fuel density for kerosene = 1250 litres/tonne

∴ 2400 litres = 1.92 tonnes

Net calorific value toe/t = 1.0556

∴ 1.92 x 1.0556 = 2.027 toe

Energy conversion factor for 1 tonne of oil equivalent to MWh = 11.63

∴ 2.027 x 11.63 = 23.57MWh

= 23.57 x10^3 = 23570kWh

Year 2017/2018

Fuel density for kerosene = 1250 litres/tonne

∴ 2750 litres = 2.2 tonnes

Net calorific value toe/t = 1.0556

∴ 2.2 x 1.0556 = 2.322 toe

Energy conversion factor for 1 tonne of oil equivalent to MWh = 11.63

∴ 2.322 x 11.63 = 27.00MWh

= 27 x 10^3 = 27000kWh

Year 2018/2019

Fuel density for kerosene = 1250 litres/tonne

∴ 3700 litres = 2.96 tonnes

Net calorific value toe/t = 1.0556

∴ 2.96 x 1.0556 = 3.125 toe

Energy conversion factor for 1 tonne of oil equivalent to MWh = 11.63

∴ 3.125 x 11.63 = 36.34MWh

= 36.34 x 10^3 = 36340kWh

Appendix H

Section Two: Environmental Management Systems (EMS).

On a scale of 1 to 5, (where 1 is strongly disagree and 5 strongly agree), how would you consider the following statements.

	1	2	3	4	5
The new EMS is a useful tool for our school					
I fully participated in the implementation of the new EMS this year.					
The children fully participated in the implementation of the new EMS this year.					
The new EMS was difficult to implement.					
I would like to have external recognition/ accreditation for implementing the EMS this year (e.g. a flag)					
I incorporate EMS topics (eg. waste, water, energy, etc.) into my teaching.					
Pupils choose topics (eg. energy, biodiversity, etc.) for exploration.					