Space and Place

Perspectives on outdoor teaching and learning

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Trött på alla som kommer med ord, ord men inget språk
for jag till den snötäckta ön.
Det vilda har inga ord.
De oskrivna sidorna breder ut sig åt alla håll!
Jag stöter på spåren av rådjursklövar i snön.
Språk men inga ord.

Tomas Tranströmer

Table of Contents

TABLES AND FIGURES

Acknowledgments

My journey to become a PhD candidate in the field of outdoor teaching and learning was not straightforward. However, in hindsight I can retrace the different paths that led me in this direction. As far back as I can remember, I have enjoyed the outdoors. From long summer holidays in the countryside and weekly horseback riding on the outskirts of the city, I developed a strong sense of place in nature as well as both a scientific interest and an aesthetic appreciation for nature. Unsurprisingly, I chose to study biology at the university. My first positions were as a teacher at agricultural upper-secondary schools and as a zoo education officer. The classroom was not the only place for knowledge and learning. My students and I often used nature and the nearby stables, enclosures and animals as places and resources for learning. My third position was as at the university, where I taught biology to pre-service teacher students. By this time, I had added a teaching diploma to my CV. Problem-based learning and fieldwork were often part of the curriculum. My interest in teaching and learning gradually evolved, and a position as a PhD candidate in outdoor education seemed an excellent way to combine my interests in nature and education.

This research was completed under a co-tutelle agreement between Linköping University, Sweden and Macquarie University, Australia. I would like to thank my supervisors from both institutions whose expertise and friendliness made this PhD journey highly enjoyable and rewarding. My thoughts are with my first supervisor, Lars Owe Dahlgren, who sadly passed away in 2011. His expertise as well as warm-hearted and open-minded personality will always be remembered. I am grateful for the opportunity he gave me to conduct part of my research in Australia. The journeys down under evoked a lifelong love-story with Sydney and Australia. I am convinced that this experience also had a significant impact on the path this thesis took with its perspective on ‘place’. The Sydney sandstone bush, the smell and the sounds of the whip-birds and cicadas will always have a place in my heart.

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To my beloved family and dearest friends, thank you for just being there.

Emilia Fägerstam

Linköping, August, 2012

List of papers

This thesis is based on the following papers:

I. Fägerstam, E. (2012). Children and young people's experience of the natural world: Teachers' perceptions and observations. *Australian Journal of Environmental Education, 28(1),* 1-16.

II. Fägerstam, E., & Blom, J. (2012). Learning biology and mathematics outdoors: effects and attitudes in a Swedish high school context. *Journal of Adventure Education & Outdoor Learning,* DOI: 10.1080/14729679.2011.647432.

III. Fägerstam, E. (2012). *High school teachers' experiences of the educational potential of outdoor teaching and learning.* Manuscript submitted for publication.

IV. Fägerstam, E., & Samuelsson, J. (2012). Learning arithmetic outdoors in junior high school – influence on performance and self-regulating skills. *Education 3-13: International Journal of Primary, Elementary and Early Years Education,* DOI: 10.1080/03004279.2012.713374.

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1. Introduction

Currently, many countries have a growing interest in and awareness of the outdoor environment as a valuable complement to traditional classroom teaching (Dahlgren, Sjölander, Szczepanski & Strid, 2007; Jordet, 2010; Martin, 2010; Mårtensson, Lisberg Jensen, Söderström & Öhman, 2011; Rickinson et al., 2004). However, outdoor education is a multifaceted field of research and education that includes adventure education, leadership skills, tranquil outdoor life '*friluftsliv'*, and human-nature relationships as well as fieldwork and other school-based learning in different subjects and settings.

The aim of this thesis is to explore teachers' and students' experiences and perceptions of outdoor teaching and learning. More specific, the aim is to explore the consequences of regular school-based outdoor teaching and learning in a junior high school context. An additional aim was to explore how urban children and students experience nature, through teachers' observations. The context for these empirical studies includes Sweden and Australia, two countries with an outdoor education tradition (Martin, 2010; Sandell & Öhman, 2010).

Possible advantages from the outdoor environment include its potential to encourage meaningful learning by moving between the abstract and concrete as well as transforming experience into knowledge through reflection and communication (Dahlgren & Szczepanski, 1998; Jordet, 2010). Traditional text-based classroom learning as the only source of knowledge was challenged by the American pragmatic philosopher John Dewey at the beginning of the 20th century (1915/2011). His perspective on learning as a continuous interplay between experience and interaction, on one hand, and reflection, on the other hand, significantly influenced outdoor education literature, although approaches and definitions differ between countries. Despite the long history of calls for increased out-of-classroom learning, Thorpe and Mayes (2009) echoed Dewey and argued that we must rethink context and experience in pedagogical practice, as follows:

> Pedagogy/…/needs to build connections across different areas of experience, between the classroom, the workplace, the home and the social life, where these connections can provide points of engagement for learners and ways of enabling them to draw on the resources of their own experience. (p. 161)

Although Thorpe and Mayes do not explicitly relate to outdoor education, the outdoor environment may enable students to build connections across different areas of experience and provide points of engagement for learners, if this is considered important.

Few studies have explored the consequences of regular school-based outdoor teaching and learning (Rickinson et al., 2004; Thomas, Potter & Allison, 2009; Thorburn & Allison, 2010). Previous longitudinal school-based research on outdoor teaching and learning has predominantly been conducted in a primary school context (Jordet, 2007; Mygind, 2005), and previous research on outdoor teaching and learning in a high school context was primarily from environmental education centres (e.g., Ballantyne & Packer, 2009) or field studies in nature (e.g., Rozenszayn & Ben-Zvi Assaraf, 2009). Thus, by researching regular school-based outdoor teaching and learning in a high school context, my intention with this thesis is to aid in filling this gap in the literature.

One of the studies composing part of this thesis concerns children's experience with nature and teachers' perceptions of the potential advantages from a nature experience. Several scholars have discussed a widely held belief that children's contact with nature is decreasing (Kellert, 2002; Lisberg Jensen, 2011; Malone, 2007; Sandberg, 2012; Tranter & Malone, 2008). Different arguments underlie a focus on children's contact with nature, such as health aspects (Söderström, 2011); affective, cognitive and evaluative development (Kellert, 2002); as well as environmental concerns (Lisberg Jensen, 2011, Sandell & Öhman, 2012). However, few studies have explored how children experience nature, and the study herein aims to contribute to this field of knowledge.

Aims for the thesis

There is a need for more school-based research on outdoor teaching and learning, particularly in high school, and the overall aim of the thesis is to explore the impact of regular school-based outdoor teaching and learning in a junior high school context. A second aim is to explore how Australian environmental education centre officers, who meet large number of students each year, and high school teachers perceive urban children's experience of nature as well as how they perceive the potential advantages from a nature experience. The research questions addressed in this thesis are as follows:

1) What are the observations and perceptions of teachers regarding how children experience nature? (paper I)

2) What is the potential of nature experiences according to teachers? (paper I)

3) What are the influences on students' performance in biology, and what are the attitudes toward outdoor teaching and learning after being partially taught outdoors? (paper II)

4) Based on one year of experience, what are teachers' perceptions of the educational potential of outdoor teaching and learning? (paper III)

5) How did teachers' perception of outdoor teaching and learning differ after one year of experience compared with their initial perceptions? (paper III)

6) What are the influences on students' performance in arithmetic and self-regulation skills after being partially taught outdoors? (paper IV)

Structure of this thesis

This thesis will continue with a background that includes an overview of research on outdoor teaching and learning (chapter 2). This chapter will also review nature experience in relation to outdoor education. Chapter 3 presents the theoretical framework. This is the result of an entire research process, wherein empirical work and literature mutually guided construction of the theoretical framework, which informed final interpretation of the results. This chapter is followed by a methodology chapter that describes and discusses research design, methods for data collection and analyses (chapter 4). Chapter 5 comprises a short summary of the findings as well as a summary of each paper. The thesis ends by revisiting the results and discussing the overall interpretation of the findings in light of the theoretical framework (chapter 6). Enclosed are the four articles submitted to or published in international journals.

2. Background

As indicated in the introduction, outdoor education is a broad and multifaceted research area. Therefore, this background is focused on school-based curriculum-related research on outdoor teaching and learning, which is the primary focus of this thesis. For the Australian study, the focus is on nature experience, and accordingly, the background will also cover the relevant research on children's experiences with nature. The chapter begins with a discussion on the 'outdoor education' concept and clarifies how it is defined in this thesis.

The concept of outdoor education

As a concept, structured learning activities conducted outside the classroom is often confused (Thorburn & Allison, 2010; Zink & Burrows, 2008). Outdoor education is likely the most-used concept, but out-of-school learning, out-of-classroom learning, and outdoor learning have been used synonymously, or with different meanings. With its roots in social welfare, camping education and natural history, outdoor education encompasses related fields, such as wilderness, adventure, experiential as well as inter- and intra-personal education (Bisson, 1996; Rickinson et al., 2004; Nicol, 2002 a, b; Thomas, Potter & Allison, 2009). A classic definition of outdoor education was provided by Donaldson and Donaldson in 1958, when they stated that 'outdoor education is *in*, *about*, and *for* the outdoors' [original emphasis] (cited in Rickinson et al., 2004, p. 17).

In many ways, this definition is still valid, but it is somewhat limited. To many educators, activities such as visits to museums and factories could fall under the outdoor education umbrella even though they are conducted indoors. The rationale is that the experience-based approach and out-of-classroom context, which are significant to outdoor education, are also valid for such activities. An additional limitation is that outdoor learning is not only learning about the outdoors. Learning about the environment outdoors is definitely one important aspect of outdoor environmental education (Nicol, 2003), but there are many other goals, including academic, personal and social. A broader definition was proposed by Priest 1986, who stated the following:

> Outdoor education is an experiential process of learning by doing, which takes place primarily through exposure to the out-of-doors. In outdoor education the emphasis for the subject of learning is placed on

> relationships, relationships concerning people and natural resources. (p. 13, cited in Eaton, 1998)

For his thesis, Eaton (1998) offered the following: 'outdoor education will be defined as all school-related academic education which takes place outdoor' (p. 9).

Notably, there is a great difference in nature and the scope of outdoor education among countries (Bentsen, Mygind & Randrup, 2009; Bentsen, SØdergaard Jensen, Mygind, & Barfoed Randrup, 2010; Maeda, 2005; Martin & Ho, 2009), and various cultural aspects are important factors in students' outdoor experience (Nakagawa & Payne, 2011). In the Scandinavian context, outdoor education is often school-based learning out of the classroom, which is consistent with Eaton's definition (1998). The place where learning transpires is the nearby natural or cultural landscape or school grounds often with a cross-curricular approach (Bentsen, Mygind & Randrup, 2009; Jordet, 2007; Mygind, 2005; Szczepanski, 2008). The research group at the National Centre for Outdoor Environmental Education (NCU), Linköping University proposed the following definition to describe outdoor education in the Swedish context:

> Outdoor education is an approach to provide learning in interplay between experience and reflection based on concrete experience in authentic situations. Outdoor learning is also an interdisciplinary research and education field which involves, among other things:
>
> The learning space being moved out into life in society, the natural and cultural environment
>
> The interplay between sensory experience and book learning being emphasises
>
> The importance of place being underlined (NCU, 2004).

In this thesis, the 'outdoor teaching and learning' concept is used to avoid the confusion sometimes associated with the 'outdoor education' concept (Thorburn & Allison, 2010). As implemented in the empirical research for this thesis, outdoor teaching was primarily disciplinary, and its primary focus was academically oriented activities. The learning space was primarily the school grounds, but natural and cultural environments were also used, particularly in paper I. Accordingly, outdoor teaching and learning are consistent with Eaton's (1998) definition because the school-related academic education transpired outdoors.

School-based outdoor teaching and learning

The setting for school-based outdoor teaching and learning is school grounds or urban or natural environments near the school. Nature can be the focus of learning for subjects such as biology or environmental education. It can also be a convenient place to go without specific site-related aims. Students can learn mathematics outdoors at many different sites. The following section provides an overview of previous research on outdoor teaching and learning as well as how nature is perceived as significant in outdoor education.

Previous research on outdoor teaching and learning in secondary school

The majority of research on outdoor teaching and learning in a secondary school context was conducted on classes travelling to particular sites, such as environmental education centres, natural parks or other natural or urban places, participating in an activity, and soon thereafter, they are quantitatively evaluated for academic or affective consequences. Examples include studies in ecology where students that attend an outdoor programme (Eaton, 1998; Prokop, Tuncer & Kvasnicak, 2007) or participate in field work (Hamilton-Ekeke, 2007; Manzanal, Barreiro & Jiménez, 1999) made greater cognitive gains than the control groups. A more qualitative approach to explore the influence of the outdoors in learning ecology was discerned in a study by Magntorn and Helldén (2007), where they explored 13- to 14-year-old students' abilities to transfer ecological knowledge between ecosystems. They found that human influence and abstract processes, such as energy flow and matter cycling, were difficult to understand in a new ecosystem. They also researched tertiary students' perspective on learning in nature (Magntorn & Helldén, 2005). Field trips were perceived as a significant part of learning ecology because the students could explore, discuss and link theory to practice. An additional qualitative study was conducted by Rozenszayn & Ben-Zvi Assaraf (2009), who revealed that collaborative outdoor learning in ecology had a positive effect on student's knowledge construction and long-term knowledge retention. Openshaw and Whittle (1993) questioned the effectiveness of ecological field trips and argued that students' problems with ecological concepts must be understood first for a field trip to have an impact, and an excessively unstructured learning environment may negatively impact the learning outcome. However, Stewart (2003) found that students' long-term recollections from learning in a botanical garden were linked to their teachers' expectations. Experience-based learning at environmental education centres seem to positively influence student learning, but the most effective learning experiences are likely those that

integrate outdoor and reflexive classroom learning (Ballantyne & Packer, 2002, 2009; Ballantyne, Anderson & Packer, 2010).

Social and affective aspects

Few studies have explored secondary students' attitudes toward outdoor learning. A three-year long action study of six English secondary schools involved in improving their school grounds demonstrated the benefits for participating students, such as increased self-confidence, decision-making skills and collaboration (Rickinson & Sanders, 2005). Participating in the project benefited curriculum-related learning, particularly the technology curriculum. Other reported effects from school grounds and community projects include stronger links between the school and broader community as well as a greater sense of belonging and responsibility (Rickinson et al., 2004).

Studies that have explored the affective consequences of environmental education centres and botanical gardens suggest that students appreciate outdoor teaching and learning (Ballantyne & Packer, 2002; Ballantyne, Anderson & Packer, 2010; Stewart, 2003). Uitto, Juuti, Lavonen and Meisalo (2006) showed that out-of-school nature experiences was the most important factor that correlated with an interest in biology for Finnish secondary students. In a study on mathematics outdoor camps in Malaysia, a country where students are rarely taught in outdoor settings, students valued learning mathematics outdoors and enjoyed the new learning environment (Noorani et al., 2010).

Research in pre-school and primary school

The trend with quantitative evaluations of knowledge and attitudes, from short-term outdoor programs, is found also in the primary school contexts (Cachelin, Paisly & Blanchard, 2007; Dimopoulos, Paraskevopoulos & Pantis, 2008; Nundy, 1999; Powers, 2004) with mixed results. Greater cognitive gains from outdoor programs were observed than with classroom learning (Cachelin, Paisly & Blanchard, 2007), but student background had a greater effect than the length of the visit (Powers, 2004). Nundy (1999) emphasised the relationship between cognitive and affective influences and argued that they are intertwined and provide a bridge to higher-order learning. There are also a number of qualitative studies that have explored the academic, social and affective consequences (Beames & Ross, 2010; Byrd et al., 2007; Dismore & Bailey, 2005; Carrier, 2009; Miller, 2007; Moffet, 2011; O'Brien & Murray, 2007; Waite, 2011). In response to the critique that outdoor education often is fragmented and decontextualised (e.g., Brookes,

2002), Beames and Ross (2010) studied students' learning in 'outdoor journeys', which transpired in the neighbourhood surrounding the school. They reported that journeys outside the classroom support cross-curricular learning connected with the location. For example, a real-life situation outdoors was reported as valuable in children learning mathematics (Dismore & Baily, 2005; Moffet, 2011). Several authors have emphasised the affective dimension of outdoor teaching (Dismore & Baily, 2005; Moffet, 2011, O'Brien & Murray, 2007; Waite, 2011). Children's enjoyment and interest were reported as significant consequences of outdoor teaching, and student-centred learning and task ownership also seem to be important consequences (Beames & Ross, 2010; Waite, 2011).

Two longitudinal school-based case studies were conducted in Scandinavian primary schools (Jordet, 2007; Mygind 2005). Their findings suggest that an outdoor environment can be used for all subjects and support affective and social advantages. Children's engagement in outdoor learning seemed not to decline during a three-year-long forest school project (Mygind, 2009). Although the sample was small and the results were ambiguous at times, Mygind's results indicate that well-being and social relationships were favoured in the school forest setting. Children's statements on aspects of teaching and learning did not differ significantly.

Teacher's perceptions on the potential of and barriers to outdoor teaching

One focus in this thesis is teachers' experiences and perceptions. Therefore, it is relevant to summarise earlier research on teachers' perceptions on the potential of and barriers to outdoor teaching. A number of studies have reported teachers' perceptions on advantages of and barriers to outdoor teaching and learning (Bentsen et al., 2010; Bixler & Floyd, 1997; Dyment, 2005; Ernst & Tornabene, 2012; Han & Foskett, 2007; Moffet, 2011; Rickinson et al., 2004; Tal, 2001; Tal & Morag 2009; Simmons, 1998; Smith, 1999; Szczepanski et al., 2007; Taylor, Power & Rees, 2010; Waite, 2011). In summary, well-documented teachers' perceptions of barriers include lack of confidence, time and resources, as well as over-crowdedness and inflexible curricula. Disciplinary issues, such as students' behaviour and lack of interest, are also a concern to teachers. Safety concerns are sometimes reported as a barrier, although not in the Scandinavian context. One conclusion is that fieldwork and learning on school grounds are not frequently practiced (Dyment, 2005; Han & Foskett, 2007; Taylor, Power & Rees, 2010). The frequency of outdoor teaching typically decreases with student age (Dyment, 2005; Jordet, 2010; Bentsen et al., 2010) perhaps

because primary schools are more effective at using their school grounds and local areas, which reflects greater flexibility in the schools' timetables (Taylor, Power & Rees, 2010).

However, despite the barriers, teachers' have also discussed the many advantages. There does not seem to be a limitation on the type of subjects that can be taught outdoors (Dyment, 2005; Jordet, 2007; Szczepanski, Malmer, Nelson & Dahlgren, 2007), but science seems to be the most regularly taught subject according to Dyment. Acknowledging national differences in context and approach, the assumptions for the potential advantages of outdoor teaching and learning are general.

Several rationales were set forth in an intervention study from Sweden on outdoor teaching in primary school (Szczepanski et al., 2007). Overarching answers from teachers' were that the outdoor context improved meaningful, multidisciplinary and multisensory learning. Outdoor learning facilitated links between theory and practice, and the value of the out-of-school context as 'authentic and real' were other reported advantages. However, the answers were given on a general level. In the Danish forest school project conducted by Mygind and colleagues (2005), teachers' found that nature improved cooperative, experiential and inquiry-based learning, but the inquiry-based and student-centred approaches often collided with teachers' intentions and plans for curriculum goals (Stelter, 2005). The potential for outdoor learning to promote experience-based learning opportunities in 'real-life' contexts are further supported by Dyment (2005), Jordet (2007), Moffet (2011) and Waite (2011).

Sweden and Norway have a long tradition of public access to nature, which likely is an important aspect in using the outdoors for learning purposes (Sandell & Öhman, 2010).

Place-based education

Discussions on context in outdoor literature primarily refer to context in a narrow sense as the immediate setting for learning. The students' cognitive and affective gain facilitated by the immediate physical context is the primary focus. However, context can also be understood in a broader sense as the community and society that surround the student. An educational tradition that emphasises the role of teaching and learning in nearby places, thereby connecting schools with the community and society, is place-based education (Gruenwald, 2003 a, b; 2005, Harrison, 2010; McInerney, Smyth & Down, 2011; McKenzie, 2008; Payne & Wattchow, 2008; Smith, 2002; Sobel, 2004; Stewart, 2008; Wattchow, 2008; Woodhouse & Knapp, 2000).

The rationale for adopting place-based education in schools is that it primarily

> …creates opportunities for young people to learn about and care for ecological and social wellbeing of the communities they inhabit and the need to connect schools with communities as part of a concerted effort to improve student engagement and participation. (McInerney, Smyth & Down, 2011, p. 5)

McInemy, Smyth and Down (2011) also argue that place-based education may acknowledge students as producers rather than consumers of knowledge and provide them with knowledge and experience to participate in democratic processes. Gruenewald (2003a), who is a prominent figure in place-based education, draws on Freire and critical pedagogy but argues for a greater emphasis on ecological issue and challenges in contrast to the social and cultural aspects of education in critical pedagogy. Acknowledging cultural and historical national differences in context, the community-focused approach, in which students learn in and about their local area, is closely related to the rationales for much of the outdoor education literature and practice (Harrison, 2010; Payne & Wattchow, 2008; Stewart, 2008; Wattchow, 2008; Woodhouse & Knapp, 2000). Jordet (2010) discusses broad and narrow rationales for outdoor education. Place-based education can be compared to his broad understanding.

However, this approach raises many unresolved questions. What 'place' means in educational research is difficult to ascertain. Nespor (2008) and Stevenson (2008) criticise the focus on local places in an era of globalisation and theories on place-based education as vague and inconsistent. A question not often discussed in the educational context, but that Stevenson ventured to ask, is

> What is meant by 'place': the physical, biophysical, social, or cultural, or all of these? Which aspects or dimensions of the local and place are important pedagogically to engage students? (p. 354)

Van Eijck and Roth (2010) view notions of '*the* place' as problematic because everyone has individual experiences of a place. They further discuss the problematic tension between natural, scientific and socio-cultural approaches to place and view place as

> …the lived entity that results from a dialogical transaction between a community and its material environment at a particular moment in

> cultural-historical time and which hence shapes and is shaped by their identity. (p. 869)

An additional dilemma is the general assumptions on relationships between place, identity and belonging despite the uncertainty and complex associations (Lewicka, 2011; McInerney, Smyth & Down, 2011). Place might be an ambiguous concept, but it is likely also a concept that requires more attention. Nespor (2008) asks for more empirical research in the field; Stevenson (2008) also considers place to be important and argues that education has the challenge to aid young people in constructing healthy identities for themselves and with their communities.

As indicated above, nature is not the only place for learning in the outdoor teaching approach. However, nature is often assumed a 'good' place; the following section will provide insight into the role of nature in outdoor teaching and learning.

Nature experience and environmental concern

The role of a nature experience is also an element in outdoor and environmental education research. A term used to describe competency in knowledge, beliefs and/or philosophies on the environment is 'ecological literacy' (Cutter-Mackenzie & Smith, 2003; Orr, 2004). According to Cutter-Mackenzie and Smith, the object of Orr's theory of ecological literacy is not developing a particular view of the environment but a complex understanding of various philosophies that lead to ecological sustainability. A primary concern for many scholars of environmental and outdoor education is recognising the educational value of experience with the natural environment (Cohn, 2011; Higgins, 1996; Lugg, 2007; Orr, 2004; Nicol, 2003; Sandell & Öhman, 2010; Sandell & Öhman, 2012; Stewart, 2006; 2011; Stewart & Müller, 2009). From a social ecological resilience perspective (Chapin et al., 2009; Folke, 2006), researchers have argued that emotional and aesthetic experiences in nature are valuable aids for students to develop a sense of belonging or connectedness to nature.

From an Australian perspective, Stewart (2006, 2011) as well as Stewart and Müller (2009) suggest that knowledge of natural history (e.g., to read a landscape, including knowledge on local flora, fauna and ecology) is fundamental for a country where most ecosystems have been in poor condition since the European settlement. From a Swedish perspective, Sandell and Öhman (2010) discuss the long tradition of direct encounters with nature in Sweden because it has a tradition of public access to nature in common law. They suggest several potential educational advantages from

encounters with nature, including an experienced-based meaning of nature and a relational ethical perspective. According to Sandell and Öhman (2012) nature experiences can have different motives. First, they can have instrumental value where a nature experience is a means for syllabus, health or social objectives. Nature might be the preferred place, despite available alternatives. Second, nature experiences can have intrinsic value and be difficult to replace with indoor or urban places. Experiencing nature is an aim in itself and a significant factor in developing, for example, environmental concerns.

Many scholars have questioned the oversimplified belief that if children experience nature they will appreciate and care for it (Kollmus & Agyeman, 2002; Sandell & Öhman, 2012), which is the subject of a viable debate without much consensus. There is no clear relationship between knowledge and attitudes as well as environmental concerns, and the assumption that knowledge leads to pro-environmental attitudes/values and ultimately to environmental concerns has proven to be difficult to verify (Heimlich, 2010; Hungerford & Volk, 1990; Kollmus & Agyeman, 2002). Studies have also supported the relationship between a connection to nature and pro-environmental behaviour. Distinguishing between attachments to natural and civic places, Scanell and Gifford (2010) showed that natural, not civic, place attachment predicted pro-environmental behaviour, and Vaske and Kobrin (2001) showed that place attachment to a local natural resource influenced environmental behaviour. Similarly, Gosling and Williams (2010) found that conservation behaviour among farmers increased with an increased connectedness to nature. However, the studies were not conducted in an educational context, and the participants were adults.

To develop a 'connection to nature index' and measure children's connection to nature, Chen-Hsuan Cheng and Monroe (2010) found that four factors were associated with children's connection to nature. They were enjoyment of nature, empathy for creatures, a sense of oneness and a sense of responsibility. Their results further showed that children's connection to nature, their previous experience in nature, their perceived family's value towards nature, and their perceived self-efficacy positively influenced their interest in performing environmental friendly behaviours. Student's knowledge of the environment and nature near their home correlated with a connection to nature, which thus indirectly influenced their interest in environmentally friendly practices. Thus, according to the 2010 study, there is likely a relationship between experience with nature, a connection to nature and an interest in environmental concerns.

Human-nature relationships

Human relationships with nature can be perceived as inherent and biological or socially constructed (Pedersen & Viken, 2003). It is beyond the scope of this thesis to engage in this debate, but the 'biophilia hypothesis' (Kellert & Wilson, 1993) has inspired many scholars, who suggest an evolutionary origin in human affiliation and an emotional response toward nature and animals. The emotional response can be considered a 'functional subunit of our adapted mind' (Verbeek & de Waal, 2002, p. 1). Kellert (2002) suggests that nature experiences are important for children's cognitive, affective and evaluative development but acknowledges the need for future research to test this concept. Kellert (ibid.) discussed three types of nature experiences in assessing the possible developmental impact on children: direct, indirect and vicarious. Children directly experience nature when engaging physically with nature and nonhuman species in outdoor play or other unstructured activities in parks, forests or backyards. Indirect experience involves more restricted physical contact. School programs and visits to botanical gardens are examples of indirect nature experiences. A vicarious or symbolic experience is when children learn about nature from media and text without physical contact. Kellert (ibid.) argued that children's direct experiences are decreasing and, to a large extent, contemporary children depend on indirect and vicarious experiences to learning about nature. However, the consequences of this deficiency were difficult to conclude from his work. His view of children's decreased direct contact with nature is supported by additional scholars (Louv, 2008; Malone, 2007; Sandberg, 2012; Tranter & Malone, 2008). When exploring urban children's contact with nature, Sandberg (2012) concluded that frequent contact with nature was rare and schools have an important role in facilitating nature experiences for children. He also concluded that children's relationships to nature are seldom a focus in childhood studies, at least from a human geography perspective.

Concluding comments and reflections

In reviewing the available research, it is clear that studies on regular school-based teaching and learning are limited. Several scholars have argued that more school-based research is necessary (Jordet, n.d.; Rickinson et al., 2004; Thomas, Potter & Allison, 2009; Thorburn & Allison, 2010). Previously, school-based longitudinal studies were conducted in primary schools (Jordet, 2007, Mygind, 2005). To the best of my knowledge, no research has explored outdoor teaching and learning on a regular basis in a secondary school context. Research in secondary schools focuses on ecology and environmental education, and information on the impact of outdoor teaching

and learning on additional subjects is limited. However, research on learning in an outdoor environmental education centre has shown that students appreciate outdoor learning, and those students often perform better on tests after their outdoor learning experience compared with peers who learned the same topic in a classroom situation. Thus, well-structured outdoor teaching can positively impact the content that students retain (cf. Rickinson et al., 2004; Öhman, 2011). However, the research area is diverse and not without methodological weaknesses, as also Rickinson et al. (2004) concluded.

Teachers perceive many barriers to outdoor teaching, such as lack of time, confidence and resources, but they also see potential advantages, such as promoting meaningful learning in 'real-life' situations. This thesis will hopefully contribute to a better understanding of the potential advantages and limitations for outdoor teaching in a junior high school. Certain scholars have critiqued many general outdoor education programs and have perceived such programs as fragmented, decontextualised (Brookes, 2002; Beames & Atencio, 2008) and 'high in cost but low in transfer value' (Thorburn & Allison, 2010, p. 101). One blind spot in these analyses is the relationship between indoor and outdoor learning (Rickinson et al., 2004). Many studies focus only on the outdoor experience and do not relate it to previous or later indoor learning. The design of this thesis is longitudinal, where a school is followed for more than one year, which supports exploration of long-term consequences and whether school-based outdoor teaching suffers from fragmentation and 'low transfer value' or if it can easily be implemented in daily work.

There are different arguments related to the value of children's nature experience, but a common thread is an assumption about the role of direct and indirect experience in promoting a sense of belonging, knowledge, ethics and values that promote behaviours leading to social-ecological resilience. The relationship between experience with and a connection to nature, values as well as behaviour is ambiguous, but certain studies indicate a relationship. However, there is no strong evidence to support such a relationship, and the relationships between different variables are unclear. However, children's connection to nature continues to inspire research, and there is a widespread societal assumption that connecting children to nature is important (Halldén, 2009; Lisberg Jensen, 2011). To enable children's experience with nature is also a keystone of outdoor education. Previous research indicates that contemporary children have less contact with nature (Malone, 2007; Sandberg, 2012; Tranter & Malone, 2008), but the way this is manifested is seldom a focus of the research. This thesis aims to contribute to this field of knowledge.

3. The theoretical framework: learning and place dimensions

Following the logic of grounded theory (Bryant & Charmaz, 2007a; Glaser & Strauss, 1967), the theoretical framework for this thesis has evolved as a continuous interplay between empirical work and the literature. Sfard (1998) wrote that 'the relationship between theory and data is dialectic in that they have a tendency for generating each other' (p. 12), which is true for the process used herein. The primary focus of this research, school-based outdoor teaching and learning in high school, has not been well-researched, and many different theories and assumptions underlie the rationale for outdoor encounters, which has resulted in the need for a flexible and evolving framework. The research has gradually evolved through an abductive approach (see chapter 4 for an extended description). The results led to a search for theories that are relevant further understanding this field, and the literature guided further analyses, which finally resulted in my interpretation of the four studies combined.

To a large extent, this chapter was inspired by Knud Illeris (2002, 2007) and Peter Jarvis (2006). Illeris and Jarvis are two educational theorists who emphasise the multidimensional nature of learning. They stress that individual as well as social dimensions must be considered to understand human learning. There is always *someone* learning *something*, or in other words acquiring knowledge, understanding, skills, attitudes or insight. However, there is also an interactive process between the learner and the social and societal environment (Illeris, 2007). This might seem like a common sense understanding of learning, but in educational discourse, often either the individual/cognitive or socio-cultural aspects are emphasised. One important notion is that, in the following discussion, the whole person learns and that body and mind are perceived as inseparable (Damasio, 1994; Jarvis, 2006).

Three dimensions of learning

Illeris (2002, 2007) emphasises that three dimensions of learning should be considered when trying to understand learning. According to Illeris (2002), learning simultaneously involves a cognitive, emotional, as well as social and societal dimension. In his later works, he instead refers to the three dimensions as content, incentive and environment (Illeris, 2007). 'Environment' has a material dimension, but Illeris (ibid.) regards the nature

of interaction with the material environment as overwhelmingly social and societally transmitted. The process of learning involves content and incentive, and the social dimension relates the interaction between individuals and the environment (Illeris, ibid.). The three dimensions will be referred to as content, social and emotional in this thesis.

Jarvis is another educational theorist who stressed that an interdisciplinary approach is necessary to study learning and included cognitive, affective and social dimensions of learning in his theories (2006). According to Jarvis, it is impossible to divorce our philosophical or psychological thoughts on learning from the sociological aspects; 'all learning theories must be inter-disciplinary' (2006, p. 52). One distinction between Illeris and Jarvis is that Jarvis emphasised individual activity and experience as a third dimension through which we learn in contrast to social/environmental experience, which is the third dimension in Illeris' work. However, according to Jarvis (ibid.), cognition, emotion and action are all affected by social context. Jarvis (ibid.) defines human learning as

> …the combination of processes whereby the whole person –body (genetic, physical and biological) and mind (knowledge, skills, attitudes, values, emotions, beliefs and senses): experiences a social situation, the perceived content of which is then transformed cognitively, emotively or practically (or through any combination) and integrated into the person's individual biography resulting in a changed (or more experienced) person. (p. 13)

According to Jarvis (ibid.), any combination of thinking, doing and experiencing emotion could compose different forms of learning. They are not only reactions to previous experiences but they can also look to the future. Jarvis further argues that the distinction between cognitive and practical learning is over-simplified if not false. Having just concluded that learning comprises three dimensions that are difficult to separate, I will attempt to disaggregate these dimensions in the following section for the sake of simplicity.

The content dimension of learning

A cognitive/constructivist approach to learning emphasises that content, knowledge, and concepts are entities that can be acquired by the learner and possessed internally. When knowledge is acquired, it can be applied, shared and transferred (Sfard, 1998; Vosniadou, 2007). Building on Piaget's theory, from this perspective, learning is as an inherently constructivist process in which individuals structure and organise new experiences into mental schemas that relate to previously established structures (Illeris, 2002, 2007;

von Glasersfeld, 1989). The constructivist approach excludes any form of learning as a transmission or filling process, and there are two central concepts of importance, assimilation and accommodation. Assimilation relates to incorporating new influences into existing structures of knowledge or modes of understanding. Accommodation relates to restructuring established structures of knowledge or modes of understanding in accordance with new conditions. Learning from a constructivist perspective is linking new concepts with pre-established concepts, and the individual strives to maintain equilibrium during interactions with the surrounding world. This equilibrium is established through interplay between assimilation and accommodation processes (Illeris, 2007; von Glasersfeld, 1989). Several educational researchers have elaborated on Piaget's concepts regarding assimilative and accommodative learning processes, but they can still be perceived as two basic concepts in Piaget's theory of cognition (von Glasersfeld, 1989).

Illeris (2007) emphasises that the content dimension not only concerns knowledge, skill and attitude; it should be understood as far more reaching. For example, reflexivity and personal development are also part of the content dimension according to Illeris.

Illeris (ibid.) argues that the terms 'scheme' and 'structures' should not be conceptualised literally, but such metaphors are necessary to understand the processes in the brain's complex structure of synaptic cell networks during learning and thinking. From a neurological perspective, cognitive functions results from dynamic interactions between distributed brain areas that operate in large-scale networks (Bressler & Menon, 2010). The human brain comprises approximately 100 billion neurons, and each neuron may be connected to thousands of others, which enables substantial, simultaneous information signal flow in many directions. At any moment, a large number of neurons are active, and each so-called "pattern of activity" corresponds to a particular mental state (Organisation for Economic Co-operation and Development (OECD), 2002). According to the report *Understanding the Brain: towards a new learning science* (OECD, 2002), learning and knowledge are defined as follows:

> If mental states are produced by patterns of neural activity, then "knowledge", defined as whatever drives cognitive flow from one mental state to another, must be encoded in the neural connections. That means learning is achieved either thorough the growth of new synapses, or the strengthening or weakening of existing ones. Actually there is good evidence for both mechanisms, with special emphasis on the first one in young brains, and on the second in mature brains. It is perhaps worth

> nothing that entering any new long term knowledge in a brain requires a modification of its anatomy. (p. 44)

The neural network is characterised by activity-dependent plasticity and the ability to form new synaptic connections, which contrasts with earlier views of adult brain neuronal networks as wired and static (Sander, Bergersen & Storm-Mathisen, 2009). One rationale in outdoor education literature is that the outdoor context enhances direct multisensory experiences, which constitutes a solid foundation for meaningful holistic learning (Dahlgren & Szczepanski, 1998; Jordet, 2010). The increased multisensory stimulation is believed to facilitate 'patterns of activity' by connecting several areas of the brain, which leads to a more robust learning experience. This assumption is supported by a constructivist approach to learning with a focus on individual assimilation and accommodation.

A social dimension to learning

Human infants are born social (Frith & Frith, 2012). We are not a *tabula rasa* but have skills and abilities that facilitate social relationships from early infanthood. New insight into research on mirror neurons shows how we are adapted to adjust to other human's feelings and activities from an early age (Rizzolatti & Fabbri-Destro, 2008). However, we also have a very long childhood to successfully learn how to live and participate in cultural settings from others. Although we are social by nature, we also learn social life activities in a culturally and socially constructed reality. As Illeris' (2002) phrases it, 'because we are talking humans, the societal dimension is given' (p. 119).

The Russian theorist Lev Vygotsky (1978) was one of the first to acknowledge the role of social aspects, such as culture and history, as relevant to learning. Followers of the socio-cultural learning theory tradition emphasise the importance of activity, participation, communication, culture and language in human learning (Daniels, 2001; Illeris, 2002, 2007; Jarvis, 2006; Wells & Claxton, 2002), but the role of the individual versus culture and society varies in socio-cultural theories of learning (Daniels, 2001). Illeris (2002, 2007) discusses seven different aspects of interaction processes based on the level of a learner's involvement as a reference framework for learning: perception, transmission, experience, imitation, activity and participation. The last two are concepts that most often compose socio-cultural learning theories, and Illeris (2007) suggests that meaningful learning is more likely to take place where one is active and engaged, i.e., learning that is memorable and useful in relevant contexts.

In comparison, action is one of three aspects of learning with thought/reflection and emotion in Jarvis' (2006) model of learning; all are influenced by the social dimension. In short, according to Illeris (2002), activity is a goal-directed action characterised by use of tools, which are not only instruments but also include language and social conventions. Participation includes the learner in a goal-directed activity with a recognised position and, thus, influence.

The social aspect of learning is elaborated in an outdoor learning context by, for example, Jordet (2010) and Rickinson et al., (2004). Outdoor teaching and learning can enhance students' social relationships and social learning in several ways, including increased participation and activity.

A socio-cultural perspective emphasises learning through participation in a cultural practice (Illeris, 2002, 2007; Jarvis, 2006; Lave & Wenger, 1991). Jarvis describes the way that psychological consciousness (i.e., our basis for interpretation of experiences) is learned and validated when we internalise social culture and it becomes our 'second nature'. Driver, Asako, Leach, Mortimer and Scott (1994) argue that learning science is not only about acquisition of scientific concepts but also about socialising students to participate in science culture.

The emotional dimension of learning

The cognitive/content and social aspects of learning both have a long history as theories of learning, but information on the role of emotions in the learning process is limited (Illeris, 2002; Immordino-Yang, 2011; Jarvis, 2006; Levine & Pizarro, 2004; Linnenbrink-Garcia & Pekrun, 2001; OECD, 2002).

The important roles of interest and emotion in successful learning have likely been understood by teachers for a long time, and Dewey (1912) discussed the interplay between interest and effort at the beginning of the 20th century. Illeris (2007) argues that in the acquisition process of learning, content closely interacts with the incentive aspects. The emotional and motivational dimension of learning affects the learning results even if it does not influence the epistemological content. Illeris (2002) draws on Furth's book *Knowledge As Desire* when he claimed the following:

> The title suggests that the acquisition of knowledge and skills is essentially libidinal and thus also includes something positively emotional – that ultimately in mankind's genetically evolved nature there lies a capacity for acquiring knowledge and skills, and a fundamentally limitless desire to do so. (p. 65)

Thus, the desire to learn is innate, but certain researchers suggest that the school system does not make use of this desire to learn but diminishes it, which results in a perception of school learning as boring and fragmented (Sanderoth, 2002; Splitter, 2000).

Reasoning and learning have long been separated from emotions (Damasio, 1994; 2003; Goleman, 1996), but currently, growing evidence suggests that emotions play a more significant role in learning than previously expected (Fredrickson, 2001; Immordino-Yang, 2011; Immordino-Yang & Damasio, 2011; Jarvis, 2006; Kuhbander, Lichtenfeld & Pekrun, 2011; Larson & Rusk, 2011; Linnenbrink-Garcia & Pekrun, 2011). Jarvis (2006) concluded that learning through emotions is much more significant than originally realised and stated that 'emotions can have a considerable effect on the way we think, on motivation and on beliefs, attitudes and values' (p. 19). Goleman (1995) wrote that a positive mood increases the ability to think flexibly and follow complicated thought patterns, which improves our ability to find solutions to problems, both intellectually and personally.

In a school context, students make many decisions on how to think and behave, which are informed by conscious or unconscious emotional states. Thus, engaging in a task or interpreting a problem is a process supported by the intertwined relation between emotions and cognition. Emotions may aid us in focusing our attention and stimulating out working memory, which are two fundamental factors in learning (Damasio, 1994). Previous research on outdoor learning primarily supports it as a motivation tool for students (Jordet, 2007; Waite, 2011).

Experience and experiential learning

Experience is a term that might require further discussion because it is frequently used in outdoor education discourse, but it is a multi-layered term. In everyday understanding, its definition ranges from a single incident to accumulated knowledge, such as a life history. Following the pragmatic philosopher John Dewey, Illeris (2002, 2007) and Jarvis (2006) regard experience as at the heart of learning. Illeris (2002) stressed that his use of the experience concept extends beyond everyday use of this term and as its use by many scholars that study experiential learning. Fox (2008) criticised the lack of a theoretical understanding of experience in much of the experiential and outdoor education contexts, and Fox emphasised the socio-cultural aspect of experience. Illeris (2002) argued that experience spans the three dimensions of learning, in contrast to, for example, 'activity', which excludes the emotional aspect. Experience is broader than physiological

perception from our senses. Illeris (ibid.) defined experiential learning as learning 'of considerable subjective significance with regard to the cognitive as well as the emotional and the socio-societal learning dimension' (p. 153). Further, experience must be rooted in a subjectively relevant social context and part of a continuous coherent process, not a single episode without connection to previous and future experiences. The learner must also be an active participant in the interaction between an individual and social and/or material surroundings, not passively enduring without commitment.

Jarvis (2006) also claimed that proponents of experiential learning often understand experience too narrowly. Drawing on everyday understanding, he distinguished between four different ways to understand the nature of experience; each is relevant to understanding human learning. These various aspects are consciousness, biography, episode and sensation. According to Jarvis (ibid.), consciousness is 'the ability to be able to be in the world and "know it"' (p. 71); it includes phenomenological and psychological dimensions. In experience as biography, Jarvis (ibid.) emphasised that accumulation of previous experiences affects current experiences, and our biography comprises bodily, emotive and cognitive dimensions. Direct encounters with the external world may include both an episodic experience and a premeditated experience, such as at a lecture in a classroom. Building on Dewey's definition of experience, Jarvis (ibid.) concluded that the significance of an experience is the disjuncture it evokes (i.e., when we become aware of the external world and realise that our interpretation thereof may not be consistent with our experience). Thus, an episodic experience urges us to ask 'why' and 'how'. In addition to Illeris (2002), Jarvis concluded that an experience is never a single episode, but it is embedded in the continuous flow of time.

From a physiological neurological perspective, our body experiences a flow of sensory stimuli that are processed in the brain by conscious and unconscious processes (Damasio, 1994). We continuously experience the world in a biological sense, but our interpretations of such experiences are framed by culture, language and our personal history (Fox, 2008; Jarvis, 2006). The way we interpret an experience also depends on unconscious and emotional aspects (Damasio, 1994; Jarvis, 2006; OECD, 2002). Jarvis acknowledged that his four means of experience are interrelated; an episodic sensory experience may also support future learning and, thereby, influence a person's biography. Providing opportunities for such experiences is one goal of outdoor education (Nicol, 2003).

The implications for this thesis

The consequences of using the perspective of the three dimensions of learning herein is that many aspects related to the consequences from outdoor teaching can be incorporated into the analysis. This approach is consistent with the exploratory character of this research, which does not focus on a particular aspect. Sfard (1998) discussed two metaphors for learning: the acquisition (knowledge as an internal possession) and participation metaphors (knowledge as an aspect of practice and activity). She concluded that each metaphor offers a theoretical aspect that the other does not provide and that none of the recognised metaphors sufficiently provide a coherent theory of learning. This is the perspective adopted herein. To limit this approach to either the individual or social/participatory aspects limits our understanding of what transpires when teaching and learning are moved out of the classroom. By choosing this approach, I follow several other scholars in their attempts to bridge the individual and socio-cultural aspects (Davis, 2008; Davis, Sumara & Luce-Kapler, 2008; Haggis, 2009; Hodkinson, Biesta & James, 2008; Mason, 2007; Stolpe, 2011; Vosniadou, 2007).

Jarvis' (2006) work on experience has bearing on the outdoor education context. Experience as sensation and an episode is likely most evident on a short-term basis, but long-term rationales include consciousness and biography. Illeris' (2002) emphasis on the social dimension and his notion that experience is rooted in a subjectively relevant social context as part of a continuous process also lie at the heart of outdoor teaching and learning theory (Jordet, 2010). I formulated the research questions primarily in terms of experience as an episode and biography. However, I perceive episode, sensation, biography and consciousness as closely interrelated.

Space and place

In the background, I presented outdoor teaching as a way to provide students with meaningful learning places. Places outside the classroom afford direct contact between the student and object of study. This is a central idea in outdoor education literature. Dahlgren and Szczepanski (1998) wrote that, when using outdoor settings as places for learning, 'these places are connected to first-hand experiences in authentic environments with the purpose to create direct contact with the material and active participation, i.e., interaction and socialization (p. 26). Echoing Dewey, Robertson (2000) argued that only a 'curriculum that blends children's lived experiences with surrounding objects and familiar spaces will create lasting meaning and understandings' (p. 14).

Thus, space and place are significant concepts in outdoor education theory as well as in the related fields of environmental and place-based education. As discussed earlier, notions of place in educational research are often conceptually confused (van Eijck & Roth, 2010; Stevenson, 2008), which also applies to the place attribute and outdoor learning experience (Brooks, 2002; Harrison, 2010; Stewart, 2008).

Place and space have received considerable attention in disciplines such as geography (Buttimer & Seamon, 1980; Massey, 1994, 2005; Relph, 1976; Tuan, 1977), philosophy (Lefebvre, 1974/1991), psychology (Morgan, 2010; Stedman, 2002) and increasingly in educational research (Robertson & Gerber, 2000; Wattchow, 2008). The following sections do not attempt to fully engage in the philosophy of space and place as such a discussion is beyond the scope of this thesis. However, the following sections attempt to relate relevant writings in the field to the research herein and the way that this literature may contribute to understanding outdoor learning.

The relevant literature for this thesis pulls from the human geography and environmental psychology disciplines, where two research traditions are clear: phenomenological (Hay, 2002; Lim & Calabrese Barton, 2010; Relph, 1976; Buttimer & Seamon, 1980; Tuan, 1977) and quantitative/positivistic (Marcouyeux & Fleury-Bahi, 2010; Lewicka, 2010; Stedman, 2002; Vaske & Kobrin, 2001). This paper focuses in the phenomenological tradition.

Specificity and scale

A lay understanding of space is its geographical, physical dimension. One definition of space is 'distance, interval, or area between or within things; extent; room; as "leave a wide *space* between rows"' (Peuquet, 2002, p. 12). I will not discuss the time dimension of space (Payne & Wattchow, 2008; Peuquet, 2002; Warf, 2008) but recognize that time and space are closely intertwined.

Place can be conceptualised in terms of specificity and scale (Devine-Wright & Clayton, 2010; Lewicka, 2011; Rose, 1995). Place often refers to a specific location, such as home or neighbourhood, but a new trend in place attachment studies is a growing interest in attachment to places, such as recreational or wilderness areas (Lewicka, 2011). Locations, such as a forest or neighbourhood, have clear boundaries. On a larger scale, place is more ambiguous, but region, country or continent can function as the level of identification. The school setting can also be a focus in studying place (Marcouyeux & Fleury-Bahi, 2010).

Place as 'insideness' and belonging

The phenomenological research tradition comprises different perceptions of the relationship between space and place, but space is primarily perceived as more abstract than place (Relph, 1976; Tuan, 1977). What transforms space into place is a human experience of space as well as the bonds that people establish and meaning they attribute to space. Relph (1976) used the term 'insideness' to explain how a sense of place is 'above all that of being inside and belonging to *your* place both as an individual and as a member of a community' (p. 64) [emphasis in original]. Thus, according to this view, people's sense of both individual and cultural identity is intimately associated with place (cf. Buttimer, 1980; Proshansky, Fabian & Kaminoff, 1983). Relph (1976) contrasts outsideness and insideness, and he distinguishes between different levels of insideness and outsideness; although, he admits that such levels are not precisely separated. According to Relph (1976), the most fundamental form of insideness is existential insideness, which is characterised by belonging to a place and a deep identity with a place. From existential insideness, he describes a continuum of empathetic and behavioural insideness to vicarious insideness. Empathetic insideness is openness to the significance of a place (i.e., that we feel it as well as know and respect its meaning and symbols). Behavioural insideness is what we experience and sense in a place, such as structures, patterns and content. Vicarious insideness is experience of a place through a second-hand experience (e.g., through correspondence with familiar places, such as artist and authors produce). A person can also be outside at different levels, from incidental to objective outsideness and, last, existential outsideness. Incidental outsideness is an unselfconscious attitude where a place is just a background setting. Objective outsideness is to look at places as objective, unchangeable realities separated from persons. Existential outsideness involves a self-conscious, reflective uninvolvement and a sense of alienation from a place.

The term 'sense of place' is often used to emphasise that places are significant because they are the focus of personal feelings. Sense of place pervades everyday life and experience, and it indicates that that places are infused with meaning and feelings (Rose, 1995). According to Stedman (2002), sense of place can be conceived 'as a collection of symbolic meanings, attachments, and satisfaction with a spatial setting held by an individual or group' (p. 563). Attachment, identity and dependence are frequently used concepts in different instruments and research fields that attempt to understand human-place relationships (Lewicka, 2011).

Social space

While Relph (1976) emphasised the personal experience of place, Buttimer, (1980), Lefebvre, (1974/1991), Massey and Jess (1995) and Massey 1994 2005) emphasised the socio-cultural and relational dimension of place and, thus, the multitude of place identities/senses of place. In contrast to Relph's (1976) bounded place, wherein one can be inside or outside, Massey (2005) argued for an open and ever-evolving space. Space is never finished nor closed. Massey (ibid.) did not distinguish between a place 'endowed by meaning', echoing Tuan 1977, and an abstract space. She argued that spaces (i.e., our stretched relationships with a globalised world) are also 'endowed with "meaning" and hence equally real, lived and concrete' (p. 185). Lefebvre (1974/1991) distinguishes between physical 'natural space', a mathematical logical notion of space, 'mental space' and 'social space'. Social space is a product of three dimensions: spatial practice (production and reproduction of particular locations, i.e., how people live their lives in a society), representations of space (conceptualised space, e.g., knowledge, signs, codes related to space) and representational spaces (space directly perceived through its associated images and symbols). Action space, activity spaces, behaviour fields and additional concepts related to spatial movement have been suggested as indices of social space (Buttimer, 1980). The nature and dynamics of people's movements in space are considered critical to their relationship with the environment.

Space, place and outdoor learning

Given this overview of place theory, what is the significance to outdoor teaching and learning? One reason why place theory is significant is the focus on nature as a place for learning. A common topic in much outdoor literature is the value of children's direct experience with nature. A rationale for teaching children outdoors in nature is the wish and assumption that they thereby possibly will more strongly connect with nature. Another assumption is the belief in a link between this connection and environmental concerns. Stedman (2002) argued the following:

> Previous neglect of place-protective behaviours - and the factors that predict them - is a problem. Scholars interested in the linkages between people and environment should care about sense of place not as an end in itself but as predisposing action. (p. 577)

Perceiving outdoor learning as experience-based learning in more general terms (Dahlgren & Szczepanski, 1998), such as a complement to classroom

learning, where the particular place is chosen for a special reason, the place also has significance. Learning in and about a place is believed to invoke meaningful personal learning. This understanding of a place corresponds to Relph's (1976) notion of insideness, either through existential insideness or empathetic insideness.

Outdoor literature (Beames & Atencio, 2008; Jordet, 2010) and place-based education literature (Gruenewald, 2003a, b) provide an additional argument. Education in and about community and society is believed fundamental to children's understanding of the place they inhabit and how they learn to live there. In addition to syllabuses goals, teaching also has broader goals, such as to prepare students to learn for life and have a functional social life. To many scholars, outdoor teaching is a promising way to fulfil these goals. In this context, place is understood more as a co-construction and social place, which is consistent with Massey's (1994, 2005) works. In outdoor literature, place is also considered a physical geographical space. From a health perspective, time outdoors implies increased physical activity in a geographically and spatially larger area.

In conclusion, space and place can be understood somewhat differently. On one hand, space is the physical and social space where people interact and meet. There is not inside or outside, but interaction and openness. On the other hand, place can be conceptualised as personal attachment, identity and belonging to a particular area. In the framework of this thesis, space is conceptualised as more abstract than place. Space is the physical geographical area where learning transpires without the notion that it is a place with particular meaning. Teaching and learning in an outdoor space facilitates movement and physical activity. However, when the area itself contributes to a learning experience, it is referred to as place. Nevertheless, I realise that there are no clear boundaries between space and place.

Although there is an increased interest in place, there is a need for a closer connection between theories on place from a geographical or environmental psychology perspective and theories on outdoor teaching and learning. One intention for this thesis is to aid in filling this gap.

In conclusion, the primary research areas are consequences from and experiences of school-based outdoor teaching and learning in a high school context as well as teachers' observations and perceptions of children's nature experience in an urban context. The analytical 'lenses' that guided my interpretation of the results are the three dimensions of learning, ***content, social and emotional***, and two dimensions, ***space and place***. The final interpretation of the results is the consequence of an abductive process, wherein empirical work and theory act as mutual guides. This process is described more extensively in the next chapter.

4. Methodology

As previously mentioned in the introduction to chapter 3, the design for this thesis was inspired by the grounded theory method (Bryant & Charmaz, 2007a; Glaser & Strauss, 1967); although, this is not a grounded theory study *per se*. This method is often characterised as an inductive method; although, more recent versions emphasise the abductive logic in grounded theory (Bryant & Charmaz, 2007; Reichertz, 2010; Richardson & Kramer, 2006, Thornberg, 2011). Abduction is a third type of inference in addition to deduction and induction (Douven, 2011). In short, deductive research is characterised by testing hypotheses generated from pre-existing theory, whereas inductive research is characterised by generalising features in the data. The concept of abduction was first introduced by the pragmatic philosopher, Charles Pierce (1958/1979), referencing the process of 'adopting a hypothesis as being suggested by the facts' (p. 122), in other words, finding new and useful explanations for observed phenomena (Richardson & Kramer, 2006). Abductive reasoning 'links empirical observations with imaginative interpretation, but does so by seeking theoretical accountability through returning to the empirical world' (Bryant & Charmaz, 2007b, p. 46). Thus, the research process is characterised by continuous interplay between empirics and pre-existing knowledge or theories. It is also characterised by comparisons and interpretations used to search for patterns and the best possible explanations from data collection and analysis (Reichertz, 2010; Thornberg, 2011).

The exploratory and abductive research process herein

I approached this research with an open mind and curiosity for, to paraphrase Glaser (1978), 'what is happening here?'. Theory was used as a source of inspiration in interview question formation and in the final analysis. However, different theoretical perspectives guided the research process at different stages. The benefit from this approach is, according to Thornberg (2011), multifaceted.

> Theoretical pluralism provides the researcher with flexible choices among different concepts and ideas and /…/ keep the researcher's eye open to all kinds of observations and aspects, not confining or blinding his or her view. Furthermore, to consider and compare different pre-existing theories

> helps the researcher to take a critical stance toward each of them and thus remain theoretically agnostic during the analysis. (p. 8)

Following abductive logic from the grounded theory method, this approach manifested as a constant motion between the data and literature. In the following section, this interplay will be described in more detail.

Outdoor education literature was an influence from the first day of this doctoral project. Early into this project, place-based education literature was also influential. This influenced interview questions and research questions in the Australian study (paper I) and interviews with the Swedish teachers in paper III. The context of the Australian study led to literature investigations on environmental education research and environmental psychology as well as the theories of place attachment and human-nature relationships in this field. The study on students' biology learning (II) was primarily exploratory, but it was guided by outdoor literature combined with literature from science education and learning from a neurocognitive perspective. Findings from paper II guided the interview questions for paper III. Statements on the multidisciplinary nature of learning in much of the outdoor education literature also guided the interview questions for paper III. The results from paper II and III guided the development of paper IV, which explored students' learning in mathematics and their attitude towards such learning on a broader level. The results from paper IV were discussed primarily through the participatory aspects of learning.

Learning theories were in continuous interplay with research findings throughout the thesis. The experience-based focus on learning in outdoor education literature led first to literature investigations of experiential learning, Dewey's pragmatic philosophy and theory of learning, neuroscience and constructivism. The results from paper II and III emphasised collaboration and communication as well as led to literature investigations of socio-cultural learning theories.

Much outdoor education literature, as well as empirics from the different studies, comprises individual constructivist and social participatory perspectives on learning. This led to a search for a learning perspective in line with both perspectives and the perspective of three dimensions of learning, acknowledging the individual learner and his or her incentive and the social environment was considered the most appropriate perspective (Illeris, 2002, 2007; Jarvis, 2006). To summarise the results, perspectives on space and place became important again and led to expanded literature investigations on place theory. Thus, finally, an abductive analytical lens, including place theory and the three dimensions of learning, guided the final analysis and discussion.

Although the logic underlying the grounded theory method guided the research process, grounded theory was not the primary methodology used. Instead, the methodology used herein was mixed method research (Creswell & Plano Clark, 2011; Johnson & Onwuegbuzie, 2004). Both methodologies are useful for exploratory research, but grounded theory requires a more systematic data analysis approach directed towards theory generation, which was not applied herein. The analysis method primarily used in the qualitative studies (paper I and III) was thematic analysis (Boyatzis, 1998; Braun & Clarke, 2006). According to Braun and Clarke (ibid.), the data coding procedures in thematic analysis are similar to the procedures in grounded theory but without the theoretical commitment to a fully developed grounded theory. See paper I or III for an expanded description of thematic analysis.

Before describing the design used for this thesis, I present an overview of the ontological and epistemological perspectives that guided the research process.

An ontological and epistemological perspective

Generally, theses stimulate reflections on ontological and epistemological questions. The researcher's choices for research questions, methodologies and methods are influenced by understanding what comprises the world and how we come to know it. Research is an activity aimed at understanding a phenomenon. Subsequently, the researcher's position on ontological and epistemological questions may be interesting. It is, at least to some, a piece in the puzzle that finally composes a thesis.

During my graduate studies in biology, an alternative perspective to the realist/empirics perspective that dominates natural sciences was unavailable. What we students observed during the experiments and research projects represented an independent reality. My scientific training was in the positivist paradigm, which is a belief in a single reality and that the relationship between the knower and the known is independent. Further, inquiry is believed to be value-free, and generalisations can be generated that are free from context and time (Tashakkori & Teddlie, (1998). However, I would not define the type of positivism I experienced as similar to vulgar depictions of positivism (cf. Zammito, 2004).

To commence post-graduate studies in the social sciences required converging different world views, which I experienced as two cultures at times (Snow, 1959). Because my research field and the project I worked on were primarily multidisciplinary, I had many opportunities to reflect on different approaches to understanding reality and knowledge.

The ontological foundation for this thesis adopts that of a moderate realist or an interpretative pragmatic realist perspective (Lenk, 2009). This world view implies a belief in a world that is independent from humans and our language but is aware of the interpretative social construction of knowledge. It is definitely easier in the natural sciences than social sciences to distinguish between the knower and the known and rely on an independent reality. The researcher's role is much more complex and intertwined when other people are the object of study and the researcher's role can be described as a creator in the research process (Charmaz, 2006). According to Lenk (2009), interpretative pragmatic realism leads to a manifold picture.

> We have no last, ultimate foundation which cannot be doubted at all, which would render a conceptual or linguistic formative basis to build a safe intellectual construction on it. We however do not operate like a rope artist without net, but we ourselves - on the basis of biological fixed dispositions and formal - operational necessities /…/ we ourselves would knit or construct our nets in which we try to catch or capture elements and parts of the world. Thus we elaborate our own net including the rope on which we try to balance ourselves. These nets and ropes may be extended and modified /…/ Any "graspability" whatsoever is interpretation-laden. The world is real, but "grasping" the world is always interpretative. (p. 20)

The epistemological perspective underlying this thesis is best characterised as post-positivist, as a median between positivism and constructivism (Tashakkori & Teddlie, 1998; Zammito, 2004). Applying the pragmatic realist ontology outlined above in a post-positivistic context, science is not isolated from humans and society, which is in contrast to the more ideal logic positivism perspective. Our understanding of reality is perceived as socially constructed with no value-free inquiry. Further, post-positivists know that observations are theory-laden and do not mirror an objective independent reality.

Thus, the results herein are perceived as interpretative, but they are also not solely social constructions. An assumption is that these results indicate something beyond the immediate situation and that an additional researcher with the same focus would not have generated fundamentally different results. However, as Miles and Huberman (1998) noted, 'a useful theory should apply to more than one case. The assessment of local causality should be tested and deepened through application of the casual explanation to other cases' (p. 147).

Mixed Methods Research

For many researchers and theorists, the two major orientations and respective research methods in social and behavioural sciences, the positivist/quantitative or constructionist/qualitative orientation were perceived as incompatible and relying on different paradigmatic positions (Tashakkori & Teddlie, 1998). Fortunately, when this thesis was written, the war seems to have ended, and a more pragmatic approach has been adopted. Qualitative and quantitative methods are no longer perceived as incommensurable and mixed methods research is an alternative approach (Bryman, 2008). Mixed methods research combines methods, philosophies and research design orientations (Creswell & Plano Clark, 2011). A definition of mixed methods research from Johnson, Onwuegbuzie and Turner (2007) is as follows:

> Mixed methods research is the type of research in which a researcher or team of researchers combines elements of qualitative and quantitative research approaches (e.g. use of qualitative and quantitative viewpoints, data collection, analysis, inference techniques) for the purposes of breadth and depth of understanding and corroboration. (p. 123)

Philosophical foundations in mixed methods research

At least two major different philosophical foundations compose mixed methods research. One is the use of multiple worldviews. Thus, multiple paradigms can be used in mixed method research. During the qualitative phase, the constructionist paradigm is used, and the quantitative phase is informed by the post-positivist paradigm. This approach is sound as long as the researcher is explicit (Creswell & Plano Clark, 2011). No paradigm is perceived as superior, but they are simply regarded as different and valuable for different research phases. However, the most common philosophical foundation for mixed methods research is adopting a pragmatic approach (Creswell & Plano Clark, 2011; Morgan, 2007). This is an alternative way of approaching commensurability with different perspectives. With a pragmatic foundation, ontology and correspondence are not the primary concerns. A pragmatist is concerned with opening up the world to social inquiry and choosing the methods that best support the research aims (Morgan, 2007; Johnson & Onwuegbuzie, 2004). The goal is to utilise the strengths of the different approaches by combining them and searching for workable solutions and improvements (Onwuegbuzie & Johnson, 2006). According to Morgan (2007), the pragmatic approach is described as follows:

> In a pragmatic approach there is no problem with asserting both that there is a "real world" and that all individuals have their own unique interpretations of that world. Rather than treating incommensurability as an all-or-nothing barrier between mutual understanding, pragmatists treat issues of inter subjectivity as a key element of social life. (p. 72)

The foundation for the design of this thesis is the pragmatic approach. The assumption is that a combination of qualitative and quantitative research approaches is the best method for approaching the research aims and better understanding the phenomena. An additional assumption is that 'workability' and mutual understanding are better guiding principles than ontology and correspondence (Morgan, 2007).

Research design

This thesis is exploratory because there are few longitudinal studies on school-based outdoor teaching and learning in secondary school.

The aim was to explore the possible impact of outdoor teaching within a broad scope. Therefore, collecting qualitative and quantitative data was considered useful in answering the different research questions. The four papers have different designs and, combined, support the final analysis. The first paper has a qualitative cross-sectional design, the second a mixed method design, the third has a qualitative longitudinal case study design and the fourth has a quantitative quasi-experimental design (Bryman, 2008).

Empirical context

This research was completed under a joint PhD agreement (a co-tutelle agreement) between Linköping University, Sweden and Macquarie University, Australia. One of the studies that compose this thesis was conducted at environmental education centres and high schools in Sydney, Australia (paper I). The other three studies were conducted at a Swedish junior high school in Southern Sweden (figure 1). The Australian high schools (n=8) and environmental education centres (n=12) were situated in different socioeconomic areas of Sydney. All but one EEC were located close to national parks or other natural environments. The EEC officers had different vocational backgrounds but were all experienced EEC officers. All of the teachers were experienced science teachers. As fieldwork is a mandatory component of the New South Wales curricula, working with EEC officers was part of teachers' teaching repertoire. Secondary schools in Sweden require three compulsory years at a junior high school/lower secondary school and, thereafter, approximately three years in a senior high

school/upper secondary school, which are voluntary. These years are taught by different teachers in separate school buildings. In Australia, teachers teach both junior and senior high school students, and the students remain at the same school for six years. Students are 12-13 years old when they commence junior high school (Year 7) in Australia but are 13-14 years old in Sweden.

The Swedish studies are part of a larger multidisciplinary intervention project. The project involved all the teachers at a high school (approximately 40). They taught approximately 450 students, and the school was in the outer area of a city with approximately 85 000 inhabitants in Southern Sweden. The teachers participated in a 7.5 ECTS (European Credit Transfer System) credit point professional development course in outdoor education.

Figure 1. The school and surroundings

The course duration was from August 2008 to October 2009. The teachers participated in three full days and five half-days of lectures and practical hands-on activities. The practical activities were in part general, including teaching in the outdoor environment and social team-bonding activities. Certain activities were also more directed toward specific disciplines where, for example, language, natural science, and social science teachers comprised different groups that were taught outdoor teaching, which focused on their discipline. Between those days, 6 seminars were held with opportunities to discuss reading on outdoor education theory as well as reflect on lesson planning and realisation.

The intervention period was September 2009 to June 2010, which is one Swedish school year. The purpose was to implement regular weekly outdoor

teaching to all students. The teachers were organised in four different teams comprising teachers from different disciplines. Each team was supposed to organise their lesson plans such that every student participated in three to four outdoor lessons per week. There was no requirement that each teacher actually conduct lessons outdoors. Consequently, certain teachers spent more time outdoors, whereas other teachers did not use the outdoor environment as frequently.

Implementation of outdoor teaching

Outdoor teaching may have several consequences and be practiced in several ways; a few examples are provided to exemplify the variety. As this project also involved PhD students in medicine, high school students' possible increased physical activity was one rationale underlying the outdoor intervention. This was reflected in implementation of outdoor teaching. The outdoor environment was occasionally used for walk-and-talks, where students supported by the teacher discussed dilemmas or chapters in the textbook before an assignment. The outdoor environment was also used for shorter walks, where samples of problems/questions related to a subject were hanging from trees, for example, and the students were to answer and discuss them in small groups.

In second and third-language learning, teachers often gave students small cards with the beginning of a conversation or a few terms, and the students would walk around and communicate with each other using the cards. In the Swedish language subject, the outdoor environment was used to inspire students to improve adjective use as well as writing rich and vivid descriptions. In mathematics, the students occasionally used trees or snowballs for calculations, but more often mathematics was incorporated into small games, where different teams competed to solve problems or equations. An example from physics is using a tree and chair and block and tackle to demonstrate the 'theory of leverage'. An example from biology is using stuffed birds and binoculars on the sport oval to assess knowledge of common species in an applied manner. An additional example from biology was to attract living birds with a recorded bird song and demonstrate as well as discuss animal behaviour. In social sciences, different places of interest around the school were visited as part the content being studied. In technology, stops at different types of fences (a stone wall, villa tree fence and fence constructed of hurdle poles) during a walk around a neighbourhood initiated a discussion on historical uses of materials through different technologies.

An exploratory sequential design

Given the limited body of research on regular outdoor teaching in high school, the aim was to explore consequences from different perspectives using different types of data collection and analysis. The overall design was emergent and flexible, where results from one study led to data collection in new groups or contexts (figure 2). The assumption was that mixed-methods research would justify conclusion through convergence and corroborate findings, in other words, validity through triangulation (Johnson & Onwuegbuzie, 2004; Creswell & Plano Clark, 2011).

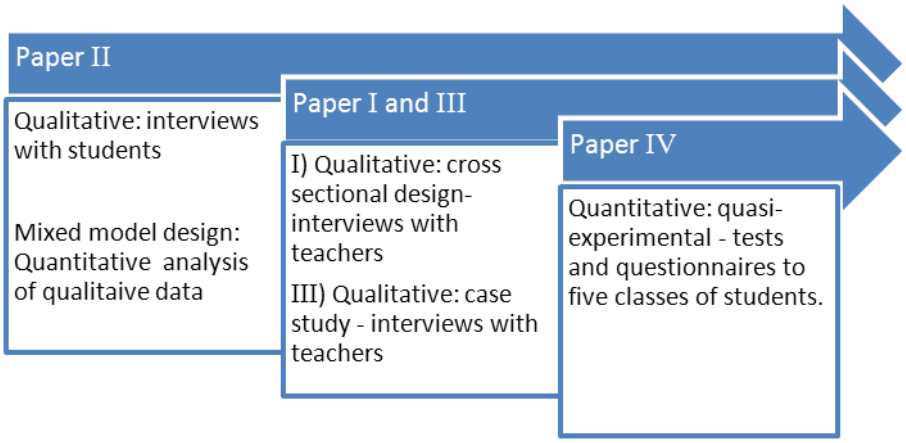

Figure 2. The emergent exploratory sequential design of the studies.

Paper II had a mixed method design where qualitative and quantitative components interacted and mixed during data analysis. Qualitative data were statistically quantified and analysed. However, the primary mixed method design was used for the entire thesis. Thus, the level of interaction between the qualitative and quantitative components was independent. Papers I and III were qualitative studies, and paper IV was a quantitative study. The components were mixed during the final analysis and in a comprehensive interpretation of the different studies. The thesis followed an *exploratory sequential design* (Creswell & Plano Clark, 2011). An exploratory sequential design is useful when variables are unknown and to generalise findings based on a few individuals to a larger sample in a second phase. This was also why an exploratory sequential design was used for this thesis.

Paper II was a first exploratory study for potential effects from outdoor teaching on students' knowledge and attitudes. The results from the

interviews on learning and affections led me to continue with the quantitative study in paper IV, where effects on mathematic knowledge and attitudes toward mathematic teaching were examined more generally. Papers I and III concerned teachers' experiences and perceptions. Paper I was a study on Sydney teachers' observations of urban children's experience with nature and teachers' perceptions of the potential from encounters with nature. Paper III was a longitudinal case study to primarily explore teachers' experiences with outdoor teaching and learning based on the year of the project. The secondary aim was to examine the extent that such perceptions differed from initial perceptions, which is why a longitudinal design was used.

Data collection

A wide range of methods have been used to access different aspects of outdoor teaching and learning. Semi-structured interviews were the only sources of data in papers I and III. Paper II was a mix of semi-structured interviews and essay-type questions, and in paper IV, the data comprise questionnaires and mathematical tests.

Table 1. Summary of the research tools and methods used to collect data in the four studies

	Paper I	**Paper II**	**Paper III**	**Paper IV**
Year	2009	2008-2009	2008-2010	2011
Sample	Teachers	Students yr 7-8	Teachers	Students yr 7
Number of participants	21	88	12	86
Type of data	Interview	Essay-type questions Interview (21 students)	Interview	Test Questionnaire
Analysis	Thematic analysis	SOLO taxonomy Mann-Whitney U-test Grounded theory inspired qualitative analysis of the interviews	Thematic analysis	Friedman ANOVA, Wilcoxon signed rank test, Mann- Whitney U- test

Methodological discussion

A limitation of this thesis is the lack of observations on the actual phenomenon studied. Four non-participants observed outdoor lessons conducted at environmental education centres in Australia and two at the school in Sweden, but they were not included as data material for the analyses herein. Interviews were the primary source of data, and they were combined with questionnaires and tests, which was considered the most appropriate way to gather a rich sample of different data types.

Interviews as a source of data

Interviews have the capability to provide a researcher with rich and vivid qualitative data on people's experiences with and perceptions of a phenomenon. They can also be used to produce quantitative data, and both approaches were applied in this thesis. However, an interview is not just a collection of verbal data, but it is a moment of co-construction between the interviewee and interviewer (Kvale, 1997). Kvale emphasised that a central aspect is the interviewer's capability to maintain focus on the research questions but also remain sensitive to the interviewee's responses and listen to what is important to him/her. My skill as an interviewer was likely better at the last interviews than the first, but all interviews were conducted with a semi-structured interview format comprising open questions at the beginning and end with more detailed questions in the middle, which followed Kvale's advice (ibid.).

The symmetry between an interviewer and interviewee is important, too (Vincent & Warren, 2001); in other words, gender, ethnicity and hierarchical structures may influence the interview. The majority of the interviewees were unfamiliar to me. They were environmental education centre officers and teachers in Australia that I did not meet before as well as high school students at a school where I was not a frequent guest. The structure was different with the Swedish teachers, wherein I was a non-participant observer during the professional development course and become acquainted with the teachers. I was also once responsible for a workshop. Thus, I had a relationship with them at the first interview (2008-2009), which was deeper at the post interview (2010). However, despite the different circumstances, I did not encounter any major symmetry differences between the different interviews.

My growing relationship with the Swedish participants may have produced to two additional limitations emphasised by Zunker & Ivankova (2011) that 'data collection may have been subject to recall bias and self-report bias associated with providing socially desirable responses' (p.876). Many of my interviews were open as well as exploratory and asked about

experiences over a long period of time, and therefore, recall bias may be a concern for the validity of this study. The Swedish teachers may more easily remember the outdoor lessons at the end of the project year than the early lessons. The first lessons may have ended differently compared with the later lessons, wherein the teachers and students were more experienced; therefore, recall bias may have influenced the results and supported a more positive picture than reality. This bias may also apply to the interviews with the Australian teachers. Memories of scared and uncomfortable children may have been more easily recalled.

The bias from providing desirable responses may have been a limitation particularly in the Swedish interview study as the researcher developed a relationship with the informants.

Quantitative data and statistical analyses

In this study, statistics were used to test the hypothesis that there is a statistically significant difference between groups of students taught traditionally indoors and groups of students taught partially outdoors. Statistical models are built on the assumption of inference from a random sample to a population. Accordingly, the sample must be representative, and larger samples are more reflective of the entire population. A limitation with my statistical analyses is the relatively small sample in paper II. The sample comprised only approximately 20 students in each group for statistical analysis of the results from the SOLO taxonomy (see paper II for a description of SOLO taxonomy), and only 10 students were in each group for statistical analysis from the interviews. Larger groups may have produced different results. However, the test used (Mann-Whitney U-test) can examine differences in small samples (Field, 2005). For the fourth study, the samples were larger and ranged from 26 to 53.

Levels of measurements

Paper II used interval data; frequencies of expressions/words in interviews and ordinal data; as well as levels of understanding (1-5) in accordance with SOLO taxonomy. In paper IV, interval and ordinal data were also used as levels of measurements as well as a test (pre- and post-test) in arithmetic performance (appendix 2e) and a self-regulation skills questionnaire from the PISA project (OECD, 2004) (appendix 2f). The test was developed by teachers and researchers in mathematics education and validated in an earlier study (Samuelsson, 2008). The test consisted of two sections that measured procedural skills and quantitative concepts with a maximum score of 30.

The PISA questionnaire is a well-documented and validated instrument, and it was considered better to use an existing questionnaire than develop a new one. The PISA questionnaire questions corresponded well with the research questions on attitudes toward mathematics. One assumption was that the 10-level Likert scale in the questionnaire and the levels of understanding from the SOLO taxonomy corresponded to the underlying differences in measurements and, thus, could be statistically analysed.

Statistical analysis

Because the data were ordinal (though, with an underlying continuous scale), non-parametric tests were considered most appropriate. This prevented assumptions on distribution of the data (or at least their means) as normal. The appropriate tests were the Wilcoxon signed rank test (instead of the parametric one sample or paired t-test), Mann-Whitney U-test (instead of the independent samples t-test), and Friedman ANOVA (instead of the parametric two-way analysis of variance). Where the parametric assumptions are met, these tests have lower power than the corresponding t-tests and ANOVA. However, where the parametric assumptions are incorrect, the non-parametric tests outperform parametric analyses. The use of non-parametric tests, then, is more conservative if the means of the data could be described by normal distributions and better if this is not the case.

Trustworthiness

The trustworthiness or quality aspects of a study can be discussed in terms of *confirmability*, *dependability*, *credibility* and *transferability* (Bryman, 2008; Miles & Huberman, 1994). To ensure *confirmability*, I present explicit descriptions of research methods, interpretation and analysis procedures, as well as ontological and epistemological positions. Thereby, I wished to create openness in the research process and provide relevant 'backstage' information to aid the reader in valuing the objectivity and quality of this research.

The issue of *dependability* concerns consistency in the research process, which should be performed with reasonable care to generate findings that will likely apply in additional circumstances (Bryman, 2008; Miles & Huberman, 1994). Four transcripts from this study were analysed by an independent researcher. Thereafter, interpretations and emerging themes were discussed and categorised by the author and independent researcher. Continuous discussions on findings and interpretations with three to four supervisors for the four papers were also a way to ensure dependability.

Are the findings believable or *credible* to readers and participants? To answer this question, a number of techniques were used (Bryman, 2008). Respondent validation concerning interpretations of findings was offered to the participants in paper III and transcripts of the interviews were sent to the participants in the Australian study (paper I) for approval.

The mixed methods research design incorporated different data collection and analysis methods, including the four non-participant observations, which could be considered an overarching way of improving credibility through triangulation. I visited the Swedish school and the teachers there several times during the outdoor project year, and I had the opportunity to speak informally with more teachers than the 12 in the interview study (paper III). Their stories confirmed the depiction from the interviews. The research team also presented preliminary results from the project to teachers and parents for feedback.

According to Miles and Huberman (1994), the last quality aspect is *transferability*. The question of transferability or generalisation is complicated for qualitative research. Miles and Huberman (ibid.) argued that examples of relevant transferability questions include whether characteristics of the sample persons, settings, processes are fully described to facilitate adequate comparisons or whether the findings are congruent with prior theory. I hope I have presented sufficient descriptions to aid readers in judging whether the findings are transferable to other contexts, and the results herein are compared with prior research in the discussion chapter. The cross-cultural research approach may be considered favourable from a transferability perspective. If similarities are found in two different cultural contexts, they are reasonably transferable to other contexts.

Ethical issues

There are different ethical principles associated with research to protect the parties involved (Gustafsson, Hermerén & Petersson, 2005; NSW, Department of Education and Training, 2006). The Australian study was approved by the state educational research approval process (SERAP number 2009131) and the ethics review committee for human research at Macquarie University (reference number HE30OCT2009-D00155).

The research in the Swedish study did not require ethical approval, but ethical principles of informed consent and confidentiality considered for the participants (Gustafsson, Hermerén & Petersson, 2005). The research herein was part of a larger research project, which was preceded by written information on the purpose of the research, information on voluntary participation, consent and confidentiality in five languages (Swedish, Arabic,

Albanian, Somali and Serbo-Croatian) for all participating teachers and families at the school. All teachers and families were also invited to information meetings with the research group. Parental consent was obtained for the student interviews.

5. Results

This section presents a short summary of the research aims and findings followed by a summary of the papers. First, additional results related to the outdoor project that were not in the four articles are presented. The additional results were considered important for the overarching picture and valuable as background information for interpreting and discussing the results from the studies.

Additional results from the one year outdoor teaching project.

Interviews with four teachers and seven Year 9 students as well as questionnaire data from the 40 teachers before the beginning of the professional development course revealed that out-of-school teaching was a rare event. According to both teachers and students, on average, a class had one or two fieldwork lessons or trips per year, which is likely 'common' in a Swedish high school context. After the outdoor teaching project, the teachers at the high school used the outdoor environment in their teaching practice to a varied extent. The teachers were divided in four teams, and each team taught approximately five classes. The teams recorded their outdoor lessons in logbooks, but only two teams performed this task consistently throughout the school year (August 2009 to June 2010). Data from these two teams and their 11 classes are presented below and in Appendix 1. There was large variation between subjects and classes. The suggested three to four outdoor lessons per week per class were not realised. The per cent of outdoor lessons per class was 4.6 %, which is approximately one lesson per week per class during the year. However, there was seasonal variation with less frequent outdoor teaching from December to March, which is winter in Sweden, and more frequent outdoor teaching during autumn and spring. Based on data from 11 classes, the range was 1.8 % to 9.8 % for lessons taught outdoors. Mathematics was most frequently taught outdoors for the two recording teams of teachers, and 14 % of the mathematics lessons were taught outdoors. Visual art, creative arts and music were not taught outdoors; although, interviews revealed that the other teacher teams did teach such subjects outdoors.

The mean final school grades in Year 9 increased during the outdoor teaching project (2009-2010, figure 3) and decreased after its completion (2011).

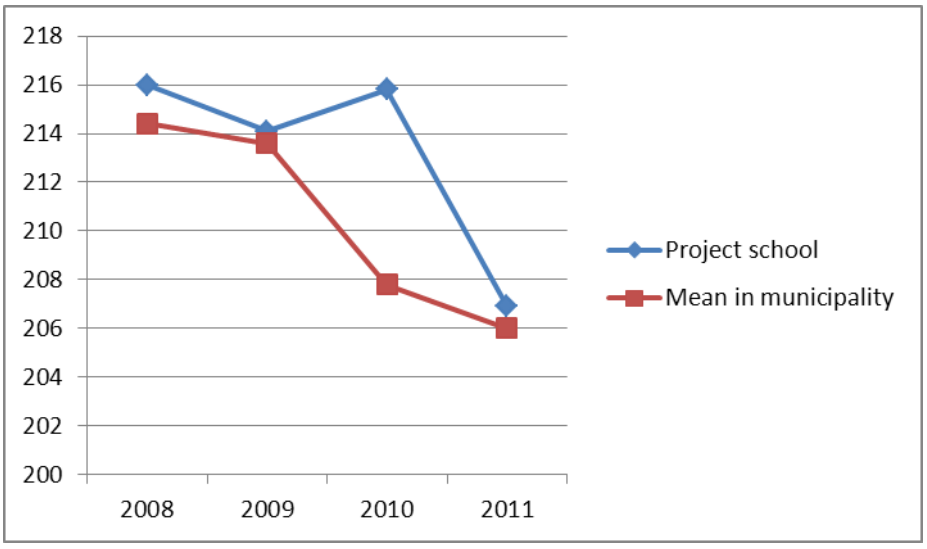

Figure 3. Mean final school grades from years 2008-2011. Source: the Swedish National Agency for Education, n. d.

Certain teachers continued to practice outdoor teaching after the project, but the number of outdoor lessons decreased after the project came to completion.

Short summary of papers

Table 2. Summary of research questions and primary findings

Primary research questions	Paper	Primary findings
What are the observations and perceptions of teachers regarding how children experience nature? What is the potential of nature experiences according to teachers?	**I**	-Children's experiences can be described as emotional, rare and vicarious. They are mainly interested but often uncomfortable outdoors in nature. -Teachers believe a connection to nature can increase environmental concerns and that ecological knowledge is a component in migrant children's understanding and development of a place identity.

What are the influences on students' performance in biology, and what are the attitudes toward outdoor teaching and learning after being partially taught outdoors?	**II**	-The students enjoyed outdoor teaching and learning and appreciated the increased student interaction, variation and first-hand experience. -Differences in academic performance for students taught outdoors included better retention of course activities and use of more content-related terms in the interview answers. -There were no differences in level of understanding for essay-type questions according to the SOLO taxonomy.
Based on one year of experience, what are teachers' perceptions of the educational potential for outdoor teaching and learning? How did teachers' perceptions of outdoor teaching differ before and after one year of experience?	**III**	-Educational potentials from outdoor teaching were increased enjoyment, interest, on-task communication, experience-based learning and participation among students. -Outdoor teaching primarily confirmed indoor knowledge, but could also expand school knowledge. The latter was used to a minor extent. -Barriers were more frequently discussed before the project; but a challenge experienced during the project included disciplinary problems before the students adjusted to the new learning environment.
What are the influences on students' performance in arithmetic and self-regulation skills after being partially taught outdoors?	**IV**	-Students partially taught arithmetic outdoors improved their performance more than students taught traditionally indoors despite lower scores on extrinsic motivation and self-concept as well as higher scores on anxiety. However, the outdoor group performed significantly lower on the arithmetic pre-test. -Intrinsic motivation decreased significantly in the indoor group, not in the outdoor group. No significant changes were observed in extrinsic motivation, anxiety and self-efficacy between the groups.

Summary of papers

Paper 1

Fägerstam, E. (2012). Children and young people's experience of the natural world: Teacher's perceptions and observations. *Australian Journal of Environmental Education, 28(1),* 1-16.

Aims

The aim of this study was to explore environmental education centre (EEC) officers' and science high school teachers' observations and perceptions of children's experience of nature. An additional aim was to explore how teachers' perceived the potential of nature experiences. Environmental education could be explained as 'learning that helps people to understand and appreciate the environment and their connection and impact on it' (NSW, Department of Education and Training, 2001), and a term used to describe competency that includes understanding various philosophies on ecological sustainability is 'ecological literacy' (Orr, 2004). Certain scholars have argued for increased emphasis on ecological literacy in Australia given the large impact on Australian ecology, flora and fauna from European settlement as well as a highly urbanised and ethnically diverse population (Stewart, 2006, 2011; Stewart & Műller, 2009; Zemits, 2006). Nature experience could be one component in ecological literacy (Orr, 2004).There is an on-going debate in the literature on children's decreasing experience and contact with nature (Kellert, 2002, Malone, 2007), but few studies have focused on how urban children experience nature.

Method

Semi-structured interviews (duration approximately 45-60 minutes) with thirteen environmental education centre officers and eight science high school teachers were conducted. The EECs and schools were in the Sydney region of New South Wales, Australia. The interview questions were about outdoor teaching and learning in general; the benefits and challenges from outdoor teaching in Sydney's ethnically diverse setting; children's sense of belonging to nature and 'sense of place'; as well as the relationship between outdoor environmental education and a sense of belonging. The data were analysed using thematic analysis (Braun & Clarke, 2006; Boyatzis, 1998).

Results

According to the participants in this study, students' experience with nature could be described as emotional, rare and fragmented. The teachers' perceptions and observations were that the students were generally engaged and interested outdoors, but many participants also report fear and discomfort in nature. Students often lacked first-hand experience with Australian nature, and, at times, visits to EECs were the only way they experienced the natural world, according to many participants. Apart from visits to EECs, school-based outdoor learning was rare because of, for example, safety issues, and inflexible and crowded curriculum as well as a lack of confidence in outdoor

teaching. This limited experience resulted in a vicarious decontextualised understanding of nature, where children learn from media and do not recognise the unique nature of Australian flora and fauna. This was particularly true for migrant children but also for Australian-born children. The high school teachers emphasised a relationship between ecological knowledge and understanding as well as development of a place identity in the Australian environment. An additional aspect emphasised in particular by the EEC officers but also by many high school teachers was the potential for an emotional response and connection to nature as a consequence of outdoor environmental education, which was thought to facilitate further environmental concerns.

Discussion

A perceived link between experience, connection to nature and environmental concerns was strong despite the limited support from research (Heimlich, 2010; Kollmus & Agyeman, 2002). However, studies also support a relationship between connectedness and environmental concerns (Chen-Hsuan Cheng and Monroe, 2010; Dutcher, Finley, Luloff & Buttolph Johnson, 2007; Scanell & Gifford, 2010), which is likely complex and varies individually. Given a lack of general causality, encounters with nature may influence pro-environmental consciousness and further environmental concern consistent with participants' perceptions and should not be neglected in environmental education. The results that suggest that many children are uncomfortable and afraid in natural settings could be compared to teachers' aims for outdoor learning in nature as a way to promote positive emotional feelings and a sense of belonging and identity. A one-day visit to an EEC is likely far too little to accomplish such goals given children's expressions of discomfort and fear. A pedagogical implication is that urban children must experience nature more continuously and that everyday school practice should include more first-hand experiences in nature to meet ecological literacy goals.

Paper 2

Fägerstam, E., & Blom, J. (2012). Learning biology and mathematics outdoors: effects and attitudes in a Swedish high school context. *Journal of Adventure Education and Outdoor Learning, DOI:10.1080/14729679.2011.647432.*

Aims

This study explores the impact of outdoor teaching and learning on students' performance and attitudes in a Swedish junior high school. There is a lack of research examining school-based outdoor learning particularly in the secondary school context (Rickinson et al., 2004; Thorburn & Allison, 2010). The aim of this study was twofold: first, to ascertain whether the context for learning impacted student's learning outcomes in biology and, secondly, to explore students' perceptions on outdoor teaching and learning in biology and mathematics. Previous studies have primarily been quantitative and/or examined effects from out-of-school learning, such as through visits to outdoor or environmental education centres (Eaton, 1998; Hamilton-Ekeke, 2007; Prokop, Tuncer & Kvasnicak, 2007). This study contributes to the research on outdoor learning by focusing on regular school-based learning in secondary school using qualitative and quantitative data from a mixed-model design (Johnson & Onwuegbuzie, 2004).

Method

A mixed method research approach was applied (Creswell & Plano Clark, 2011). Qualitative data through essay-type questions were collected from all students in four classes (two Year 7 and two Year 8 classes, n=88) at the beginning of their biology courses and repeated approximately six months after the courses were completed. In Year 7, the topic was classification, and in Year 8, the topic was ecology. One Year 7 and one Year 8 class composed the experimental groups and received six outdoor lessons each. The corresponding classes were primarily taught indoors but received two outdoor lessons each. The essay-type questions were categorised according to the Structure of Observed Learning Outcome (SOLO) taxonomy (Biggs & Collins, 1982; Magntorn & Helldén, 2007). The five different levels of understanding in the SOLO taxonomy are: pre-structural, uni-structural, multi-structural, relational and extended abstract. Portions of the qualitative data from the essay-type questions were quantified and statistically analysed using the Mann-Whitney U-test.

Five months after completion of the biology courses, semi-structured interviews with 21 of the students from both Years 7 and 8 were conducted. The duration was 10-20 minutes, and they were asked to recall the course content and activities as well as discuss their perceptions of this new manner of teaching. The interviews were analysed through open coding followed by focused coding, which is inspired by the grounded theory (Charmaz, 2006). One category developed from analysis of the data, 'activity and content', and

the number of content-related terms was statistically analysed using the Mann-Whitney U-test.

Results

Analysis of the essay-type questions according to the SOLO taxonomy revealed no significant differences in either Year 7 or 8. The level of understanding was rather low with an approximate mean of 2 for all classes. However, the outdoor class used examples to illustrate the hierarchical classification levels twice as often in Year 7 ($z=-1.93$, $p<0.05$).

During the interviews, when the students were asked to recall the biology course they had participated in five months earlier, certain differences between the groups were observed. The indoor group, particularly from Year 8, had vague and diffuse memories and primarily recalled teacher-oriented activities. The outdoor group more clearly recalled the course activities and used significantly more content-related terms ($z= -2.12$, $p<0.05$) as well as a combination of verbs and nouns that described the activities and content ($z=-2.8$, $p<0.05$) from their coursework.

Analysis of the interviews revealed that outdoor teaching and learning, which was a new method to the students in this study, was highly appreciated. The students enjoyed the novelty aspect and break from their daily routines. They also appreciated the first-hand outdoor experiences and increased interaction among the students in the outdoor learning settings. All students expressed positive feelings, although cold and wet weather, noise as well as difficulties in concentrating and hearing the teacher were also mentioned.

Discussion

The results using the SOLO taxonomy revealed no significant differences between the groups, but the sample was small and the amount of outdoor teaching was limited. However, certain qualitative differences in the way the students recalled and discussed their coursework were observed with the outdoor group revealing more vivid memories. Recent in neuroscience research may contribute to the understanding the differences in long-term memory retrieval. The cognitive model for dual memory systems assumes that humans have two distinct, separate memory systems, the declarative/explicit and non-declarative/implicit that operate in parallel (Björklund, 2008; Rajah & McIntosh, 2005). According to this model, differences in long-term memory retrieval may be due to both conscious and unconscious aspects, sensory perception, emotions and novelty (Björklund, 2008; Damasio, 1994; Krebs, Schott, Schütze & Düzel, 2009; Wittman,

Sciltz, Boehler & Düzel, 2008). For the students, multi-sensory perceptions, positive emotions and the novelty aspect could have contributed to the difference in recalling course content and activities. This was a small-scale study, but the implications from this study are that outdoor teaching and learning is an appreciated complement to traditional classroom teaching, and students that are partially taught outdoors performed equally or slightly better than their indoor counterparts on typical textbook questions.

Paper 3

Fägerstam, E. (2012). High school teachers' experiences of the educational potential of outdoor teaching and learning. *Manuscript submitted for publication.*

Aims

Few studies have explored school-based outdoor learning in a secondary school context (Rickinson et al., 2004; Thorburn & Allison, 2009), and this study aimed to explore high school teachers' experiences with regular school-based outdoor teaching and learning. A second aim was to explore the way that teachers' perceptions of outdoor teaching and learning changed after involvement in a one-year outdoor teaching project. Previous research on learning on school grounds suggests potentials and barriers (Dyment, 2005). The potentials are, for example, a shift towards a more contextual, multisensory and interdisciplinary learning experience. Reported challenges are, for example, a lack of confidence, time, resources and interest from the students (Bentsen et al, 2010; Dyment, 2005; Han & Foskett, 2007; Rickinson et al, 2004).

Method

This study is based on semi-structured interviews with twelve junior high school teachers from different disciplines. Ten teachers were interviewed on their perceptions and experiences of outdoor teaching and learning before a one-year intervention project. Seven of the teachers and two additional teachers were interviewed after completion of the project on their experiences. The duration of the interviews was approximately 30-60 minutes. In the pre-project interviews, the participants were asked to discuss different learning environments (classroom, school ground, urban and natural environment) as well as their experiences and perceptions of teaching and learning outdoors. All post-project interviews began with the open question 'can you tell me about your experiences of outdoor teaching and learning

from this year?' The interviews were analysed using thematic analysis (Braun & Clarke, 2006; Boyatzis, 1998).

Results

According to the teachers in this study, outdoor teaching and learning has several potential advantages but also limitations and barriers. A primary theme after the project but not before it was the potential that outdoor teaching may increase student's collaboration and participation in school work. The students defined as 'shy students' by the teachers seemed to benefit especially when teaching was moved out of the classroom. Outdoor teaching also had the potential advantage to improve relationships between teachers and students. Potential educational advantages included increased on-task communication, particularly in language learning, and value on shared experiences in outdoor learning compared with and indoor learning and as support for further learning. Outdoor teaching had the potential to expand learning in school by using the proximal nature and municipality as a place to learn, but primarily, it was used to confirm outdoor learning as complementary to indoor learning. The high expectations for place-based and multidisciplinary learning before the project were difficult to realise. Lack of time and an inflexible schedule were mentioned as rationale for such difficulty. Despite the fact that the initial perceptions of the school ground were that it was an unattractive and excessively noisy learning environment, this was the place primarily used, and it was a good environment according to the participants. A common theme before the project was perceived disciplinary problems and lack of interest from the students, but student's interest and enjoyment were perceived as a significant advantage after the project. However, the change in method was not always smooth. All teachers witnessed an introductory period that last for up to three months of problematic disciplinary issues and lack of concentration.

Discussion

The results from this study suggest that outdoor teaching in high school is possible and an appreciated complement to traditional classroom teaching. In many ways, the results from this study confirmed previous studies from a primary school, which demonstrates that outdoor teaching can increase experience-based multisensory learning as well as communicative and participatory learning (Jordet, 2010; Mygind, 2005). This study contributes research focused on regular outdoor teaching in a secondary school context. The findings reveal that students need not travel far away to experience positive benefits from outdoor teaching, which was the focus of many

previous studies on secondary schools. Furthermore, learning on school grounds and near the school positively impacted students' enjoyment and motivation. Contrary to initial perceptions of outdoor education as primarily 'authentic' learning at particular places away from the school, this study suggests instead that the social and physical space of the school grounds contribute substantially to the advantages teachers experienced from outdoor teaching.

Many teachers' witnessed a long introductory period before they could optimally use the outdoor environment due to disciplinary problems. However, in the end, they found it worthwhile, which may be an important observation for practical implications.

The teacher's experiences indicated that an outdoor learning environment can introduce learning experiences that are consistent with Jarvis' (2006) emphasis on three dimensions of learning, cognitive/content, social and emotional. The importance of the emotional aspect of learning was also stressed by Immordino-Yang and Damasio (2007) and Immordino-Yang (2011), although further studies are necessary to evaluate the possible impact of positive emotions on students' academic achievement.

Paper 4

Fägerstam, E., & Samuelsson, J. (2012). Learning arithmetic outdoors in junior high school-influence on performance and self-regulating skills. *Education 3-13: Journal for Research in Primary, Elementary and Early Years Education,* DOI: 10.1080/03004279.2012.713374.

Aims

There is limited research exploring the impact of the learning environment on mathematics (Boaler, 1999; Samuelsson, 2008) especially for outdoor learning. Moffet (2011) and Noorani et al., (2010) explored the attitudes towards outdoor mathematics learning, but to the authors' knowledge, there are no studies exploring the influence of outdoor learning on academic performance. The aims for this study were to explore the possible influence of outdoor teaching and learning on junior high school students' performance in arithmetic and self-regulation skills (intrinsic motivation, extrinsic motivation, self-concept and anxiety).

Method

Five Year 7 classes, wherein students are 13-14 years old, participated in the study (n=86). Two classes were taught one of their four weekly mathematics lessons outdoors through the entire year (outdoor group). The other classes were taught traditionally indoors with lecturing and independent work in text books (traditional group). At the beginning of Year 7, the students answered a test that measured arithmetic skills and a questionnaire on self-regulating skills. After ten weeks, they were given a similar post-test on mathematic skills and the self-regulating skills questionnaire again. The self-regulating questionnaire was also distributed at the end of the year. The number of students that answered all three self-regulating questionnaires and mathematic tests was 28 in the traditional group and 26 in the outdoor group. The data were analysed using the Friedman ANOVA, Wilcoxon signed rank test and Mann-Whitney U-test.

Results

Initially, a difference in arithmetic skills was observed between the groups. The traditional group performed significantly better on the pre-test ($z=-2.13$, $p<0.05$). The mean test score for the traditional group was 22, and it was 20 for the outdoor group. However, after the ten-week intervention, no significant differences were observed between the groups (figure 4). The traditional group improved their performance significantly over time ($z= -3.18$, $p<0.001$) as did the outdoor group ($z= -4.15$, $p<0.001$).

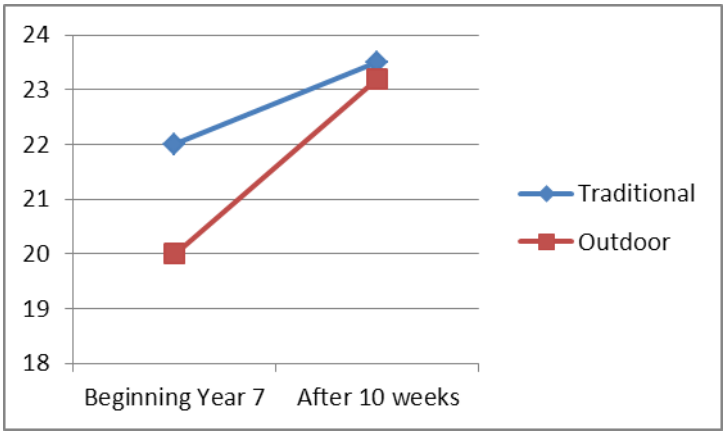

Figure 4. Mean test scores in arithmetic for the two groups of students before and after an outdoor teaching intervention.

To conclude, the outdoor group improved their performance more than the traditional group; although, unsurprisingly, both groups improved their skills after the ten-week course in arithmetic.

Initially, a significant difference was observed between the groups in extrinsic motivation ($z=-2.46$, $p<0.05$) and self-concept ($z=-2.26$, $p<0.05$); the outdoor group scored lower. The outdoor group also scored significantly higher in anxiety ($z=-2.04$, $p<0.05$). Initially, no significant difference was observed for intrinsic motivation, but intrinsic motivation changed significantly over time (figure 2), χ^2 (2) =5.94, p=0.051. Intrinsic motivation decreased significantly for the traditional group from the beginning of the year to the first post-test at 10 weeks, $z= -2.77$, $p<0.01$. No other differences were observed, although the trend demonstrated that the outdoor group initially showed decreased intrinsic motivation (figure 5). Thus, there were initial differences in three of the four variables (extrinsic motivation, self-concept and anxiety); the outdoor group reported less confidence, higher anxiety and less extrinsic motivation. However, only one variable (intrinsic motivation) changed significantly over time. The traditional group showed decreased intrinsic motivation between pre-test and the ten-week post-test, but the outdoor group did not.

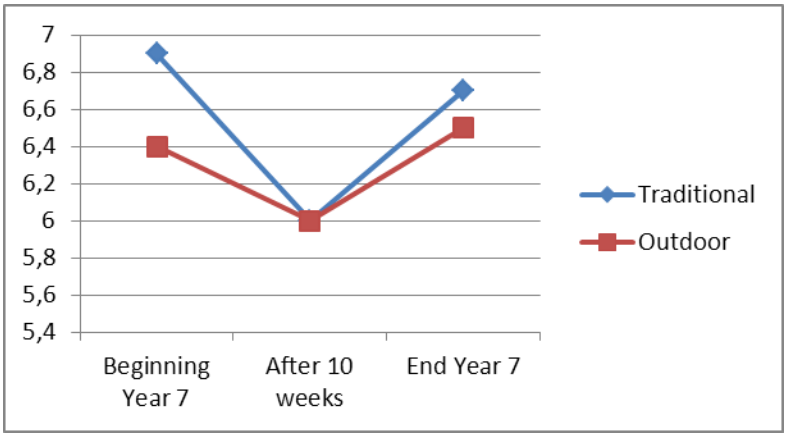

Figure 5. Differences in mean score for intrinsic motivation between the two groups of students.

Discussion

The results demonstrate small but significant differences between the groups in arithmetic skills and intrinsic motivation. In discussing the results, there are likely many factors that influenced such results. Such influences may include the teacher and a larger potential for development in the outdoor group. However, the observation that the outdoor group improved their results more than the indoor group despite lower scores in extrinsic motivation and self-concept and higher scores in anxiety suggests that the 'outdoor teaching' variable may have influence, as low self-efficacy and high anxiety have been shown to negatively impact mathematic performance (Shores & Shannon, 2007; Wells, 1994). Outdoor mathematic instruction was often organised as cooperative small-group learning in friendly competition, which has been shown to positively impact academic performance (Hattie, 2009, Opdenakker & Van Damme, 2006; Springer, Stanne & Donovan, 1999). Given the significant decrease in intrinsic motivation in the traditional indoor group but not in the outdoor group, the results support an earlier observation that students appreciate outdoor mathematics (Moffet, 2011; Noorani et al., 2010).

6. Discussion

Based on the analytical framework presented in chapter 3, this discussion will interpret the findings from all four papers. How do they corroborate, and what inferences can be made? This chapter begins with certain general reflections, which is followed by a section that revisits the results, and final interpretations of the findings from all four papers are discussed. Thereafter, barriers and limitations are discussed. The chapter ends with implications, areas for further research and concluding remarks.

General reflections

A minority of the teachers at the Swedish high school taught outdoors on a regular basis during the project, which indicates that this approach has limitations. The results from the Australian study also revealed that outdoor teaching was rarely practiced apart from the yearly visit to environmental education centres. Organisation of high school education does not easily comport with outdoor education in place-based multidisciplinary teaching for journeys away from the school grounds. However, school practices do not easily change, and expecting substantial changes in teaching methods over one year is likely unrealistic. The mean number of lessons each class were taught outdoors in the school project were one per week compared with the suggested three to four lessons a week; although, there were signification differences between classes and subjects. One outdoor lesson per week may not seem significant, but compared with the statements from teachers and students that outdoor learning transpired once or twice a year before the project, it is a considerable difference. Thus, ecological validity in the Swedish studies should be considered high. Outdoor teaching became a well-known and regularly practiced teaching method to complement the traditional classroom practice. Although it was primarily the mathematics and language teachers (Swedish, English, German) that regularly and frequently used the outdoor environment, social science teachers did so fairly often, and all subjects (but not all teachers) were represented outdoors on occasion. Future studies may reveal long lasting changes from the project.

The teacher effect would likely benefit from more attention. As Damber (2010) concluded in her study on second language learning, the teacher has a profound effect on achievement in literacy. In research on outdoor education, the teacher effect is seldom emphasised, which is also true for this thesis too.

The increase in mean final grades, which produced a gap between the school involved in this project and the remaining high schools in the municipality, is interesting but difficult to interpret. One possible explanation is that outdoor teaching during the project increased the students' academic performance. All of the Year 9 students participated in the project; although, the level of outdoor teaching varied between classes. An additional interpretation is that the outdoor teaching enhanced the relationship and communication between students and their teachers. This may have provided particularly unobtrusive students with a greater opportunity to demonstrate their knowledge and, consequently, raise their grades. However, the gap might also be a coincidence or unintended effect of the project, the 'Hawthorne effect' (Jones, 1992). The Hawthorne effect refers to the tendency for study participants to change their behaviour because they are observed. Students balancing between two grades may have more often received the higher grade because of teachers' unconscious or conscious response to participating in the teaching project that examines the effects from a different teaching method.

The 21 students in study II were positive toward outdoor teaching; although, there were differences primarily in the students' perception of its influence on concentration and focus. Comparisons between the outdoor and indoor groups in academic performance revealed no significant changes or favoured the outdoor group (II and IV). Thus, although outdoor teaching was considered time demanding by the majority of teachers and less efficient by certain teachers (papers I, II, and III), my results do not indicate a negative impact on students' academic performance, rather the opposite. The implications are that, given the physical and psychological benefits of outdoor activity (cf. Annerstedt & Währborg, 2011; Söderström, 2011), outdoor teaching in high school could be practiced more than it is currently practiced.

The results revealed that outdoor teaching can positively influence the three different dimensions of learning emphasised by Illeris (2002, 2007) and Jarvis (2006); thought, the social and emotional dimensions were most easily discerned. Further research exploring the content dimension is necessary; although, on-task communication and shared experiences were two unexpected but valuable advantages. An interesting observation was that outdoor teaching afforded social and physical space (on the school grounds) that seemed to be more important as prerequisites to learning than the students' individual experience at a specific place (papers II and III). This contrasted with teachers' initial perceptions of the potential for outdoor teaching, where place-based learning, 'authentic' learning and journeys away

from school were common themes. Stevenson's (2008) question is as follows:

> What is mean by 'place': the physical, biophysical, social, or cultural, or all of these? Which aspects or dimensions of the local and place are important pedagogically to engage students? (p. 354)

One answer could be that physical and social space play a much more important role in students' engagement than is discussed in outdoor- and place-based education literature. The Australian teachers (paper I) emphasised the value of biophysical place (a nature experience) in terms of place attachment, place identity and environmental concerns, which are themes that certain Swedish participants (paper III) also discussed. This theme is a debated issue in the literature. Liseberg Jensen (2011) concludes that the assumption that children need contact with nature is a question of norms and values in the society. Whether this assumption is 'true' or not is difficult to test. Lisberg Jensen further argues that if there is societal support for the idea that a nature experience is a means to well-being and sustainability, then it suffices to encourage children's contact with nature. Sandberg (2012) emphasises the role of school in supporting children's contact with nature; observations in this thesis confirm such emphasis.

Results revisited: an analytical summary

The aim of this section is to corroborate findings from all four papers and discuss the results from a theoretical perspective of the three dimensions of learning and dimensions of space and place. The analysis is also summarised in figure 6 at the end of this section. I am aware of the difficulty of analysing my results from both a learning perspective and a place perspective. However, my intention is that this attempt will expand understanding of the nature of the 'learning' in outdoor learning, which has been identified as a blind spot by Rickinson et al., 2004.

Shared experiences: content, social and emotional dimensions as well as space and place dimensions

Many teachers discussed shared episodic memories from learning in places other than the classroom as a valuable consequence of outdoor teaching. It is difficult to relate such shared experiences to either the dimensions of learning or the space and place dimensions; likely they are all related. The teachers used the shared experiences as a pedagogical tool for further learning and transfer between outdoor and indoor teaching. The teachers had few

difficulties in organising outdoor and indoor teaching in a coherent way; neither teachers nor students expressed difficulties concerning the interplay between indoor and outdoor teaching. Thus, regular school-based outdoor teaching and learning were easily incorporated in the daily work and did not generate fragmentation or 'high cost and low transfer value' (c.f. Thorburn & Allison, 2010).

Multisensory, experience-based and embodied learning: content dimension as well as space and place dimensions

Students' long lasting episodic memories from the coursework (II) and a greater improvement in arithmetic, regardless of the lower scores on self-concept and higher scores in anxiety, suggest an advantage to outdoor teaching (IV). However, it must be noted that the sample was small in the second study, and the fourth study comprised many confounding variables. The essay-type question test did not reveal any significant differences between the groups, which suggest that a few lessons outdoors do not have a great impact on assessment scores for typical school book questions. However, other qualities may be associated with the outdoor lessons that are difficult to capture in a single test. Place and space outdoors are different from a classroom settings. The students in the outdoor group participated in an ecological practice where a particular place in nature was explored, which resulted in memorable narratives wherein they were active participants in contrast to the indoor group, who primarily discussed teacher-oriented activities.

The physical outdoor space enabled embodiment of the subjects taught which might have improved understanding by adding another dimension to mathematics learning, but it also improved student's attention and focus. The outdoor mathematic lessons often transpired in the green area on the school grounds (see figure 1). Several studies suggest that green outdoor environments reduce stress and improve attention (Annerstedt & Währborg, 2011; Kaplan, 1995; Söderström, 2011; Faber Taylor & Kuo, 2009; Wells & Evans, 2003), which may have impacted students' mathematic learning.

According to teachers and students (I, II, and III), one major potential for outdoor teaching was relating scientific theoretical knowledge to everyday understanding and personal experience. They acknowledged that 'seeing, feeling and doing' added another dimension to the learning process compared with only reading in books. An explanation from a biological point of view is that a person's integrated information from different sensory systems afforded by the outdoor environment is assembled in the brain to produce a

coherent picture (Ghazanfar & Schroeder, 2006), which enhances conscious and unconscious learning as well as viable episodic memories (Björklund, 2008; Moreno & Mayer, 2007; Stolpe, 2011).

Jordet (2010) discusses the relationship between indoor and outdoor experiences as a hermeneutic circle, wherein outdoor activities continuously interact with indoor reflections, which further prepare people for new outdoor activities. However, the results from this study indicate that the outdoors was primarily used in a deductive manner to confirm and solidify indoor textbook knowledge.

On-task communication: content and social dimensions as well as the space dimension

An interesting observation was that the language and mathematic teachers in particular regularly practiced outdoor teaching. Students' increased self-confidence in speaking a second or third language and increased on-task communication were two examples of advantages observed by the teachers.

In the pre-project interviews, the language teachers expressed concerns on how they could utilise the outdoor environment. A common view was that it is easy for science teachers but not language teachers to teach outdoors. In contrast to this initial concern, the findings revealed that science was a subject least frequently practiced outdoors, and language was a subject most frequently taught outdoors.

The frequency of outdoor teaching in this study is possibly more related to specific individuals than particular subjects, but it is an interesting observation that language was taught outdoors so frequently with positive results. This observation is in contrast to earlier studies where science, particularly biology, was the primary subject for outdoor teaching. An important implication for teaching is that outdoor teaching in high school is not restricted to science and geography, but it has educational potential for language and mathematical learning as well as for other subjects.

Collaboration, cooperation and participation: social and space dimensions

A theme that was not expected initially but was frequently reported is increased and improved social relationship and social learning outdoors. The space outdoors seemed to improve social mobility, and students collaborated and participated more (papers II and III). Teaching outdoors had an impact on how learning was organised. Observed in this study, outdoor teaching lends itself to small group learning and practical student-centred learning

more easily than classroom learning (papers II, III, and IV). A logical consequence of small-group practical learning is increased communication.

An assumption for certain socio-cultural approaches to learning is that higher cognitive skills in individuals develop through participation in socially and culturally organised activities. A possible reason is that collaborative learning aids students in combining their abilities for more complex achievements than the students could have achieved individually (McCormick & Paechter, 1999). Teachers and students reported how outdoor learning favoured on-task communication, which was discussed in the previous section.

Altered relationship: social and emotional dimension as well as the space dimension

Improved teacher-students relationships was a theme discussed by many of the participants; for example, students that typically maintain a low profile increased their participation. Such altered relationships were also likely an aspect of the positive climate in the class, as discussed later. Altered and improved teacher-student relationships as a result of outdoor teaching were also observed in previous studies, primarily in a primary school context (Jordet, 2007; Mygind, Dietrich & Stelter, 2009). This thesis suggests that altered relationships between teachers and students as well as students and other students as a consequence of outdoor teaching are not restricted to primary school students; high school students and teachers also appreciate the altered class hierarchies. A finding not often discussed in previous research and literature was that so called shy students seemed to benefit particularly when teaching was moved to the outdoor space. Teaching and learning in the outdoor space also had the potential to challenge boundaries between 'high achieving' and 'low achieving' students according to the teachers. A larger number of students obtained the possibility to demonstrate other aspect of their personalities as well as different abilities and capabilities.

Place identity and place attachment: social and emotional dimensions as well as the place dimension

If dimensions of space dominated the Swedish study, places such as nature and our connection to it compose significant dimension of outdoor teaching and learning in the Australian study (paper I). However, certain Swedish teachers also discussed outdoor teaching as a way to develop a connection to nature and place-based education as a way to increase knowledge on the nearby environment as well as increase place attachment to the neighbourhood. The general view was that children today have limited

possibilities to experience natural environments, which results in a vicarious understanding and limited ecological literacy. The Australian teachers also discussed personal experience in nature as a component in developing and understanding an Australian identity particularly for migrant students.

The perception of place herein is consistent with Relph's (1976) notions of insideness and belonging to the Australian natural world. The common view was that children needed support in their journeys from outside to inside experiences and to develop a sense of place. Lewicka (2011) suggested that a sense of place and place attachment are important for human existence. Lewicka (ibid.) further argued that the question of 'how to reconcile the need for close emotional ties to specific places, with the fluidity of the contemporary world is a real challenge' (p. 226). This challenge was emphasised by the majority of the participants in the Australian study and many of the Swedish participants. In contemporary urban societies where direct nature experience is less frequent (Sandberg 2012), outdoor teaching could be a way of introducing children to nature and allowing them the opportunity to enjoy nature instead of being fearful of it. However, fear and discomfort were primarily emphasised in the Australian perspective. That Australia has a more dangerous fauna than Sweden is certainly one possible explanation. However, the Swedish tradition of encounters with nature, which is facilitated by the law of public access to nature, might also have contributed to the observation that Swedish teachers and students seldom mentioned fear or discomfort as barriers to outdoor teaching. However, the results suggest that outdoor teaching and learning have the potential to expand school knowledge by using nearby nature and community as places for learning in high school, although the high expectations of this 'place-based' approach were not realised.

Enjoyment, engagement and break from the daily routines: the emotional dimension as well as space and place dimensions

A primary concern initially expressed was students' supposed lack of discipline and engagement in outdoor situations. However, contrary to initial views, a primary theme after the project was the potential for increased enjoyment and engagement among students due to outdoor teaching and learning (II, III, and IV). Interested and engaged students outdoors was also observed by the majority of Australian teachers (I); although, they also reported fear and discomfort in nature. Positive affective outcomes are not new. However, in previous research, the results primarily relate to a one-time occasion, a shorter period of time or are from a primary school. The novelty

aspect was likely a factor of importance therein, as in study II. The contribution from this study is two-fold. First, it confirms the previous study by Mygind (2009) that novelty is not a primary factor because regular outdoor teaching and learning evoked positive feelings of enjoyment and interest. Second, in contrast to earlier studies, these outcomes were in a high school context, which is an area that needs more studies

Enjoyment, interest, engagement as well as good relationships between teachers and peers can characterise a good climate in a class (Damber, 2010). A good climate in the class was an important indicator for class success in second language learning (Damber, ibid.). The findings from this study suggest that outdoor teaching on the school grounds can improve the class climate at a rather 'low cost'. The variation and break from the daily routines afforded by the outdoor space and place was likely also a contributing factor. This aspects is also related to content and social dimensions.

The primary findings from the four papers included herein are summarised in figure 6. I am aware of the difficulty of presenting five dimensions in a two-dimensional figure, and figure 6 should not be understood as a fixed matrix where the different educational potentials are strictly related to one or two of the dimensions of learning or to space *or* place. However, in certain cases, I found that the suggested potential was more related to a particular dimension, whereas in other cases, different potentials were more overarching. The reason for including the figure is that it may aid the reader in understanding the primary findings on educational potential for outdoor teaching and learning comprehensively as it was experienced and expressed by the participants in the four papers. The figure is intended as a summary and complement to the written discussion.

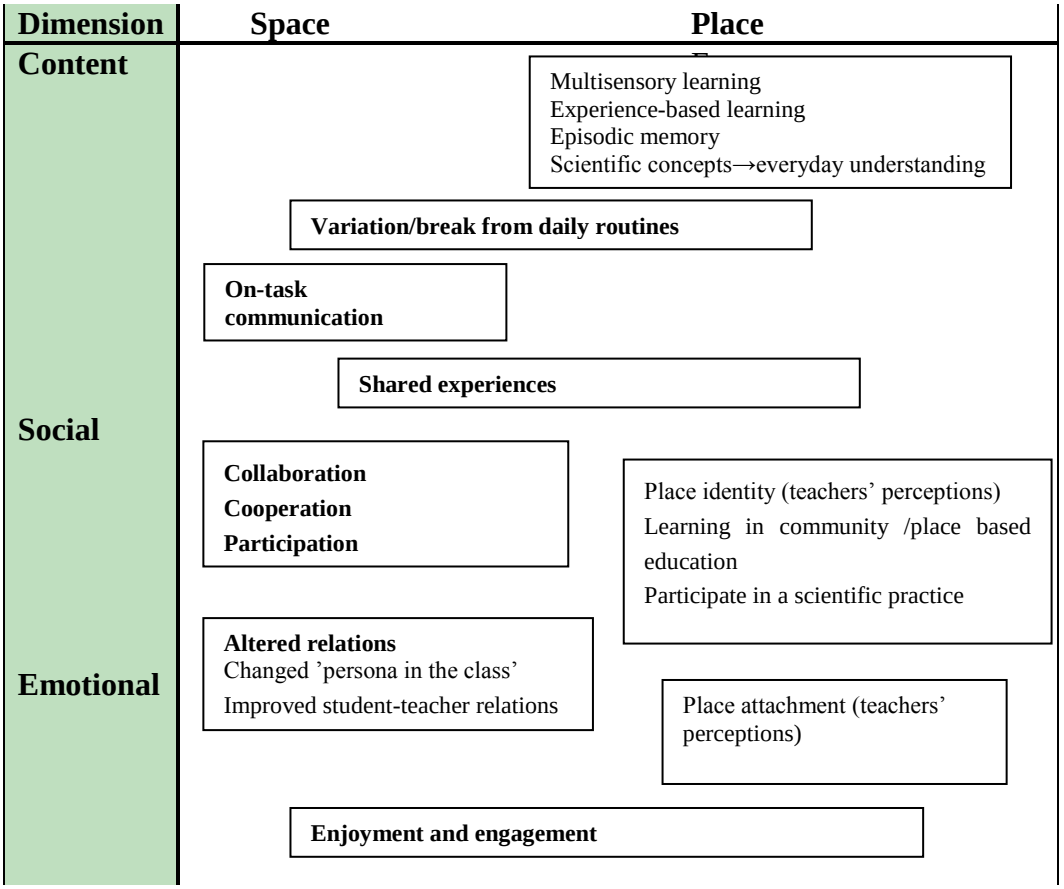

Figure 6. A summary of primary findings from four empirical studies. What was the educational potential of outdoor learning in terms of the theoretical perspectives of the three dimensions of learning and two dimension of place? Position in the figure is intended to relate to the most appropriate dimension/s. Bold font indicates more emphasis from participants than normal font.

Barriers and limitations

Leaving the classroom is not an easy task for the majority of high school teachers. The results from the Australian study (paper I) and Swedish longitudinal study (paper III) showed that teachers perceive many barriers to outdoor teaching, primarily an inflexible time schedule that leaves little room for time-demanding outdoor activities. Many teachers regarded one lesson as too short to teach 25 students outdoors and have time for travel, teaching and concluding. The reflective portion of the outdoor experience was characterised as very important by several teachers. Other barriers mentioned by both Swedish and Australian teachers were a lack of equipment, for example in science class, and a crowded curriculum. On the other hand, the need for provision of outdoor activities stated in the syllabus was a rationale for outdoor teaching in Australia. When this discussion is written, there are extended explicit aims in the syllabi for biology, geography and physical education related to outdoor activities (Swedish National Agency for Education, 2011). How this will affect the teaching practice is an open question, but likely, the frequency of outdoor teaching will increase in Swedish schools, as syllabus requirements was often the primary rationale for Australian teachers. Differences between the countries were that safety aspects and organisational issues, such as the need for parents' consent, are barriers in Australia, not in Sweden.

An experience made by many of the participant teachers was the long implementation period, up to three months, before the students realized that going outdoors was part of everyday school practice. During the transitional period, lack of discipline and concentration were a concern.

The view on the outdoor lessons was contradictory. Many teachers believed they were valuable and gave students varied opportunities to learn in other ways than the traditional classroom. On the other hand, they were regarded as 'bonus-lessons' and were easy to withdraw if there was an assessment period or if the students had not behaved well during earlier outdoor lessons.

The Swedish teacher study revealed that the teachers had many expectations before the project that were not really realised. Place-based education at settings other than the school was not frequent primarily because of time and cost for travel; although, this was more frequent than before the project. The multidisciplinary approach frequently discussed in the pre-project interviews was not practiced. As one teacher stated, 'one new methodological thing at a time is sufficient' was most likely a major reason why teacher collaboration and multidisciplinary teaching was not an observable consequence.

Implications

The results from this study suggest that outdoor learning on a regular basis in high school have many potential advantages. Social and emotional dimensions of learning were clearly positively influenced. In this study, outdoor teaching generally increased the students' desire to learn. They often expressed curiosity, engagement, wellbeing and enjoyment in the outdoor learning situation. As Sanderoth (2002) concluded,

> …desire to learn in school correlates with a feeling of satisfaction, a capacity for confidence, commitment and wellbeing. Desire to learn can increase if the pupils see the significance of certain activities, and decreases if the pupil is not involved in the activity. (p. 340)

This is possible in a traditional classroom situation, too. However, to a larger extent, the outdoor environment afforded a social and physical space as well as meaningful places to evoke a desire to learn in the students. In Dambert's (2010) study of what characterises over-achieving classes in second language learning, several factor were identified. Students' recalled a good climate in class as fundamental for successful learning. Her findings on successful factors can be compared to findings from this study. Outdoor teaching and learning could facilitate enjoyment, interest and good interpersonal relations, which have been identified as success factors by Damber (ibid.).

Sanderoth (2002) argued that students' in Western societies often find school meaningless, and their desire to learn disappears. Sanderoth also claimed that a challenge for the school is to create learning situations that are perceived as meaningful and related to students' everyday world. The results from this study suggest that outdoor learning have many qualities requested by Sanderoth (ibid.).

There was large variation in teachers' individual use of the outdoor environment, which is likely more related to intrinsic motivation than external factors, such as the subject taught, even though certain subjects seemed easier than others to teach outdoors. Lack of self-confidence is a previous reported factor limiting teacher's use of the outdoor environment. Given the educational potential for outdoor teaching and learning as demonstrated by the thesis herein, outdoor teaching could be relevant as part of pre-service teacher education, which would at least allow teachers to make an informed choice on when to go outdoors or indoors. One observation that may have implications for practice is that, despite teachers' initial concerns, the school grounds were good learning environments. Positive outcomes, which were suggested in research concerning outdoor learning in settings

away from school, were also reported when teaching was moved out only to the school grounds.

Areas for further research

An area for further research is to explore students' experience and perceptions after outdoor teaching has been a regular practice for a longer period of time. In the study on students' attitudes (paper II), it was their first experience with regular outdoor teaching, and the novelty aspect was clear. Do their perceptions change when outdoor teaching has been practiced during their entire high school period?

Another area for research is to explore why so many teachers do not practice or want to practice regular outdoor teaching. A minority of the Swedish teachers did teach regularly outdoors during the project year; although, the majority of the participating teachers in the project did try, and all participating teachers in the studies (papers I and III) could discuss advantages. Jordet (n.d.) discussed teachers' competences in relation to outdoor teaching. He distinguished between subject, leadership and relational competences. My studies indicate that certain teachers had difficulties with outdoor teaching and students' participation, whereas others did not. In what way does the outdoor environment challenge different competencies? If increased enjoyment, engagement and performance, in mathematics or other subjects, are related is an area for further research. The role of emotions in cognition has been emphasised by several scholars (Immordino-Yang, 2011, Immordino-Yang & Damasio, 2007; Jarvis, 2006; Larson & Rusk, 2011). They argued that emotions and learning are deeply intertwined, and emotions should be given enhanced attention in educational research.

Concluding remarks

The results from this thesis confirm a great deal of previous research, but they also add new insights to the knowledge in the field of outdoor teaching and learning. Previous research on regular school-based outdoor teaching and learning has primarily been conducted in primary schools, and this thesis contributes by adding research results from a secondary school context. My results revealed that changing teaching methods is difficult because the expected three to four lessons per week did not transpire. In addition, only a small number of teachers taught outdoors regularly throughout the entire project year. However, the mean of one outdoor lesson per week and class was a considerable change and provided a solid foundation for the results presented herein. Several teachers that participated in the interviews used the outdoor environment more frequently.

To broaden the area of study to include Australian teachers highlighted similarities and differences between the two countries. Teachers from both countries perceived outdoor teaching as a way to improve students' place attachment as well as knowledge and understanding of the local environment. One difference was that in the ethnically diverse city, Sydney, experiences outdoors in the nearby natural environment were believed to aid students in developing a place identity. Australian urban children's experiences with nature could be characterised as emotional, rare and fragmented. They were primarily engaged in outdoor environmental education programs, but they often expressed discomfort in nature and had little knowledge about Australian ecology. From the perspective of ecological sustainability and Australia's unique and fragile ecosystem, this is problematic. A one-day visit to an environmental education centre per year is insufficient if we want children to connect with nature and develop ecological literacy, which could support future environmental concerns.

Place and space are indistinct concepts but are interesting and relevant for outdoor teaching and learning. The results from this thesis suggest that the social and physical space outdoors contributed more than the significance of a particular place for teachers' rationale in practicing outdoor teaching in the Swedish high school. Thus, dimensions of learning that are social and emotional were more prominent than content dimensions. However, despite teachers' perceptions of outdoor teaching as time-demanding and less efficient, no differences in academic performance were observed between students taught indoors or partially outdoors; the outdoor groups performed slightly better and had better recall of the course activities. This result suggests advantages in academic performance; although, this aspect requires further research. On-task communication, particularly in language learning, had one of the most evident academic potential as well as use of shared first-hand experiences as support for further learning, both indoors and outdoors.

If learning is perceived to build upon individual content learning, social and emotional dimensions, outdoor teaching has much to offer secondary school students. Outdoor teaching should not be practiced only in primary school; the high school students in this study expressed much engagement and enjoyment outdoors. A good climate in class is a vital component for successful learning (Damber, 2010) and outdoor teaching, also on the school grounds were a good way to achieve this.

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Appendix 1

Table 3. Number of lessons taught outdoors, physical education excluded. Self-reported data from two of the four teams of teachers at the school, 2009-2010, shown in total and as per cent in respective class and subject

Subject	**7a**	**7b**	**7c**	**7d**	**8a**	**8b**	**8c**	**8d**	**9a**	**9b**	**9c**	**total**	**%**
Swedish	2	0	4	1	2	1	4	1	5	2	0	22	2.1
German	7	7	8	8	1	1	8	9	7	7	7	70	4.5
English	0	2	0	1	4	2	2	18	0	1	1	31	3.5
Mathematics	9	2	9	32	0	1	10	31	14	8	27	143	14
Social sciences	4	2	4	7	1	4	5	2	13	8	1	51	3.4
Natural sciences/ technology	0	0	0	0	2	1	1	1	1	1	1	8	0.6
Domestic science	0	0	0	0	1	1	1	2	0	0	0	5	1.4
Creative arts	0	0	0	0	0	0	0	0	0	0	0	0	0
Visual arts	0	0	0	0	0	0	0	0	0	0	0	0	0
Music	0	0	0	0	0	0	0	0	0	0	0	0	0
Life style and health	1	1	1	1	4	4	6	4	0	1	0	23	2.2
Group time	0	0	0	1	0	2	1	5	0	0	0	9	1.8
Social activity	0	0	1	1	0	0	1	1	0	0	1	5	na
Physical activity day	0	0	9	9	0	0	9	9	0	0	9	45	na
total	23	14	36	61	15	17	48	83	40	28	47	412	
% of total time, year 7-9 respectively	3	1.8	4.6	7.9	1.8	2.0	5.7	9.8	4.7	3.3	5.5	4.6	

Appendix 2a

Interview guide for junior high school students (Paper II)

1. You read about ecology/the living world last semester. Can you tell me about that?
   - Is there anything particular you remember?
   - What did you do?
   - How did you like it?
   - Why?
   - What did you learn?
   - What was most interesting/fun with that topic?
   - What was not so interesting/fun with that topic?

2. Have you had lessons outdoors sometimes?
   - In what subjects?
   - What do you think about that?

3. What do you think of outdoor lessons compared to indoor lessons?
   - What are the differences?

4. Would you like to have more outdoor teaching?
   - Why/why not?

5. What do you think about science education?
6. Is there anything else you would like to tell me?

Appendix 2b

Interview guide for Australian EEC/high school teachers (Paper I

The first part of the interview included a discussion about four pictures (a meadow, an old industrial environment, school grounds, and a classroom)

This is a picture of a Swedish meadow that has been used for growing the hay used during winter. It is an example of a cultural natural environment that is still fairly common but is becoming less common due to different farming methods. They are currently used primarily for cattle grazing. They often have rich biodiversity, and many people find them to be beautiful and relaxing environments.

1a. Is there is a similar or corresponding environment in Australia?
1b. From your perspective as a science teacher/EEC officer, what is the potential of teaching and learning in the Swedish and Australian examples?

Same as above with an industrial landscape
Same as above with a schoolyard
Same as above with a classroom

2. Looking at these photographs from Sweden, what aspects of teaching and learning do you think are specific for each of these pictures (and the corresponding environments in Australia just mentioned)?

I would now like to hear your comments about field-trips/outdoor learning/place-based learning.

3. What is your own experience of field trips/outdoor teaching ?

Are there opportunities and times in your day-to-day teaching that lend themselves to students working outdoors?

Where have you taken students? Why?

How do you integrate outdoor learning/field trips into your current classroom practice?

4. Is the term “sense of place” familiar to you? What comes to mind?

What do you want your students to learn about the places where you teach?

Do you think outdoor learning helps students develop a “sense of place”? How?

Australia is a multicultural country like Sweden, and I wonder if you could tell me about your experiences teaching in an ethnically diverse setting.

5. What experience do you have working with students from diverse backgrounds?

6. What are the pedagogical challenges for you as teacher when working with students from diverse backgrounds?

7. How do students’ different backgrounds and experiences influence your teaching?

I would now like to focus on environmental/sustainability education in Australia and your perspective as a high school science teacher/EEC officer.

8. What do you think is the most important knowledge that young Australians need to have about environmental education for sustainability?

Why is this knowledge so crucial?

9. Is there anything more you would like to tell me?

Appendix 2c

Pre interview guide for Swedish high school teachers (Paper III)

Interview organized around four different pictures: natural environment (meadow), old industrial environment, school grounds, and classroom

1. Can you tell me what subjects you teach at this school?

2. Discussion around the four pictures. Each picture followed by the open question: what are your reflections about teaching and learning in this environment?

3. What is your previous experience of outdoor teaching?

4. Can you tell me something about your overarching aims with teaching?

5. What do you want to achieve?

6. Do you think outdoor education can contribute to those aims in some way? How?

7. What is your perception of outdoor education? Have it changed during the project?

8. Anything else you want to tell me?

Appendix 2d

Post interview guide for Swedish high school teachers (Paper III)

Can you tell me about your experiences and reflections from this year with outdoor teaching? Depending on what informants brings up the following issues are subject for further discussion

Differences outdoor teaching versus indoor teaching
Relation between outdoor and indoor teaching
Teacher collaboration
Student collaboration
Differences in academic performance from outdoor versus indoor teaching and learning
Examples of use of the outdoor environment during the project
Is there a significance of place, if so in what way?

Anything else you want to tell me?

Appendix 2e

Test in arithmetic for Year 7 (Paper IV)

Calculate

1.	$19+9=$	2.	$\frac{450}{9}=$
3.	$1-\frac{3}{5}=$	4.	$2.1+0.7=$
5.	$13.1+0.01=$	6.	$10-0.3=$
7.	$21\cdot 10=$	8.	$10\cdot 2.45=$
9.	$420/10=$	10.	$290-14=$
11.	$141/6=$	12.	$42\cdot 34=$
13.	$567+273=$	14.	$5\cdot 6.4=$
15.	$5\cdot 9.6=$		

Solve the following tasks

16. Underline the largest of the following numbers

1.49 1.499 1.5 1.099

17. Underline the smallest of the following numbers

$\frac{1}{3}$ 0.1 $\frac{1}{5}$ 0,5 $\frac{1}{8}$

18.Write the numbers which comprise

a) 3 multiples of hundreds, 5 units and 6 hundredth parts

_____

b) 3 multiples of tens and 4 tenth

_____

19. Underline the largest number

a) 0.1 0.7

b) 0.7 0.13

c) 0.44435 0.61

20. You have the number 123.45. Let the multiple of hundred change place with the tenth. What number do you get?

_____

21. What number should be written in the square [ ]

a) 10	20	30	[ ]	[ ]
b) 8.4	8.6	8.8	[ ]	[ ]
c) 14.34	14.32	14.30	[ ]	[ ]

22. What number is possible to divide with 3?

a) 124 235 336 88

23. What number is possible to divide with 5?

b) 467 982 170 23

24. Round the number 367.25 to

a) multiples of hundreds b) tenth

Appendix 2f

Self-regulation skills questionnaire (OECD, 2004) (Paper IV)

This is my view of mathematics

_____

Name Class

Intrinsic motivation

1 I enjoy reading about mathematics
Do not agree Totally agree

[ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ]

2. I look forward to my mathematics lessons
Do not agree Totally agree

[ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ]

3. I do mathematics because I enjoy it
Do not agree Totally agree

[ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ]

4. I am interested in the things we do in mathematics
Do not agree Totally agree

[ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [

Extrinsic motivation
5. Making an effort in mathematics is worth it because it will help me in the work that I want to do later

Do not agree Totally agree

[ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ]

6. Learning mathematics is an important subject for me because it will help me with the subjects that I will study further on in school
Do not agree Totally agree

[ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ]

7. Mathematics is an important subject for me because I need it for what I want to study later on
Do not agree Totally agree

[ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ]

8. I will learn many things in mathematics that will help me get a job
Do not agree Totally agree

[ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ]

Self-concept

9. I am good at mathematics
Do not agree Totally agree

[ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ]

10. I get good grades
Do not agree Totally agree

[ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ]
11. I learn mathematics quickly

Do not agree Totally agree

[ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ]

12. I have always believed that mathematics is one of my best subjects
Do not agree Totally agree

[ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ]

13. In my mathematics class, I understand even the most difficult work
Do not agree Totally agree

[ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ]

Anxiety

14. I often worry that it will be difficult for me in mathematics classes
Do not agree Totally agree

[ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ]

15. I get very tense when I have to do mathematics homework
Do not agree Totally agree

[ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ]

16. I get nervous doing mathematics problems
Do not agree Totally agree

[ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ]

17. I feel helpless when doing mathematics
Do not agree Totally agree

[ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [

18. I worry that I will get poor grades in mathematics
Do not agree Totally agree

[ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [

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