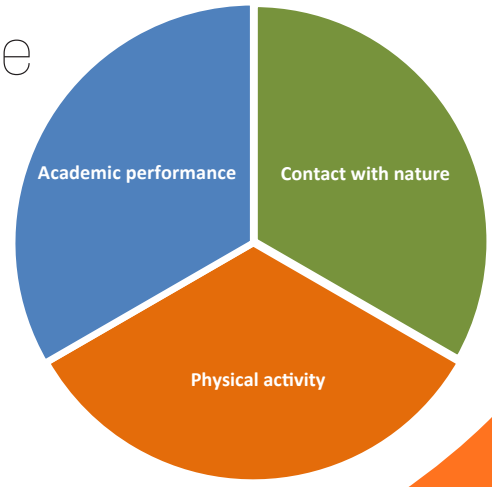
Skrifter från Forum för ämnesdidaktik Linköpings universitet nr 11

Teaching with the Sky as a Ceiling

A review about the significance of outdoor teaching for children's learning in compulsory school



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Reports from Forum för ämnesdidaktik No 11

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A review of research about the significance of outdoor teaching for children's learning in compulsory school

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LINKÖPING UNIVERSITY
SLU
MOVIUM THINK TANK

Utenavet
nationellt nätverk för främjande av utomhusbaserat lärande

This research review has been produced at the request of *Utenavet – the National Network for Promoting Outdoor-based Learning* in Sweden. Utenavet distributes knowledge and inspiration about outdoor education and nature guidance and works for an introduction of outdoor education into the Swedish educational system on all levels.

Utenavet communicates good examples of outdoor space based education, and one of its major intentions is to demonstrate how experiences in nature and cultural heritage can contribute to the achievement of curricular goals. In addition, Utenavet regularly arranges conferences for teachers, pedagogues, city and public health planners in Sweden and the Nordic countries.

Utenavet includes Forum for Outdoor Education at Linköping University; Swedish Outdoor Association; Federation of Swedish Farmers (LRF); Nature School Association; Forest in School national cooperation program; Swedish Local Heritage Federation; Movium Think Tank; and Swedish Centre for Nature Interpretation (SCNI) at the Swedish University of Agricultural Sciences (SLU).

www.utenavet.se

Teaching with the sky as a ceiling

Reports from *Forum för ämnesdidaktik* [Forum for subject didactics] at Linköping University No 11

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Better academic performance with outdoor teaching?

Nobody would question the importance of knowledgeable and dedicated teachers for students' learning, academic performance, and goal achievement. However, the environments that the teachers choose for their pedagogical activities – indoors as well as outdoors – are also important for successful schooling. The aim of the present review is to collect and describe existing scientific evidence of how outdoor education may influence learning and school achievements among children and youth.

In October 2016 Johan Faskunger, PhD in Physical Activity and Public Health, and investigator at ProActivity Ltd, received an assignment by Utenavet – a national network for promoting outdoor-based learning in Sweden – to produce a review concerning outdoor education and its effects on students' health, learning, and development. The task was to collect scientific evidence that illustrates the effects of outdoor education on students' learning in compulsory school. The work builds on a study of results and conclusions from scientific and systematic reviews in which the authors have collected research that demonstrates the effects on school results through outdoor teaching, physical activities and contacts with nature during childhood.

The conclusions drawn from the survey should contribute to actions that could be taken by decision-makers, education authorities, school and teacher education leaders in stimulating teachers to use the outdoor environment as a pedagogical space and a teaching resource. This review of knowledge could, hopefully, also be used as support in teacher education institutions that are planning to develop outdoor education as a model. City planners, landscape architects, property owners, and public health developers responsible for planning, designing and administering outdoor environments for children and youth should also benefit from the conclusions drawn from the review, as it is connected to the importance of a purposeful design of the outdoor environment and how this can contribute to children's play as well as their learning and wellbeing during schooldays.

We want to express our gratitude to the authors of this survey, to Johan Faskunger in particular, for his extensive work on the background and the main text, to outdoor education specialist and junior lecturer Anders Szczepanski, at the Forum for Outdoor Education, Linköping University, and to senior lecturer Petter Åkerblom at the Department of Urban and Rural Development, Swedish University of Agricultural Sciences (SLU), for editorial work. This project was financed by Utenavet, Department of Urban and Rural Development at SLU, and the Movium Think Tank.

Linköping in May 2018

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Summary

The present review is built on results and conclusions from scientific and systematic overviews, where the authors have studied and analysed research, which illustrates how academic performance among comprehensive school students is affected by outdoor teaching, by regular physical activities and/or contact with nature.

The review demonstrates that the evidence is strong enough to ascertain that outdoor education has a positive effect, directly as well as indirectly, on academic performance and achievements. Very few studies indicate a correlation between outdoor education and negative effects on students' learning, teachers' work situation, or the school situation in general.

It is therefore concluded that there is sufficient evidence for recommending more outdoor education in everyday school activities – as incidents of teaching in combination with being outdoors generate a number of positive effects on students' learning, health, physique, as well as their personal and social development. In sum, this overview demonstrates the following:

- outdoor education leads to a number of positive effects for school age children, e.g., improved learning (better cognitive abilities, concentration, working memory, and motivation for studies),
- sufficient evidence for the possibility to introduce more outdoor-based elements in teaching among children and youth in the whole educational system,
- sufficient evidence for positive effects of outdoor education on cognition, which makes it worthwhile to strengthen existing as well as new national efforts that could enhance outdoor education, physical activities, and contact with nature in compulsory school, e.g., by involving teacher education institutions in a comprehensive development project at a national level,
- outdoor education is in line with modern pedagogical models of school development, teaching and learning.

Support for improved goal achievement and good public health

Research shows that outdoor education with regular physical activities and contact with nature can have positive and meaningful effects, both directly and indirectly, on learning, academic performance, health and wellbeing, as well as on students' personal and social development.

The statistical effects (effect measures) are typically at a rather low to medium level. However, at a social level they could potentially be most relevant from a public health and school perspective, as they contribute to better goal achievement in the compulsory school, preschool and leisure-time centre. The conditions are, that programmes and

competence-raising measures are taken to initiate outdoor teaching on a large scale and that they are long-term endeavours. According to research long-lasting and more extensive programmes are more effective, physically, socially as well as cognitively, than shorter ad-hoc educational initiatives.

Strong evidence for factors that indirectly influence school performance

Research shows that regular physical activity with mobility and contact with nature during the school day has overall positive effects on learning ability, academic performance and a number of other factors that are important for students' development and for teaching. Essential scientific arguments exist, that outdoor teaching, compared to classroom teaching using more or less traditional teaching methods, promotes factors that have indirect effects on academic performance, such as, improved concentration, working memory, and personal and social development. According to the research this, in turn, could lead to increased study motivation, better self-confidence, self-control and impulse control, creativity, ability to collaborate, and intentions for a healthier lifestyle (physical exercise and eating habits). A high degree of physical activities, together with contact with nature during the school day and in teaching, correlates with academic performance and with a number of factors that have an indirect, positive impact on school results among students.

More time in teaching theoretical subjects does *not* lead to better results

Research indicates that increased physical activities during the school day or more Physical Education (PE) lessons do not have a negative influence on the results in theoretical subjects. On the contrary, most of the research indicates that more physical activities seem to have positive effects on students' achievements in theoretical subjects, even if more research is needed in this area. Nor is there any proof that an increase in the amount of teaching hours in theoretical subjects, at the expense of e.g., physical education, has any positive effects on the results in theoretical subjects. Several researchers and systematic overviews indicate that more classroom teaching in theoretical subjects can raise the risk of physical and mental ill health among students.

More longitudinal research is needed

In order to increase goal achievement, improve academic results and promote sound everyday habits among children and youth, there is enough strong evidence in the research review for considering a systematic implementation of outdoor education in compulsory school. However, a great deal of the research consists of short-term evaluations, which makes it more difficult to draw conclusions as regards outdoor activities in school and how they can contribute to a purposeful school development that will positively influence academic achievements in the long run. In other words, more longitudinal studies are needed in a Swedish school context.

The overall layout of the research review

The present review of research literature is divided into three main sections, according to the effects of outdoor education on academic performance, physical activities, and contact with nature, respectively.

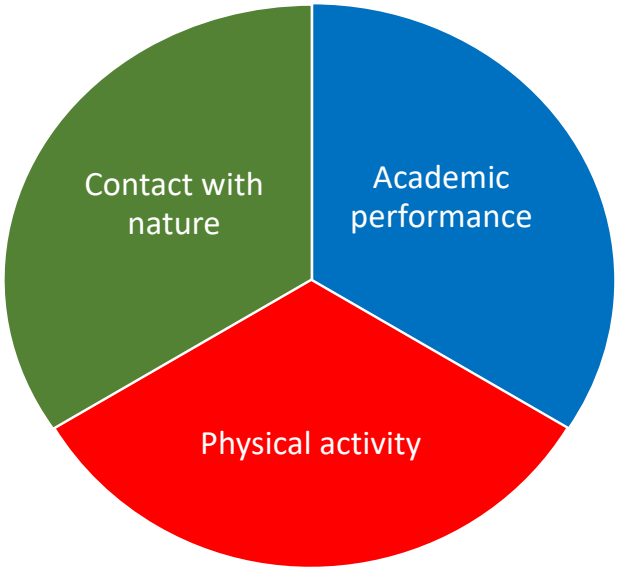


Figure 1. The main categories of the research material regarding effects of outdoor teaching.

Aims and objectives of the assignment

Some teachers are of the opinion that students' knowledge becomes more sustainable if they teach both indoors and outdoors, and that such alternations may lead to better academic achievements. Even if this may be true, it is rare that the conditions for schools to practise outdoor education are taken into consideration when new school buildings are planned (de Laval & Åkerblom, 2014). In this chapter we will discuss directions and attitudes to outdoor education as a phenomenon and school as a physical environment, two essential points of departure in working with the present review.

Trends in urban development, the restricted freedom of movement among children and youth, and measures taken by society, which were discussed in previous chapter, brings to the fore a question about possible effects on students' performance of combining being outdoors with teacher-lead activities. To clarify such connections and give examples of the importance of the outdoor environment as a pedagogical space from a learning and teaching perspective has, therefore, been essential in producing this research review.

The work has been directed towards analysing and categorising relevant research, so as to communicate results and conclusions with school leaders and authorities, both at a national and a local level. The point of departure was research findings pointing to the fact that children as well as adults become healthier and stronger and feel better when they spend time outdoors regularly. People who spend time regularly in the wild or in parks develop a stronger feeling for nature (Mårtensson et al., 2011). Proven experience tells us that in the long run this may facilitate engagement in working for sustainable development. The importance of nature and outdoor education to learning and academic performance, i.e., the possible cognitive effects, is less focused and, thus, less known.

The aim of this overview is to illuminate and clarify existing, relevant knowledge concerning the cognitive and emotional effects of outdoor education, as a complement to research findings about classroom-based teaching and learning. The purpose is thus to investigate the scientific evidence regarding possible direct or indirect correlations between classroom and outdoor teaching, learning, physical activities, and contact with nature.

The objective is that the evidence should contribute to and inspire actions at all levels of the education system, in order to strengthen possibilities for schools to develop outdoor-based teaching efforts in all subjects and themes, as a complement to classroom teaching.

Definition of concepts

PEDAGOGUE

In this overview the word 'pedagogue' is used to denominate teachers and other persons involved in pedagogical work, teaching and learning in preschool, comprehensive school (grades 1-9), leisure-time centre, upper-secondary school (grades 10-12), and the special school for intellectually disabled.

OUTDOOR TEACHING

In the research review the concept of 'outdoor teaching' is used throughout, even if many other concepts may occur within the area, e.g., place-based learning, environmental education, outdoor-based learning, and adventure education. Outdoor teaching is teaching connected to subjects and themes/topics that can be placed outside a building. It does not mean that teaching takes place outdoors instead of indoors but that there is an interplay between outdoor and indoor activities. 'Green outdoor education' refers to pedagogical activities in outdoor environments rich in flora and fauna, where one of the main ideas is to promote students' contact with the natural and cultural landscape.

OUTDOOR EDUCATION

Outdoor education is a perspective aimed at learning in interaction between sensual experiences and reflections based on concrete experiences in authentic situations (Szczepanski et al., 2007). 'Outdoor education' is a wider concept than 'outdoor teaching' and includes also pedagogical activities outside school as an institution, e.g., natural and cultural guidance within adventure and other kinds of tourism, health promotion in the physical environment, and team building and leadership development within business enterprise. Outdoor education is, in addition, an inter-disciplinary research and education area, which, i.a., means (NCU, 2004) that,

- the learning space moves out into society, the natural and cultural landscape,
- the interplay between sensual experience and literary knowledge is emphasized,
- the importance of place to learning is highlighted.

COGNITIVE ABILITY AND COGNITION

Cognitive ability is the individual's ability to use language, to communicate about, e.g., mathematics, natural science and technology, to remember different places, develop a sense of space, draw conclusions from mathematical calculations, discover patterns and relations, similarities and differences (see Gärdenfors, 2010). Cognitive ability is influenced by psychological and physiological processes and characteristics in the individual.

ACADEMIC PERFORMANCE AND ACADEMIC OUTCOME

Academic performance and academic outcome refer to the measurable outcome of the students' engagement in school work, e.g., presence, assessment of individual as well as group projects, artistic creativity, test results, marks etc. Good academic outcome is connected to a student's high cognitive ability, but can also be affected by social factors, such as family background, teacher competence, and quality and amount of teaching (Esteban-Cornejo et al., 2015).

PROGRAMME

'Programme' is used as a comprehensive name for various strategic initiatives within the framework of local, regional, or national school development.

Background

Support for outdoor education in curricula and the Education Act

Already today the Education Act of 2010 and the Swedish National Curriculum of 2011 Lgr11) give some support to outdoor teaching, even though the Education Act does not focus specifically on the physical school environment as much as on the pedagogical and psycho-social environment (Björklid, 2005).

The Education Act mentions environmental issues that have a bearing on outdoor milieu and outdoor teaching in preschool and compulsory school activities. According to the Education Act children and youth should be offered sufficient environment, materials and space so as to be able to fulfil curricular goals (Education Act 2010:800, 1st chapter 4 §, 2nd chapter 35th §, and 8th chapter 8th §). Curricula for both preschool and school establish that activities in school are supposed to promote students' learning and overall development, and not just show the way to basic school knowledge.

The national curriculum for preschool (Lpfö 98) states that education shall offer the children a safe, open, rich, and attractive environment. The environment should challenge, inspire and encourage the children to play and move around. The preschool has many important tasks, among others:

The preschool should put great emphasis on issues concerning the environment and nature conservation. An ecological approach and a positive belief in the future should typify the preschool's activities. The preschool should contribute to ensuring that children acquire a caring attitude to nature and the environment and understand that they are a part of nature's recycling process. The preschool should help children understand that daily reality and work can be organised in such a way such that it contributes to a better environment, both now and in the future.

> The preschool should provide children with a well-balanced daily rhythm and environment related to their age and time spent in the preschool. A balance should be attained between care and rest, as well as other activities. Children should be able to switch activities during the course of the day. Preschool should provide scope for the child's own plans, imagination and creativity in play, and learning, both indoors and outdoors. Time spent outdoors should provide opportunities for play and other activities, both in planned and natural environments. (Lpfö 98, p. 7)

The preschool curriculum thus gives support to integration of outdoor activities into daily pedagogical activities, so that outdoor activities, according to the preschool's mission, may constitute a component in play and learning.

The national curriculum for the compulsory school (Lgr 11) also gives support for outdoor teaching, at least indirectly. Several of the goals that are to be achieved clearly justify the practice of outdoor teaching, for example:

> The national school system is based on democratic foundations. The Education Act (2010:800) stipulates that education in the school system aims at pupils acquiring and developing knowledge

> and values. It should promote the development and learning of all pupils, and a lifelong desire to learn. (p 9)
>
> Creative activities and games are essential components of active learning. In the early years of schooling, play in particular is of great importance in helping pupils to acquire knowledge. The school should strive to provide all pupils with daily physical activity within the framework of the entire school day. (p 11)
>
> Physical activities and a healthy lifestyle are fundamental to people's well-being. Positive experiences of movement and outdoor life during childhood and adolescence are of great importance if we are to continue to be physically active later on in life. Having skills and knowledge about sports and health is an asset for both the individual and society. (p 50)
>
> Through teaching, pupils should develop the ability to spend time in outdoor settings and nature during different seasons of the year and acquire an under standing of the value of an active outdoor life. (p 50)

Through teaching, pupils should be given the opportunity to develop their interpersonal skills and respect for others. Teaching should create the conditions for all pupils throughout their schooling to regularly take part in physical activities at school and contribute to the pupils developing good physical awareness and a belief in their own physical capacity.

Through teaching, pupils should develop the ability to spend time in outdoor settings and nature during different seasons of the year and acquire an understanding of the value of an active outdoor life. Teaching should also contribute to pupils developing knowledge of the risks and safety factors related to physical activities and how to respond to emergency situations. (p 50)

Knowledge of biology is of great importance for society in such diverse areas as health, natural resource use and the environment. Knowledge of nature and people provides pupils with tools to shape their own well-being, and also contribute to sustainable development. (p 105)

Urban development – a threat to our school yards?

Children and youth constitute one fifth of the Swedish population. Every weekday close to 1,2 million children attend schools around the country (SCB, 2018), almost 2 million if we include preschool. In an era of development towards higher density cities, heavier traffic, and a more stressful life for many adults, the freedom of mobility for children and youth has decreased, as they are taken by car to their school and leisure-time activities. It has been shown that many children do not spend time in other environments than the home, school, and perhaps a well-defined appropriate leisure-time activity – and in the car to and from these places (Boverket, 2015b). The physical, social and psycho-social environments have thereby received an ever-greater importance to children and youth in their development and learning. The form and use of the various learning environments also have an impact on other conditions of development, such as lifestyle, behaviour and health (Green et al., 2009).

Children's and youngsters' limited freedom of movement

As today's parents more often drive their children to school and leisure activities the school yard has become one of the very few outdoor environments where the children can be outside on their own conditions (Boverket, 2015b). The shape and content of the school yard is of the outmost importance regarding how it will inspire them to play, learn and be physically active – or not. This is reinforced in places where house-building has led to elimination of green areas to the extent that children's and youngsters' possibilities to move around freely outdoors have been jeopardized. There are several examples of how urbanisation during the 2010's has resulted in minimal or close to non-existing school and preschool yards.

National directions concerning improved school environments

The Swedish government has, however, observed this in some ways. In the years 2016-2018 they had set aside subsidies aimed at improving the outside environment of schools and preschools. Prior to this, the Swedish National Board of Housing, Building and Planning (Boverket) and the Think Tank Movium at the Swedish University of Agricultural Sciences at Alnarp had receive a government assignment to produce national guidelines for planning, designing and administering the outdoor environment for schools and preschools (Boverket, 2015b). This work started by specifying how the requirements of the Law on Planning and Building as regards 'enough free space' at schools and preschools (8:e chapter, 9-11 §§, PBL) were to be interpreted (See Box 1: National guidelines).

The outdoor environment as pedagogical space

In the guidelines of The National Board of Housing, Building and Planning it is stated that the school yard is essential for children's free play but also as a space for teaching. Historically, the school yard has played an important role in teaching (Paget & Åkerblom, 2003; Åkerblom, 2005; Larsson et al., 2017). Research as well as proved experience indicate that the outdoor environment can be used to make school work meaningful and to promote competence, entrepreneurship and skills training as regards sustainable development (Szczepanski et al., 2007; Gamson Danks, 2010; Larsson et al., 2017). The National Board also refers to single studies, such as Fägerstam (2012), which indicate positive effects and sustainable knowledge gained from teaching with a mixture of indoor and outdoor activities.

Box 1. National guidelines for planning, designing and administering the outdoor environment in school and preschool

In 2015 the National Board of Housing, Building and Planning published two sets of guidelines, 'Make room for children and youngsters! Guidelines for planning, designing and administration of the outdoor environment of schools and preschools' (Boverket, 2015b) and 'General guidelines (2015:1) concerning free space for play and outdoor activities in leisure time centres, preschools, schools and similar institutions' (Boverket, 2015a). These guidelines are supposed to function as advice when a municipality is given permission to build, rebuild or extend schools and preschools.

CREATING SUITABLE OUTDOOR ENVIRONMENTS FOR TEACHING AND LEARNING

According to the above-mentioned guidelines, planners, architects and school authorities should create conditions for appropriate activities. This means that the free space (school yard or outdoor space) should be used for play, recreation as well as physical and pedagogical activities in the work for which the free space is intended. The guidelines might therefore be of great help in the school or preschool that wants to design the outdoor environment to suit their activities and thus create better conditions for 'pedagogical use of the ground'.

The government proposition 'Politics for designed living environment' emphasizes the importance of children and youth being 'guaranteed good access to high-quality living environment, nature and outdoor environments for play, activities and development' (Prop. 2017/18:110, pp. 55-59). The government suggests that the National Board of Housing, Building and Planning, in cooperation with other relevant actors, i.a., the National Agency for Education, get an assignment to produce new guidelines for municipalities and other authorities concerning accessible and sustainable high-quality design of the physical environment in schools and preschools, indoors as well as outdoors (p. 55).

ECHO SYSTEMS IN THE OUTDOOR ENVIRONMENT INDICATE CONNECTIONS BETWEEN THEORY AND PRACTICE

The Board of Housing, Building and Planning expresses the view that the school yard has to be designed so as to make it suitable for outdoor teaching. Some examples of pedagogical outdoor environments are cultivation, water arrangements, environments for animals, plants, and energy production, that is, different kinds of echo systems. With such functions teaching can demonstrate the connection between theory and practice. School subjects, such as, mother tongue, social studies, languages, arts and craft, sports and health, could be suitable for using the outdoors as a pedagogical space.

Simultaneously, outdoor teaching could be a health factor in the school environment, as it offers variation and interaction between indoor and outdoor spaces, which contributes to the students getting both fresh air and more physical activity.

Characteristics and theoretical basis of outdoor teaching

Outdoor teaching has a long tradition in Sweden (Nobel, 1982; Åkerblom, 2005; Szczepanski, 2008: de Laval & Åkerblom, 2014) as well as internationally (Rickinson, 2004; Szczepanski et al., 2007; Malone & Waite, 2016; Larsson et al., 2017).

We do not have any recent comprehensive statistics regarding how much pedagogical activity in Swedish schools that takes place outdoors. Experience during the last decades tells us, however, that thousands of teachers from preschool and all through the education system in Sweden use outdoor teaching in various forms, see www.utenavet.se.

Their interest in outdoor education is more often based on practical teaching experiences than on scientific knowledge. These teachers feel that there are positive connections between outdoor education and cognitive ability, learning and factors that, at least indirectly, affect students' academic performance in a positive way, including improved study motivation, health and self- esteem. Research that has given support to this kind of arguments has long existed, although it has often been connected to the concept of environmental education (e.g., Rickinson, 2004, Rickinson et al., 2004). Today outdoor education is getting more and more attention at international research conferences on learning and child development, for example, in the recently published 'Student Outcomes and Natural Schooling' (Malone & Waite, 2016)

Goal achievement, variation and reciprocal action

Teachers and researchers, who are interested in outdoor teaching, are of the opinion that the outdoor environment has an action-oriented, authentic, sensual and place-related potential that inspires teachers to develop their teaching outdoors, because of the limitations they experience in the classroom when trying to achieve educational goals. Such ideas are supported by several international professional organisations and academic institutions, e.g., International School Grounds Alliance (ISGA, undated) and Linköping University (NCU, 2004; Szczepanski et al., 2007).

Outdoor teaching is often built on pedagogy which promotes influence and participation, reflection and creativity (Åkerblom, 2005; Szczepanski, 2008). It also seems to appeal to students with low motivation for text-based teaching in the classroom, and may thus, in turn, affect goal achievement in a positive direction by levelling the differences between high and low achievers and raise academic performance in the latter group (Cederberg & Ericsson, 2015). Research supports the assumption that outdoor teaching in a natural environment contributes to variation in learning and interaction between outdoor and indoor activities, as it offers concrete and authentic contexts characterised by a learning community where students and teachers learn from each other.

Outdoors the mission of the school can be brought to life

Research as well as proved experience indicate that good results can be achieved through outdoor teaching, which offers opportunities to make curricular achievement goals (Lgr11) and intentions in most subjects and topics more realistic. Teachers who

choose to teach outdoors within close proximity of the school are able to use authentic environments (the reality) so as to arouse awareness about sustainable development, climate challenges and other environmental issues, to create and safeguard ecological systems, and to preserve natural and cultural habitats – all with support in the goals and objectives expressed in the National Curriculum (Lgr 11).

Outdoor teaching is a complement to traditional, classroom-based teaching. In practice, this means making use of other rooms, places and contexts in order to strengthen learning and development among students (Szczepanski, 2013). An interplay between outside and inside in itself contributes to a more movement-intensive learning environment, more physical activity and a less sedentary lifestyle.

However, outdoor teaching does *not* mean that *all* teaching should take place outdoors. Nor does it mean that all subject matter or topics are suited for teaching outside of the classroom. Interaction between various places is the actual success factor, i. e., to choose the appropriate learning environment for the planned activity, whether it is in open air or inside a building. The challenge for the teachers to develop their ability to recognize the outdoor environment with its authentic context as a pedagogical space for teaching and learning. The didactical and reflective competence of the teachers is decisive for which spaces they choose for the students to be able to change focus between practical and theoretical experiences and transform their experiences into active and sustainable knowledge (see Box 2).

The influence on school results of a sedentary lifestyle as opposed to physical activity

There are both classroom teachers and special needs teachers, as well as health scientists who use outdoor education as a pedagogical model, thus contributing to children's contact with the natural environment (Szczepanski, 2013; Szczepanski & Andersson, 2015). Children and young people in general spend less time outdoors today (Andersson et al., 2013); meanwhile stress-related symptoms and clinical diagnoses are increasing, and children's motor development and movement habits have attracted much attention (Ericsson, 2017). The time spent sitting still indoors has increased in all groups of society, not least among children and youth. A recently published survey of movement patterns among young people demonstrates that no more than 44 per cent of the boys and 22 per cent of the girls move around at least 60 minutes per day, as recommended (Nyberg, 2017). In fact, the early years is now the period of a life cycle when we can observe the greatest decrease in physical activity (WHO, 2006).

Box 2. Didactical perspectives on learning in an outdoor context

Learning can be regarded as an integral part of a person's physical, cognitive and social functions and as such involved in creating knowledge and experience; we think, perceive, feel and act in harmony with other human beings, contexts and places in our physical surroundings (Szczepanski, 2008). According to this view outdoor teaching plays an essential role, with its focus on building bridges between theory and practical experience. The ultimate goal is to facilitate students' learning by promoting their curiosity, motivation and interest (ibid.).

THE DIDACTICS OF OUTDOOR TEACHING

Outdoor teaching as a phenomenon is strongly related to the didactical where-question, that is, where learning and teaching take place (Szczepanski & Andersson, 2015). Learning and teaching are carried out in a landscape-related environment – in the preschool or school yard, in a nearby park or nature-area (e.g., a wood) in or just outside town (Dahlgren & Szczepanski, 2004). It is not only 'green' environments, such as parks, gardens and woods, that are valuable, even if such areas are frequently used in the outdoor education context. Also 'blue' environments, like rivers, dams, lakes and the sea, are relevant as learning environments. There are, in addition, examples of schools situated in highly urbanised areas that successfully use 'grey' environments, for instance, squares, streets and other urban areas in outdoor teaching (cf., Szczepanski & Andersson, 2015, 140-141; 2016).

THE WHAT, WHERE, WHEN, HOW, AND WHY OF LEARNING

Outdoor teaching also paves the way for a debate about other important didactical questions, besides the where-questions about the importance of place in teaching and learning. The when-question is about the point in time when a certain element in teaching is relevant. The what-question deals with what content or theme that is suitable for teaching indoors or outdoors. The how-question concerns how teaching should be done so as to achieve the best possible results for all students (e.g., through activity-based and creative teaching outdoors). All this is, in turn, based on the why-question. i.e., why a preschool or a school should place more teaching outdoors, using teaching methods based on empirical and scientific evidence (Dahlgren & Szczepanski, 2004).

Method

The present research review is a so-called *narrative review*, a technique which is suitable if the topic in question is spread over a variety of disciplines using different research methods. A narrative method is used in this review, as the relevant literature can be found within the areas of health (physical activity), nature and outdoor life, as well as within educational research with a focus on teaching and learning. Studies included in the review are either peer-reviewed articles published in scientific journals or reports from various authorities or institutions. The review is primarily based on results and conclusions from these articles and reports. The literature search has not been as systematic and comprehensive as in a systematic overview or meta-analysis.

Systematic overviews and meta-analyses in focus

It is important to point out that the present review is built on a large amount of available research that describes possible correlations between outdoor teaching and school-related achievements among students and teachers. This means that the review is not based on separate studies. Results and conclusions are, to a great extent, based on so-called systematic reviews and meta-analyses of published research studies. Systematic reviews, including meta-analyses, base their conclusions on results from a large number of scientific studies; they apply strict rules and quality requirements regarding what studies are allowed to influence the final results and determine the knowledge base. Studies that are assessed as being of low quality and poorly designed have been discarded in the process. Several studies of moderate to high quality and design are needed for the evidence and the level of knowledge to be deemed as good or high. Evidence is accumulated when many different studies demonstrate the same or similar results and when very few or none of the studies demonstrate contrary results. Furthermore, it is an advantage if many different research groups independently, and with studies from different countries, arrive at similar results. This indicates that the intervention or programme in question is likely to function in different cultures and social and political circumstances.

Sources and samples

In working with this research review, published research reports have been collected and scrutinized with the ambition to illuminate the effects of outdoor teaching as reflected in academic performance. The source material has, for the most part, consisted of systematic reviews and meta-analyses of evaluations in preschool, compulsory school (grade 1-9) and upper secondary school (grades 10-12). The collected research has studied effects of outdoor teaching on learning, physical activity, cognition, and health among children and youth. This research area has seen an increasing trend ever since the beginning of the 21st century, with an increasing number of published scientific studies and international overviews.

Categorisation of the research material

The literature search indicated at an early stage that there are several closely related areas of research that are relevant to this research review. As outdoor teaching means that students move around more and that they are exposed to greenery and nature more often, compared to traditional indoor-teaching, the results of the studied reviews could be sorted into three main categories: (1) improved academic performance, (2) increased physical activity, and (2) more contact with nature. The categories often overlap in the studies, but in the account below they have been separated into various aspects that have an impact on the students when teaching takes place outdoors. In figure 1 this separation is illustrated according to the following: academic performance outdoors (blue); contact with nature (green); physical activity outdoors (red). The literature overview in the next chapter is describe based on these three categories.

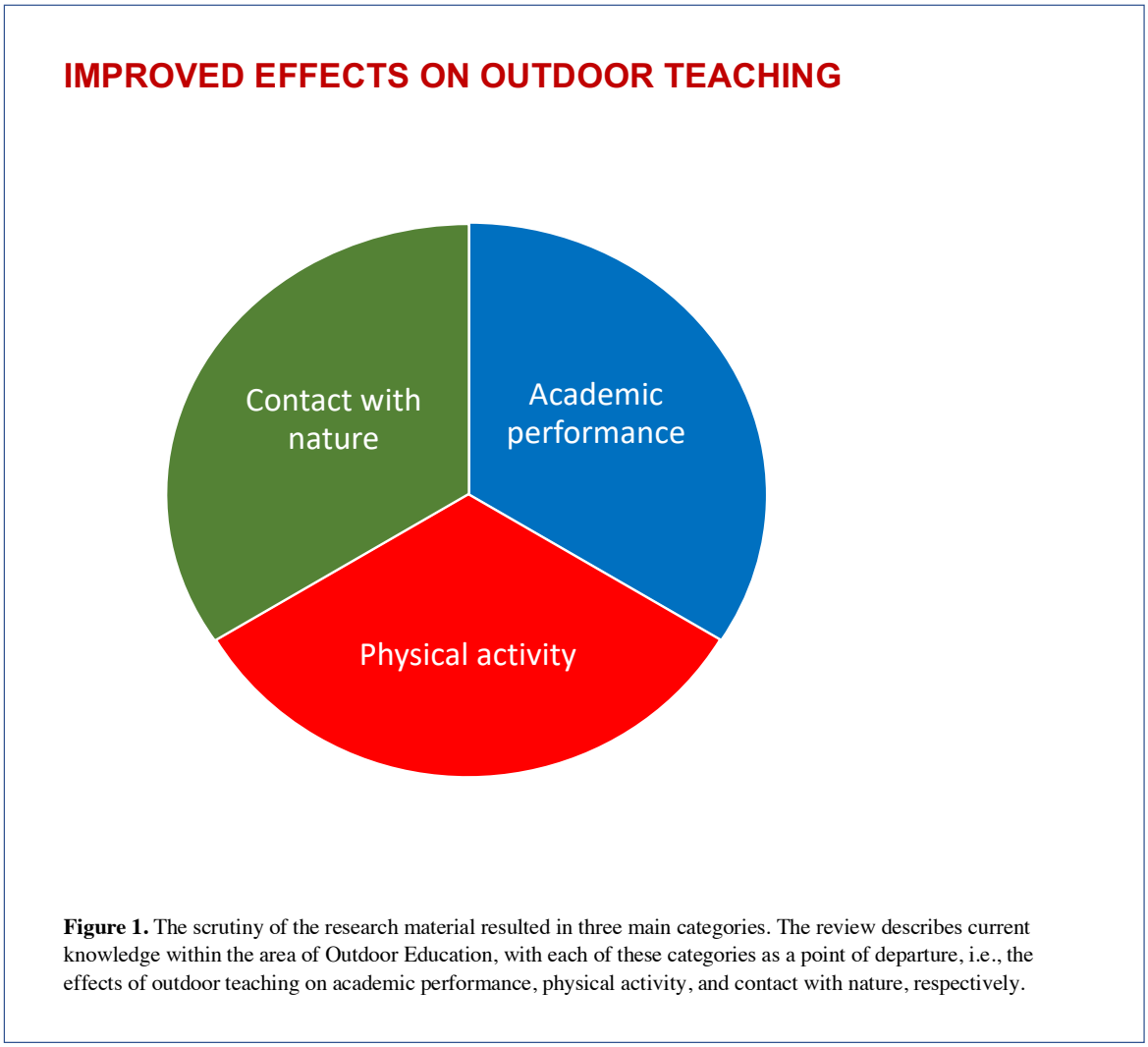
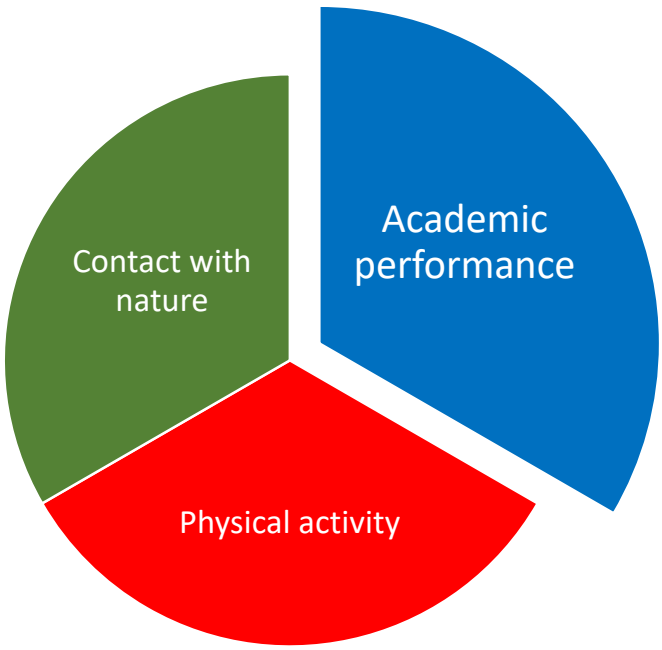


Figure 1. The scrutiny of the research material resulted in three main categories. The review describes current knowledge within the area of Outdoor Education, with each of these categories as a point of departure, i.e., the effects of outdoor teaching on academic performance, physical activity, and contact with nature, respectively.

Literature review and results

As mentioned earlier, the present review is primarily built on results and conclusions from international, systematic reviews and meta-analyses regarding the effects of outdoor teaching. There are no systematic reviews that may offer a comprehensive picture concerning effects of Swedish educational programmes or evaluations in this area. Therefore, some Swedish studies and reports have also been included in the present review. Examples of keywords and databases used are listed in Appendix 1.

The effects of outdoor teaching on academic performance



Current state of knowledge in the area

Research about the effects of outdoor teaching is substantial and includes numerous studies and systematic reviews. In the present review sixteen reviews and meta-analyses were identified, mostly from English-speaking countries. These reviews are, in turn, built on more than one hundred separate studies. Most of the reviews (a number of ten), however, focused on programmes and evaluations of adventures in the wilderness, which were not that relevant to Swedish conditions in school and preschool. Below follows a presentation of the reviews that are most relevant from a Swedish perspective.

A systematic review of mostly British research by Fiennes et al. (2015) gives a clear picture of the current state of knowledge about effects on students' academic performance. All studies included in the review (N=58) demonstrated short-term positive effects for participants who had had outdoor teaching, compared to participants who had only been taught indoors. The effects were visible in, for instance:

- improved processing skills in natural science
- higher motivation for learning
- more physical activity
- better eating habits
- better self-confidence

Fiennes et al. (2015) also demonstrate that extended and long-lasting programmes are more effective than short and sporadic interventions.

Most of the outcome measures in outdoor teaching and learning focus on individual factors, like character, health and development, rather than having a direct link to academic subjects, achievements, and marks. This makes it difficult to compare outdoor teaching with other academic interventions aimed at promoting learning, academic performance and personal development. Positive effects on indirect outcome measures are likely to be important also for better marks and academic achievements, but more research is needed to make it possible to investigate such correlations. Systematic reviews that focus on specific academic subjects have been examined, and in general they indicate very positive results in a shorter perspective:

- Mathematics (Hattie et al., 1997; Rickinson et al., 2004; Neill, 2008a),
- Natural Sciences (Rickinson et al., 2004; Gill, 2011),
- Language, reading and writing skills (Hattie et al., 1997; Rickinson et al., 2004; Neill, 2008a; Gill, 2011).

A few studies have had a longer time-frame. Almost all of these studies account for decreasing effects or a backward trend at the follow-up after the end of the educational programme, which is a rather common phenomenon in social and behavioural science research, where human beings are involved. One exception was a meta-analysis which showed that the degree of experienced self-control was high even in the long run in the group that took part in the outdoor programme (Hattie et al., 1997). The programmes in these studies were, however, more oriented towards adventures and excursions than traditional teaching.

Improved learning and increased environmental awareness

Another systematic review (Gill, 2011) has found evidence that children who are regularly exposed to nature develop increased environmental awareness and a stronger feeling for the local environment as adults. Living close to green areas is also positively linked to more physical activity, better mental health and emotional control as well as impulse control among children and youth with or without special diagnoses. Students who took part in 'green' outdoor teaching improved their learning ability and developed healthier eating habits compared to others. Thus, experience of green environments had a strong relation with higher levels of environmental awareness.

Gill (2011) found, in his review, rather strong evidence that students in schools with regular green outdoor teaching and forest schools developed better social skills compared to students in control schools with classroom teaching only. Furthermore, the students at the outdoor teaching schools improved their self-control, their subject knowledge and their self-awareness. Play in natural environments was said to develop the preschool children's motor skills and their physical condition to a higher degree compared to children in other schools without a natural environment close to the school yard.

In table 1 effects of outdoor teaching are presented. These effects were achieved through teaching in school yards and projects in the local community, as well as through field visits. 'Field visits' is a joint name for different types of teaching in connection with excursions beyond the students' normal everyday environment. Studies that specifically deal with adventures and travels into the wilderness are excluded from this review, as they fall outside the frames of the national goals of preschools and schools. However, for your information, these studies are listed in Appendix 4.

Table 1. Effects of outdoor teaching (Fiennes et al., 2015)

Outdoor teaching in school yards and local community projects:	Outdoor teaching in field visits / excursions:
- Increased self-confidence - Better processing skills in natural sciences - Better understanding of design and technology - Higher motivation for learning - Increased sense of responsibility - More play and movements - Increased motivation for healthier eating habits - Increased motivation for training/ exercise	- Better memory - Improved social skills - Improved learning

A review of scientific studies published during the period 1990-2010 accounted for effects on learning through school yard-based and 'green' outdoor teaching (Williams & Dixon, 2013). The authors found 48 studies of approved quality. No less than 83 per cent of the studies demonstrated positive and significant results in the group that was taught outdoors, compared to the group that was taught indoors. Only one study showed negative results for outdoor teaching in one particular aspect, namely, weaker school bonding.

The students appreciate realism – and moving about more

Outdoor teaching in green environments seemed particularly effective in natural science subjects, where 93 per cent of the studies exposed a positive and significant improvement. In teaching of mathematics and language the corresponding figures were 80 and 72 per cent, respectively.

Furthermore, a total of 87 per cent of the included studies reported a positive correlation between outdoor teaching and a greater volume of physical activity among the students. One overarching explanation to the positive results was that students saw outdoor teaching as a reality-based and efficient way to get theoretical subjects and their concepts explained in a practical and activity-based context, thereby making classroom teaching more concrete and comprehensible (Williams & Dixon, 2013).

There are relatively good scientific indications that outdoor teaching also facilitates the creative and emotional development of children and youth as well as their social competence and skills, compared to students who have been solely taught in the classroom. See for instance Davies et al. (2013).

Knowledge about implementation – the example of LINE

Few studies and overviews specifically focus on implementation of or action plans for outdoor programmes in preschool and school. It is essential in the near future to obtain knowledge about implementation and factors that may facilitate the introduction and acceptance of outdoor teaching in preschools, schools and communities. The lack of research on and evaluation of the actual implementation process in regard to public health interventions in general is obvious (Faskunger, 2013), and the same applies to programmes and interventions in preschool and school (Fiennes et al., 2015). As a consequence, the education system often tries to launch evidence-based interventions and methods by using non-evidence-based implementation methods (Faskunger, 2013).

One exception is the recently published, extensive English project LINE: Learning outside the classroom In the Natural Environment (Waite et al., 2016). The project was running between 2012 and 2016 and included 125 schools (an additional 65 schools took part in the project but not in the evaluation), where more than 40 000 students and around 2500 teachers and almost as many assistants participated. The evaluation showed that LINE generated a long list of positive effects for both teachers and students. Some examples of positive effects for the teachers:

- satisfaction with the teaching and the academic performance it resulted in for the students,
- personal and social development,
- personal well-being (> 70 % agreed)

Some examples of positive effects for the students:

- satisfaction with lessons,
- improved social skills,
- experienced well-being,

- experienced positive effects on personal health (> 90 % agreed).

The project report accounts in detail for success factors and obstacles as regards implementation of LINE, which cannot be described in detail within the frames of the present review. However, it can be said, in short, that the project was very successful, thanks to carefully chosen local key-persons in the schools, who were supposed to implement the independent teaching modules with support from LINE. The regular contact with these key-persons was essential in order for the programme to function well and overcome obstacles and difficulties that could occur. According to the evaluation outdoor teaching was regarded as cost effective.

Another example, a joint effort from Australia and the UK, focused on implementing outdoor education and on developing strategies as well as a framework for facilitating communication with decision-makers. An international conference on the same theme was held in London in 2015, which resulted in a report, *Student outcomes and natural schooling – pathways from evidence to impact. Report 2016* (Malone & Waite, 2016).

Swedish research

There are about fifteen Swedish academic dissertations and research reports, which specifically touch upon outdoor teaching or outdoor environments in a pedagogical and didactical perspective (Ericsson, 2003; Åkerblom, 2003; Björklid, 2005; Åkerblom, 2005; Björneloo, 2007; Szczepanski, 2008; Backman, 2010; Ericsson, 2011; Fägerstam, 2012; Wilhelmsson, 2012; Eliasson, 2013; Berkhuizen, 2014; Engdahl, 2014; Hansson, 2014; Jørgensen, 2014; Sjöstrand Öhrfelt, 2015). One of these studies, the dissertation by Fägerstam (2012), has investigated the effects of an outdoor teaching programme in the lower secondary-school (grades 7-9) compared to a control group. Also, the longitudinal and experimental studies by Ericsson (2003, 2011) within the so-called Bunkeflo project in Malmö are relevant to the present review, with its focus on effects of outdoor teaching, because the intervention contained quite a few outdoor-based physical activities in a school context, and that it investigated the effects on academic performance.

Fägerstam's dissertation (2012) studied qualitative and quantitative (mixed method) effects of outdoor teaching among lower secondary students and teachers in a comprehensive school during a schoolyear. Other lower secondary schools in the same municipality functioned as control schools and the follow-up went on from schoolyear 7 to schoolyear 9. The intentions were that approximately four lessons per week and class would be held outdoors. Outdoor teaching took place primarily in school yards or in the neighbourhood. The evaluation revealed that it generated more student-focused teaching, and learning was improved in group collaboration. Furthermore, the relationship between teachers and students changed which contributed to increased student participation and influence, as well as an atmosphere of 'we learn together'. The students appreciated the influence they were given, shy students, in particular, benefitted from the altered teaching environment. According to the study, students who were taught ecology outdoors developed a richer language than those in the control group who were taught in the classroom; the improvement also prevailed. In the short term the students who were taught outdoors received higher marks than those in the

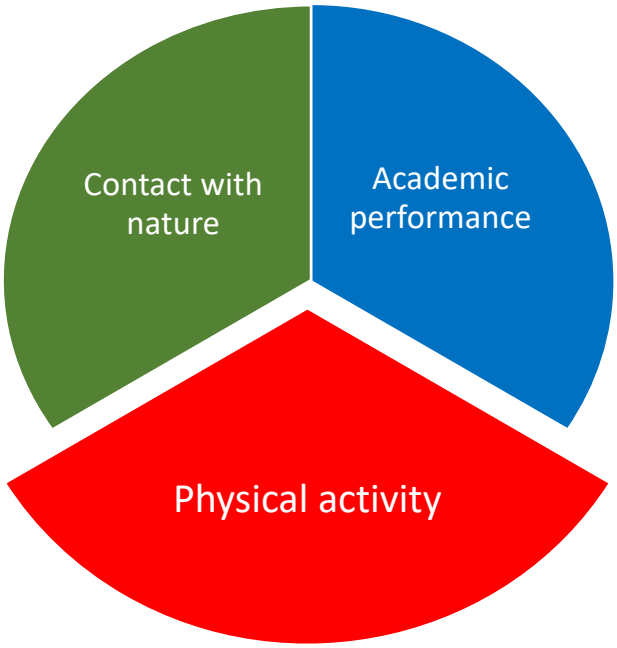
control schools in the same municipality, but the differences were not significant at the follow-up after the programme was finished. The average amount of outdoor teaching in a schoolyear and class was about one lesson per week (4.6 %), which means that all teachers did not manage to maintain the planned volume of outdoor teaching (4 lessons/week). The portion of outdoor teaching per class varied from 1,8 to 9.8 per cent, and the frequency was lower during the winter period than during autumn and spring. It is obvious, according to this research, that a longer implementation period is needed when teachers want to use learning situations in the physical outdoor environment; nevertheless, when these teaching arrangements are established it is 'worth the effort'.

In a longitudinal and experimental study by Ericsson (2011) students in grades 1 – 9 were followed. The study investigated effects of increased physical activity, training of motor functions and outdoor teaching on the students' marks in the school subject Sports and Health (Physical Education, PE). The experimental group had motor training in daily PE lessons. The study demonstrated that the experimental group, getting more outdoor teaching, received better marks in PE and also better motor functions, compared to the students in the control group who received ordinary classroom teaching. Ericsson's dissertation (2003) studied effects of extra physical activity and motor training among elementary school children in the Bunkeflo area in the city of Malmö. The dissertation showed that all-round movement and positive experiences of physical activities promoted the students' motor skills and also had positive effects on their academic performance and development (according to results on national assessments in Swedish and Mathematics in grade 3). Early assessment of the students' motor abilities could identify children at risk of academic failure. Ericsson pointed out that an essential reason for the better motor skills among the experimental students was that they spent more time outdoors during the PE lessons.

As for Swedish studies published in journals with a peer-review process we found about 30 (they are not accounted for one-by-one for reasons of space). None of these reported efficiency of a specific programme for outdoor teaching, apart from the study in Fägerstam's dissertation (2012), the study by Gustafsson et al. (2012), and Ericsson's publications (2003, 2011).

Gustafsson et al. (2012) investigated effects of outdoor teaching on mental health during a schoolyear among students in a preschool class at an elementary school in the outskirts of the city of Linköping (experimental school). The control school was an inner-city school in Linköping with traditional classroom teaching (see also Szczepanski, 2008). The students in the experimental school showed positive effects on mental health in the follow-up compared to the students in the control school. However, the effects were not significant when demographical factors were controlled for. The mental effects of outdoor teaching were more positive among the boys (significant) than among the girls (non-significant). The researchers concluded that it is important in future research to examine potential differences in development when effects of outdoor teaching are investigated.

The effects of outdoor teaching on physical activity



Regular outdoor teaching normally involves increased physical activity for the students and less sitting down, compared to a situation where all or almost all teaching takes place in the classroom. It is outside the frame of this review to describe all health effects of regular or occasional physical activity among children and youth.

Suffice it to say, that research demonstrates clearly positive and strong physical, mental, and psycho-social learning effects among children and youth during regular physical activity, in comparison to insufficient movement and a sedentary lifestyle. Regular physical activity contributes to:

- increase fitness
- increase muscle strength
- counteract uneasiness/anxiety
- improve bone health
- counteract risk factors concerning cardiovascular disease
- improve self-perception
- improve motor skills

Motor skills are often disregarded in discussions about physical activity, public health and health-promoting actions, but good motor skills are basic requirements for adopting a physically active lifestyle. Good motor skills are shown to be correlated with high cognitive ability and development throughout childhood and adolescence (Ericsson, 2017).

Even occasional incidents of movement lead to positive effects that are relevant in a preschool and school perspective, e.g., when it comes to learning (Faskunger, 2008; Berg & Ekblom, 2015). For a detailed account, see recommendations for children's and young people's physical activity and its health effects on www.fyss.se (Berg & Ekblom, 2016).

Outdoor stay stimulates play and movement

The more time the students spend in school-related outdoor environments, the higher their physical activity level (Klesges et al., 1990; Baranowski et al., 1993; Sallis et al., 1993). Preschool and school are counted as central 'areas' for promoting physical activity among children and youth, together with the areas of leisure and transport (Faskunger, 2008). Spending many hours inside the house, however, is likely to lead to a sedentary lifestyle and not being able to reach the general recommendations as regards physical activity from a health perspective for children and youth as well as adults (Proper et al., 2011; Faskunger, 2012). A sedentary lifestyle brought about in childhood tends to follow the individual into adulthood (Bangsbo et al., 2016). It increases substantially the risk of contracting a great deal of illness, such as cardiovascular disease, osteoporosis, diabetes, certain types of cancer, and premature death in adulthood. The correlations seem to be independent of the degree of physical activity, that is, individuals who exercise regularly or are physically active still run a higher risk of disease if they also spend many hours sitting or long periods of immobility (Proper et al., 2011; Faskunger, 2012).

Current state of knowledge in the area

The present review shows that there is a correlation between the physical activity level of children and youth, on one hand, and cognitive abilities and academic performance, on the other. This conclusion is based on results from ten systematic research reviews, meta-analyses and other overviews. Physically active students perform better than inactive students, and the degree of physical activity during a school day is of great importance in order to reach positive effects. It is important for cognitive abilities that are related to academic results, such as, concentration, alertness, reading ability, working memory, positive behaviour in the classroom, and self-control – almost no studies have been found with clear negative correlations. Occasional as well as regular physical activity demonstrate positive effects on cognition, brain structure, brain functions and academic performance among children and youth with or without various forms of medical diagnoses (Sibley & Etnier, 2003; Tomporowski, 2003; Taras, 2005; Trudeau & Shephard, 2008; Bailey et al., 2009, Fedewa & Ahn, 2011; Rasberry et al., 2011; Singh et al., 2012; Esteban-Cornejo et al., 2015; Bangsbo et al., 2016; Donnelly et al., 2016), even if Taras (2005) concludes that the support for long-term effects is limited, since many studies are cross-sectional or have included only short-term follow-ups.

Taras' overview (2005) was made twelve years ago, and since then many studies have been carried out, that strengthen the evidence of physical activity. There is, however, still need for high quality research studies with an experimental design and long-term follow-ups, preferably longer than 12 months (Singh et al., 2012) so as to further

strengthen the knowledge base. Physical activity before, during and after the school day is correlated to improvement in academic achievement. More outdoor teaching during the school day overall does *not* lead to lower achievement in theoretical subjects (Trudeau & Shephard, 2008; Bangsbo et al., 2016). Trudeau and Shephard also found that increased teaching in theoretical subjects, at the expense of PE, did *not* improve academic achievement, and the authors were of the opinion that further focus on sedentary teaching in the classroom could increase the risk of poor health among children and youth.

Physical activity promotes cognition

A meta-analysis based on 44 studies (Sibley & Etnier, 2003) showed that all forms of physical activity promote cognition among the young, e.g., reading ability and mathematical skills. This means that activities even at a rather low level of intensity, like slow walks, being outside in the school yard and avoiding long periods of sitting still, are important behaviours to promote in school.

Rasberry et al. (2011) found a total of 251 correlations between physical activity and academic achievement among children and youth in their systematic review, based on 50 scientific studies. Students with a high level of physical activity performed better academically and showed more positive academic behaviour, that is, they had better cognitive competence and skills and more positive attitudes compared to children with a lower level of physical activity, as revealed after controlling for other factors, such as, parents' socio-economic and educational level. Practically no study could show a negative correlation between physical activity and academic performance among the students.

The above results are corroborated in other reviews, e.g., the meta-analysis by Fedewa and Ahn (2011), which showed in 20 studies that physically well-trained children had better cognitive functions and perform better in school compared to less well-trained children. The correlation remained even after adjusting for socio-economic and demographic factors. In addition, the systematic review by Singh et al. (2012) demonstrated strong indications that a high incidence of regular physical activity among students is correlated to better academic achievements in comparison with students with a low level of physical activity or, for the most part, a sedentary lifestyle. This overview scrutinized, i. a., 14 studies with long-term follow-ups, which strengthens the reliability of the correlations in question.

Occasional activities also promote learning

Donnelly et al., (2016) have published a systematic review based on 137 studies that support the correlations between high levels of regular physical activity or a good physical condition and cognitive ability among children and youth. According to the review, also occasional incidents of movement, exercise and play can improve cognitive functions among children in the short run (so called 'acute effect'), such as, outdoor teaching and other outdoor activities during the school day.

Finally, a systematic review by Esteban-Cornejo et al. (2015) found strong evidence for a correlation between regular physical activity and higher cognitive ability as well as

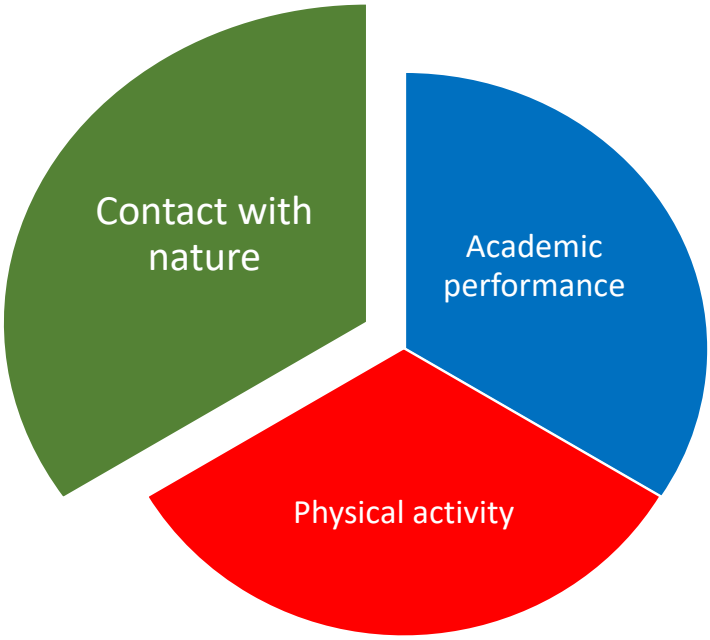
better academic performance among youth. No less than 75 per cent of the studies showed a positive and significant correlation. Cognitive ability was above all strengthened by relatively high intensity physical activity (making the students sweaty and short of breath, and often calls for a change to training suit), whereas academic performance had a strong correlation with moderate and regular physical activity (which is often associated with a quick walk and does not necessarily call for a training suit). In these studies, the greatest effect of physical activity was found among the girls. It was found that the correlations between physical activity, cognition and academic performance can also be explained by the positive effects of physical activity on improved self-concept and prevention of depression and anxiety. The exact 'dose-response' correlations between amount and intensity of physical activity, cognition and academic performance are left to be scientifically established. Some reviews indicate that the cognitive ability is stimulated more by moderate to intense physical activity (also occasional incidents of movement, so called 'pulse training'), whereas academic performance has a stronger correlation with the total amount of physical activity.

Table 2. Studied research material about correlations between physical activity and cognitive ability and learning.

Main author, year, and type of study	**Additional information**	**Results**
Tomporowski, 2003 Overview	42 studies, 46 experiments, 1968-2000	Physical activity leads to instant and positive effects on different cognitive skills, such as reaction skill, problem solving and goal-oriented work for school children with or without clinical diagnoses. Positive effects for children with ADHD and lack of impulse control.
Sibley & Eitner, 2003 Meta-analysis	44 studies	All types of physical activity were correlated with cognition among children and youth, e.g., reading ability and mathematical skills. Effect size: .32.
Taras, 2005 Overview	24 studies 1984-2004	The overview identified a correlation between physical activity and school-related effects, e.g., better concentration. Support for long-term effects, e.g., academic performance, is limited.
Trudeau, 2008 Systematic review	17 studies 1966-2007	Physical activity is positively correlated to concentration, memory and positive classroom behaviours among students. Increased physical activity and more PE at school did *not* impair results in theoretical subjects. More lessons in theoretical subjects did *not* improve academic achieve-ments, and the review pointed out that an increased amount of lessons in theoretical

		subjects may raise the risk of poor health among students.
Rasberry, 2011 Systematic review	50 studies	Half of the studies showed a significant and positive correlation between physical activity and academic performance. Few studies reported negative correlations. More physical activity during a school day did *not* lead to poorer results in theoretical subjects.
Fedewa, 2011 Meta-analysis	59 studies 1947-2009	Significant and positive correlations between physical activity, academic performance and cognitive ability. Particularly strong correlation for 'fitness-oriented' (aerobic) physical activity.
Singh, 2012 Systematic review	14 studies, 4 of which were interventions 1990-2010	Significant and positive correlations displayed between physical activity and long-term academic performance for students. Great need for higher-quality studies exists, as only two studies were deemed to be of high quality. The studies should evaluate correlations between physical activity and academic performance from a 'dose-response' perspective (i.e., what effects the amount and tentative intensity physical activity may have on academic performance).
Esteban-Cornejo, 2015 Systematic review	20 studies 2000-2013	Intense physical activity is correlated with higher cognitive ability. Academic performance is correlated with general physical activity, especially among girls. Type of activity, better self-concept and lower incidence of depression may partly explain the correlation between physical activity, cognitive ability and academic performance. 75 % of the studies showed positive correlation, and almost none reported any negative correlations.
Donnelly, 2016 Systematic review	137 studies 1990-2014	A correlation exists between cognitive ability among students and regular, high physical-activity rate or fitness. Occasional incidents of movement, exercise and play will also improve cognitive ability in the short run. Today there is limited evidence related to correlations between physical activity, PE lessons and learning or academic performance – depending on the low to moderate quality of available studies (need for future studies with higher quality).

Effects of outdoor teaching on contact with nature, including green school yards



Potential effects of children's and young people's contacts with nature and outdoor environments is interesting in the present research review, as many schools and preschools have developed or should be able to develop accessibility to nature and greenery in the school yard or in close proximity to it, so as to use it as a pedagogical asset. This is, of course, not applicable to the cases where preschools or schools from the beginning have been located on building spots without a yard, and if there are no natural or green areas in the vicinity.

Nature and greenery are useful in a great number of school subjects – not only in natural sciences. Nature is also interesting to this review, because it raises the probability for human beings, including children and youth, to be physically active on a regular basis (Gill, 2011, 2014). This could have positive effects on learning and academic performance, as is reported in this review. Today, many Swedish preschools and schools use the school yard and nearby nature for outdoor teaching, to various degrees. This can be stated, even if no comprehensive survey is available concerning the prevalence of outdoor teaching in the country and its share of the total amount of teaching. Nevertheless, a good introduction to the importance of contact with nature

during childhood, based on different research disciplines and perspectives, can be found in a report from the Swedish Environmental Protection Agency, *'The wholesome outdoor stay?'* (Mårtensson et al., 2011).

Current state of knowledge in the area

Altogether, there are today relatively strong indications for contact with nature having positive effects, physically as well as mentally, for both adults, children and youths. Several systematic reviews and similar reports (Greenspace Scotland, 2008; Gill, 2011, 2014) demonstrate that getting familiar with nature during childhood and adolescence promotes environmental awareness and a feel for nature in adulthood (cf. Wells & Lekies, 2006). Regular stay in nature improves students' mental health and emotional control as well as impulse control. This is true both for children with specific diagnoses (e.g., ADHD) and all other children. Students who take part in teaching in, for instance, school gardens perform better in natural science and have healthier eating habits compared to other students. There are also strong indications that play and movement outdoors in green environments improve preschool children's general and fine motor skills.

It is utterly important that children develop their motor competence, for several reasons. Recently published research shows that motor competence is strongly related to cognitive ability and academic performance – sometimes even stronger than can be observed between these skills and factors such as IQ and students' socio-economic background. Children's motor skills have been deteriorating in the last decades compared to earlier generations, and this is raising the risk of a sedentary lifestyle, thus impairing their possibilities of experiencing 'the joy of movement' later in life (Myer et al., 2015). Children with low motor competence have:

- less sense of competence for movement,
- lower oxygen uptake,
- less muscle strength,
- inferior muscle endurance,
- poorer and more unhealthy weight status (Vedul-Kjelsås et al., 2015).

There exists relatively strong evidence, that regular 'green' outdoor teaching leads to better social skills, self-control and self-awareness among students, in comparison with students who have been taught in the classroom (Gill, 2011, 2014). The scientific evidence is also relatively strong that school programmes aimed at outdoor-based environmental and nature protection lead to better psycho-social health among the students, compared to students who receive only classroom teaching (Gill, 2011, 2014).

In essence, research indicates that closeness and access to nature increases human physical activity and that contact with nature is related to personal well-being and easier recuperation from stress and certain illnesses (Gill, 2011, 2014). Nature and greenery also improve the conditions for outdoor teaching. An abundance of trees and bushes in the residential areas, for instance, has a protective effect during local heat waves, by offering shady places. Heat waves, of course, are less of a problem in Sweden than in countries with a warmer and dryer climate, but green traffic-islands and many parks nevertheless create better conditions for schools and preschools to offer outdoor teaching. Green yards and nearby areas also contribute to less exposure to the

sun and UV-radiation, and at the same time they seem to increase the students' physical activity (Boldemann et al., 2006).

Moreover, scientific evidence has been found that closeness and access to nature may counteract emotional and behavioural problems among children and youth, e.g., children diagnosed with ADHD (Greenspace Scotland, 2008). Green spaces are also essential for social interactions and seem to facilitate social harmony and social capital (Greenspace Scotland, 2008). Nature has a soothing effect on humans in general. Contact with nature – even short incidents of contact – lowers the level of stress hormones in the body, it promotes faster recovery and contributes to a lower risk for children to contract disease, as it is more difficult for air-born infectious matter to spread, while the children's immune system is strengthened when they spend time outdoors (Ekvall, 2012). The amount of greenery and elements of nature in the preschool and school yard thus plays an important role for the students' health, physical activity and overall psycho-social development.

In residential areas where green spaces are allowed to develop the quality of the air is better, there is less noise, the inhabitants are less exposed to cars and other motor vehicles, and the area has lower risk of being flooded in case of heavy rains (Greenspace Scotland, 2008). Such general efforts improve the conditions for both adults and children to spend time outside the house and give a lot of opportunities to move about, which, in turn, creates better conditions for preschools and schools to have outdoor teaching in nearby nature areas. It is known from before that feeling safe plays an important role when it comes to physical activity and freedom of movement, not least among children and youth (Faskunger, 2007, 2008).

Even when exposure to nature is more 'indirect', favourable effects can be obtained in a preschool and school perspective. Overlooking green pastures, for example from the classroom window or from the school yard, seems to generate positive health effects, particularly as regards diminishing stress and improving recovery (Greenspace Scotland, 2008).

The school as a health-promoting arena

It is important for the present review to investigate, how preschools and schools function as health-promoting arenas. If the arena has great potential for supporting positive health behaviours and daily habits, it is also logical to think that there is some potential for promoting and initiating outdoor teaching and, thereby, contributing to better cognitive and affective skills. Health and learning are strongly linked to each other. Students with a good health status perform better at school, which, in turn, relates strongly to good health later in life (Langford et al., 2014).

The present research review indicates the existence of evidence that schools and preschools can be efficient arenas for enhancing physical activity, oxygen uptake/'fitness', healthy habits, as well as healthy weight loss among children and youth. These facts are based on results and conclusions from several systematic overviews (WHO, 2006; van Sluijs et al., 2007; Kriemler et al., 2011; Demetriou & Höner, 2012; Lavelle et al., 2012; Langford et al., 2014). Educational programmes and initiatives mentioned in these reports are also cost effective for society, according to a report from the World Health Organisation (WHO, 2006). Moreover, targeted efforts

concerning teenage girls are proved to be effective when it comes to promoting physical activity (Camacho-Minano, 2011). A systematic review that was carried out within the framework of the Cochrane Collaboration project (Langford et al., 2014) demonstrates that health-promoting schools are efficient in facilitating physical activity, oxygen uptake, healthy body-weight (body mass index: BMI), intake of fruit and vegetables, and in preventing smoking as well as bullying among students. The effect sizes were generally low to moderate, but it was felt that the programmes had great potential to become important for both education and public health, provided that health-promoting schools – or similar initiatives – were implemented in the whole school system and went on for a substantial amount of time. Unfortunately, few studies in the systematic overview had outcome measures related to grades (only 2 out of 67 studies; 3 %), school attendance (3/67; 4,5 %), or academic performance (7/67; 10 %). The school-related measures referred to the following: how satisfied the students are with school and how much they like it; how they experience their own competence in school; atmosphere and social climate in the school. At this point and in this context, it is not possible to draw any general conclusions as regards the effects of the concept of 'Health-promoting schools' in relation to grades and academic performance (Langford et al., 2014).

Effects of green school yards and outdoor environments

Should it be at all possible for preschools and schools to practise outdoor teaching, at least one requirement has to be met, that is, a functional, green, multifarious, useful and attractive outdoor environment, laid out for this purpose. As has been mentioned earlier, it is more and more common, that schools are built without a school yard or located on plots that are too small to be optimal for educational use. Undoubtedly, this leads to negative consequences for the conditions that are necessary for practising outdoor teaching and also for the quality of the students' breaks (de Laval & Åkerblom, 2012). Another restricting dimension is, most likely, lack of renovation or restoration of the school yards. We have not seen much investment into developing outdoor environments at preschools and schools, compared to the amount of investments that have been made into the interior environments (Dahlgren & Szczepanski, 1997; Paget & Åkerblom, 2003).

Green school yards can be seen as an essential base for the students' daily contact with nature and as an important element for the purpose of raising the quality of breaks and also for facilitating the implementation of outdoor teaching. Pedagogues are more inclined to move their teaching outside if they have access to high quality green spaces (Mårtensson et al., 2011). As concerns knowledge about the planning and design of a purposeful outdoor space with an ecological touch, you are referred to e.g., The Swedish National Board of Housing, Building and Planning (Boverket, 2015b) and Gamson Danks (2010).

It is essential that preschool and school yards are pedagogically designed, that is, shaped in a way so as to challenge and encourage the children to play, to learn and to be physically active, at the same time creating conditions for outdoor teaching. The shape, quality and size of the school yard will have an impact on the amount of physical activity that the students get into as well as on the conditions for the quality of outdoor teaching. The school yard is one of the few environments that can increase the

students' physical activity on equal terms, irrespective of their socio-economic background, leisure-time interests, parents' educational level and their possibilities to give their children a lift to various leisure activities. It should be mentioned in this context, that around half of the total physical activity among children and youth takes place during the school-day (Van Kann et al., 2016).

We have not found any comprehensive survey of the quality of existing preschool and school yards in Sweden, but most actors within the field of outdoor education agree that a majority of the school yards have shortcomings as regards facilities for play, movement and outdoor teaching. These shortcomings often refer to the space being too small in relation to the number of children or being covered with asphalt, unimaginative and flat areas and lack of nature-rich green spaces, where the children can spend time in peace and quiet (de Laval & Åkerblom, 2012). The variation of quality of the school yards is considerable (Björklid, 2005). The school inspectorate claims in a report (Skolinspektionen, 2012, p. 27) that 'many preschool yards are surprisingly dull and uninspiring from a learning point of view'. There is nothing to suggest that the quality of school yards is better in comprehensive school or upper-secondary school than in preschool.

Nevertheless, we have found solid research-based knowledge as regards what kind of model and design that would promote 'movement-inspiring' preschool and school yards. Environmental psychologists, landscape architects, building engineers and pedagogues belong to the professionals who have shown a keen interest in modelling and designing yards for children and youth (see e.g., Boverket, 2015b).

Patrik Grahn and his colleagues have examined outdoor environments in preschools in several comparative studies (Grahn et al., 1997, Grahn, 2003). They conclude that there are considerable differences among the preschools concerning children's play and movement that can be attributed to the design of the outdoor space. Yards that contained green rooms, nature/woods, hilly terrain, and large open spaces were correlated to positive health factors among the children, as compared to yards with a poorer layout. Children who spent time in yards with a variety of greenery were less absent for reasons of illness, they developed better muscle strength, balance, agility and motor skills, and better ability to concentrate, compared to children who spent time in yards with a less interesting layout and less greenery.

A study from the capital city of Stockholm investigated the importance of preschool yards to children's movement. It was found that preschool children are 21 per cent more physically active if the preschool yard has trees, bushes, hilly and uneven terrain, and a relatively large open space, in comparison with preschool children whose yard is less attractive and smaller (Boldemann et al., 2006). Since children and young people when growing up are exposed to preschool and school yards during a considerable amount of time, the quality of these spaces is of great importance in creating favourable conditions for their cognitive development, academic performance and physical activity.

Another Swedish study by Pagels et al. (2014) shows that activity-friendly school yards have great potential when it comes to maintaining physical activity among children and youth over time. That children's physical activity drops with age is a strong epidemiological fact. Time spent outdoors, on the other hand, is an important factor for

high physical activity at a health-promoting level. The existence of football grounds was particularly favourable for the boys' physical activity in middle school, whereas the existence of woody areas on or nearby the school yard was primarily favourable for the girls' physical activity at a health promoting level. Physical activity was measured objectively with a movement indicator, a so-called accelerometer. As it is well established that Swedish girls are less physically active than boys (Nyberg, 2017), it is obvious that investments in green yards and nature in close proximity to schools at all grade-levels should be regarded as an important part in the efforts to promote equal movement and health among all children and youth.

Improvements in the layout of school yards to encourage movement and play could create a substantial increase in physical activity among children and youth during the time they spend in the school yard, according to a study from the US (Sallis et al., 2001). Painted loops, patterns and figures on the ground tend to raise the physical activity among young children, according to English studies (Stratton, 2000, 2006). When the school yards were arranged with spaces for play and sports the children's physical activity was much intensified for boys and girls alike (Sallis et al., 2001). The knowledge is rather weak regarding how to plan and design yards where topography and lighting are utilised to facilitate physical and outdoor activities all year round among lower- and upper-secondary school students, primarily because no studies with special focus on such factors have been found.

The importance of outdoor teaching – discussion and conclusions

The most important general conclusion in the present research review is that there exists a substantial amount of knowledge based on relatively strong evidence, that outdoor teaching creates positive and meaningful effects on education and on children's and young people's development. The evidence is particularly clear as regards effects on physical activity and factors that are connected to personal and social development.

The evidence is sufficiently strong so as to recommend outdoor teaching in preschool and comprehensive school, in as much as research demonstrates that teaching combined with being out-of-doors generates a series of positive effects on health, physical activity, cognitive ability and the students' personal and social development.

The evidence is also sufficiently strong for establishing that outdoor teaching contributes, indirectly as well as directly, to improved academic performance and successful results. Moreover, according to this review there are extremely few studies that indicate any correlations between outdoor teaching and negative effects on students' learning, teachers' work situation, or school activities on the whole.

No limitations in the steering documents for outdoor teaching

This research review substantiates that schools, by increasing the amount of lessons outdoors and by alternating between outdoor and classroom teaching, could contribute to better goal achievement overall and get students to perform better and also feel better. The review also shows that there is scientific evidence that outdoor teaching may contribute to raised study motivation, not least among students who have experienced lower levels of study motivation during traditional classroom-based teaching.

Preschool and school should promote the student's all-round development, not just show the way to basic school knowledge, as stated in the national curricula (Lpfö 98; Lgr 11). Research shows that a purposeful physical environment and well-structured outdoor teaching can obviously contribute to the students' all-round development as well as their engagement and participation in their own learning. Sad to say, we miss a survey of the prevalence of outdoor teaching within the Swedish school system.

Research indicates that outdoor teaching facilitates cognitive development and learning among a great deal of students.

The national curriculum for the compulsory school, grades 0-12 (Lgr 11) highlights the importance of creative and aesthetic forms of expression to enhance active learning. Outdoor teaching contributes, to a large extent, to creating a pedagogical learning environment that promotes both student participation and creative work. Swedish

research demonstrates that outdoor activities and outdoor teaching also have potential to break traditional gender patterns and to stimulate equality in play and other activities, compared to classroom teaching and staying inside (Änggård, 2009). Outdoor teaching may, in other words, be an important piece of the puzzle if the school will be able to counteract traditional gender patterns and, thus, contribute to the task as laid out in the national curricula.

Indirect factors for improvement of academic performance and goal achievement

The present review demonstrates, on the whole, that outdoor teaching, regular physical activity and contact with nature have positive and meaningful effects on the development of children and youth from a preschool and school perspective. Positive effects on learning, cognition and academic achievements are also apparent.

Scientific support is especially strong for the positive effects of factors that indirectly influence academic performance, such as:

- improved concentration
- better working memory
- more positive personal and social development
- increased motivation for studies
- more positive behaviour throughout school
- better self-control and impulse-control
- growing self-concept and self-confidence
- improved collaborative skills
- intentions for a healthier life-style (exercise and eating habits)

Educational programmes that are more extensive and have a longer duration seem to obtain better effects than shorter and sporadic pedagogical programmes. Even if the effects usually are on a low to moderate level concerning academic achievements, according to many studies, such programmes are still most relevant in a public health and school perspective, as they have potential to reach many students simultaneously and for a long time.

High physical activity has a strong scientific correlation with cognitive ability and academic performance in both natural sciences and the humanities among students. Regular contact with nature in outdoor-based school environments and outdoor teaching have proved to have similar positive effects.

Too much time inside may counteract goal achievement

More teaching in theoretical subjects (language, mathematics, natural science and home technology) at the expense of e.g., Physical Education does *not* lead to better results in theoretical subjects, and several researchers and reviews have pointed out that increased classroom teaching in theoretical subjects may even raise the risk of physical and mental ill health among students.

Areas of development and needs of research

Research proves that children's health, motivation and creativity are positively influenced by daily and regular stay in green natural and cultural landscapes. This fact should, in the context of preschool and school, be regarded as an essential component in children's learning, their personal and social development and their health.

Moreover, research indicates that contact with nature functions as a 'lubricant' for developing raised awareness and knowledge about nature, nature conservation, milieu, environment and culture conservation and about human living conditions in general. At the same time, there is a need for more research that evaluates effects and efficiency in the long run, through longitudinal studies, qualitative as well as quantitative, and with a clearer focus on the effects of outdoor teaching on grades, presence and direct measures of academic performance.

More longitudinal research needed

The existing research is not comprehensive and there is a great need for evaluations of better quality and design and with a longer time-frame for follow-ups, so as to further strengthen the knowledge base concerning outdoor teaching and its importance for students' learning, development and health/well-being. In particular, there is a need of well-focused longitudinal studies throughout the whole school system (preschool, comprehensive school, upper secondary school). The need of more research is, of course, not limited to the areas of learning and teaching, it extends to other research domains, such as health, landscape planning, and the social sciences.

Owing to the strong international evidence that exists in the area, it is clear that future focus and resources should be allocated to implementation and initiation of programmes that increase the amount of outdoor teaching in preschool and school, rather than confining the resources to examining the effects and efficiency of such teaching (Waite et al., 2016).

Not least is there, from a Swedish point of view, a need for experimental research carried out in Sweden with the aim to investigate effects and efficiency of outdoor teaching and possible ways to implement such programmes throughout the school system.

Older youth are under-represented

It has been difficult to find evaluations of programmes for older youth. For the most part, the international research studies have focused on effects of outdoor environments and teaching at preschool and primary school levels (grades 1-6). Evaluations concerning older students (lower- and upper-secondary levels) are not that prevalent. In other words, the need of high-quality studies about the effects of outdoor teaching directed towards this age group of students is obvious.

One encouraging example, which could hopefully be a model, is the Swedish PhD thesis (Fägerstam, 2012), which is described earlier in this review. The study focuses on the effects of outdoor teaching among lower-secondary students (grades 7-9) and their teachers. Furthermore, the effects are studied during a relatively long time, which

contributes to the knowledge of possible long-term effects of outdoor teaching among this age group. It should be noted that the students who took part in the study had no earlier experiences of systematic outdoor teaching at school (Fägerstam, 2012).

Few evaluations of sub-groups

It has also been difficult to find evaluations with a focus on potential differences between sub-groups of students. Most of the research has focused on 'normal groups' of children and youth or has not analysed data on possible differences between various sub-groups. In other words, analyses of similarities or differences between sub-groups are missing, including gender, socio-economic conditions, ethnicity and geography. Only very few studies reveal important information about the participants in these respects (William & Dixon, 2013).

This kind of analyses could give detailed information about what teaching programmes and interventions that may work best for different groups of students, rather than just giving information about average effects for the whole student population.

A variety of outcome measures makes comparisons hazardous

Despite a great number of studies and overviews that report effects of outdoor teaching and physical activity, the use of outcome measures in evaluations is 'sprawling', that is, many different measures are used. Most actors in the area, though, seem to agree about what programmes and interventions that function, but they are less in agreement as concerns the outcome measures that should be used (Fiennes et al., 2015). The accumulated knowledge base regarding outdoor teaching is relatively strong but would be even stronger had researchers decided to come together in using the same measures. This would make it easier to carry through overall assessments and comparisons of effects and efficiency.

Surprisingly few studies have used outcome measures of the effects of outdoor teaching on students' academic performance – albeit that the funds for such studies most often come from the educational sector (Fiennes et al., 2015). Similar conclusions are made in the systematic review by Langford et al. (2014), in which focus lies on the effects of health-promoting schools. There is a need of both quantitative and qualitative studies that investigate effects of outdoor teaching on school-related outcome measures, such as grades, presence and academic performance, although the existing reviews display a relatively strong correlation.

Process information is important

Another general phenomenon is that researchers when designing their studies are not so apt at describing their programmes and interventions and give process information, such as; What works, for whom and for what groups? Under what circumstances? Why does the programme work or not? Are there any positive or negative effects? Reporting that a certain programme was successful is only one piece of many in the complex patterns. This type of information is decisive for the possibility to implement functional educational programmes in preschools and school, or in other contexts than the one where the study was conducted. Different kinds of evaluation – formative assessment,

evaluation of processes, effects and outcomes – are important parts in order to raise comprehension and improve the current knowledge base.

A related phenomenon in this kind of review is that a theoretical anchorage is often missing in the studies, or the researcher is not very accurate in reporting the connection between the programme or intervention, on one hand, and the theory or model, on the other. Few studies are based on a developmental theory or a theory of change, which makes it difficult to understand how and why the interventions are working.

Better theoretical anchorage is needed about change processes

The systematic review by Fiennes et al. (2015) points out a general need of researchers who will use a model or theory of change to guide evaluation and interpretation of the results. All the same, a researcher cannot ignore the importance of pluralism as regards research methods, i.e., using a combination of different research methods. It is essential to raise the level of understanding of how and why the programmes works, so as to bring about change in the future and in other contexts. More programmes and interventions need to be tested under different circumstances and by different research groups independent of each other. This is a crucial criterion when the strength of the knowledge base is to be established and when it is to be decided whether the programmes can be implemented in other contexts, for instance, in another country or cultural community (since many educational programmes originate in English-speaking countries).

The reliability is rarely corroborated

One overarching problem found in the examined research material has to do with lack of information about the reliability of the evaluations. There are still quite a few studies that have no information or discussion about validity, reliability or possible distractions in relation to the programme or the evaluation. In the review by Williams and Dixon (2013) validity is mentioned only in 69 per cent of the studies, and then just on connection to the material that was used for collection of data. There is undoubtedly quite a few more sources of distraction than validity and reliability of test instruments to consider in an evaluation process. The lack of such information makes it difficult to assess the degree of distractions that have occurred during the intervention and evaluation.

Yet another characteristic that has to do with reliability is the researcher's own influence on the research process and the results. This is rarely discussed in the evaluations, although it is well known within the field of teaching and learning, where outdoor teaching is included, that teachers/pedagogues involved in a programme or evaluation often have a lot of knowledge and experience and are strongly committed to outdoor teaching (Fiennes et al., 2015). That pedagogues and/or researchers are highly motivated to use outdoor teaching is, of course, a great advantage to the programme, not least as regards contact with the students, but it could, at the same time, be a problem in the evaluation process, if they are unaware of it and fails to disregard their own practised experience and pre-comprehension.

Minor and short-term studies

Many studies are of short duration and have relatively few participants, which makes them statistically problematic when it comes to measuring quantitative effects. In qualitative studies with verbal methods of analysis few participants are less of a problem. Many studies have no information about sample size power calculations. This lack of statistical information makes it hard to assess whether non-significant correlations are caused by poor statistical material or whether the programme is simply not effective or did not 'take root' in the organisation during the implementation process. Without such statistical calculations there is an obvious risk that researchers, project leaders or decision-makers take the wrong decisions about the programme in question, in other words, make a type 2 error. An outdoor teaching programme would then run the risk of being discontinued or given less priority, although it might, in actual fact, be efficient and of advantage to the students and the teachers. A programme with low efficiency rate according to the evaluation could actually be very effective, had it been implemented in a better way, or had the statistical material in the evaluation been adequate.

The problems of implementation

If the positive effects of outdoor teaching can be partly attributed to highly motivated and competent teachers and researchers, one can foresee some problems when trying to transfer the model to other school contexts, where the teachers maybe are less knowledgeable about outdoor teaching and therefore are less motivated to implement it. In this context external evaluation is really justified. Future research needs to describe in detail the tentative influence that the evaluation may have on the final results of a project, with the intention to avoid any potential source of disturbances. If the educational programmes are carried out by the regular group of teachers there is less of a risk that the researcher will have an impact on the process. It is also advantageous when action plans and research studies are implemented by pedagogues in preschool and school, in as much as they are carried out under normal circumstances and conditions, which means that the evaluation can show effects of the programme in realistic situations.

Programmes carried out under normal conditions are also easier to implement in other situations, compared to programmes that are carried out under ideal conditions and therefore may have large human and economic resources and competencies at hand. With regard to disturbances, the Swedish dissertation by Fägerstam (2012) showed that the effects of outdoor teaching at the studied school did not depend on 'the charm of novelty', i.e., that the effects of the programme came about because it was something new and exciting to the students compared to traditional classroom teaching. Rather, it turned out that the effects remained as long as the outdoor teaching went on.

Reliability of the measuring instruments

There are shortcomings in the studies concerning the measuring instruments used (Fiennes et al., 2015). Many studies are based on measures using instruments that are not properly validated, and in some cases the researcher does not give information on whether the instruments are valid or not. Poorly validated measuring instruments must

be seen as a weakness in research, since it will be difficult or impossible to assess the validity and reliability of a study. Moreover, some studies are based on self-reports, i.e., subjective measures. Future studies need to investigate the effects of outdoor teaching using more objective measures, but, on the other hand, qualitative measures are also desirable in gathering knowledge in future studies (Fiennes et al., 2015). In addition, longitudinal follow-up studies are also needed, as mentioned earlier (ibid.).

The research material in the present review contains several cross-sectional studies where effects or outdoor teaching are measured on one single occasion. Cross-sectional studies may reveal potential correlations but cannot explain a cause-and effect relationship. That is, one study cannot on its own prove that an outdoor teaching programme has led to any effects on the students. The effects could as well be caused by certain experiences, characteristics and knowledge that the participating students had, compared to the students who did not take part in the outdoor teaching programme. A cross-sectional study can be compared to a photograph where the image itself displays different static objects but fails to catch movements (the process). Therefore, it will be difficult to understand how the objects relate to each other. An intervention with a follow-up may be able to establish the cause-and-effect relationship by showing that changes in one variable leads to changes in other variables. Thus, an intervention with a follow-up may be compared to a film where it is more obvious (than in a photograph) how the objects are related to each other, what movements there are in the material and what could cause a certain phenomenon. It should also be possible to make up plans for studies based on mixed methods, a mixture of quantitative and qualitative analyses, as have been used in some of the studies described in the present review (Fiennes et al., 2015; Malone & Waite, 2016).

Effects wear off in short-term programmes

The effects of outdoor teaching tend to wear off or disappear, as described in some studies, after the programme has finished, possibly because many programmes have gone on for too short a time. Consequently, there is a need of more so-called longitudinal studies that would examine effects of outdoor teaching on students' learning and other student characteristics in the long run, using a variety of follow-up measures, quantitative as well as qualitative, in order to show a cause-and-effect relationship. Those studies which have followed students for a longer period of time often demonstrate positive results on e.g., self-control and working memory (Fiennes et al., 2015). In the systematic review of effects of 'health-promoting' schools by Langford et al. (2014), only 12 out of 67 studies (18 %) evaluated the effects in the long run. What exactly 'the long run' means is, of course, a matter of interpretation, but there is an obvious need of more evaluations that are stretched over a longer time period than 12 months, preferably even longer. The Swedish evaluation study, 'the Bunkeflo project' (Ericsson, 2011), is a model in this respect with its nine-year long time-frame.

The fact that there exist no clear recommendations as to what 'volume' of outdoor teaching that is needed for a school or a programme to be regarded as 'outdoor education profile/ orientation' creates a certain problem when effects of outdoor teaching are to be evaluated. The problem is due to the participants (students) probably having been exposed to various volumes of outdoor teaching. A comparison can be

made with an attempt to evaluate the effects of a certain medicine, when the participants have received different doses or have had different experiences of the drug. Future evaluations, therefore, need to be clearer in their descriptions and reports as regards the amount and extent of outdoor teaching, physical activity and/or exposure to nature the students have received by taking part in the programme (or not, as is the case with the control group in comparisons).

The effects on teachers of outdoor teaching – a pressing research task

A final problem to bring up as regards the knowledge base is that most of the research focuses on the effects on students. Students' learning and academic performance are naturally influenced by an array of factors within and outside preschool/school. Hence, there is an urgent need to evaluate effects of outdoor teaching on teachers and pedagogues and their teaching activities, as well as the rest of the staff throughout the whole school system.

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Appendices

Appendix 1. Keywords

In the present research review we have used the Swedish and English keywords described below, and the results and conclusions are primarily based on aggregated information from peer-reviewed systematic overviews and meta-analyses published in scientific journals. In addition, some relevant research reports and separate studies have been included in areas where reviews are missing for some reason or where it seemed appropriate from a Swedish perspective. The review is not a comprehensive survey of all research in the area of Outdoor Education, although results and conclusions are identical to existing knowledge and available scientific evidence.

Swedish keywords

Utomhuspedagogik [Outdoor education], uteundervisning [open air teaching], uteverksamhet [outdoor activities], utomhusdidaktik [outdoor pedagogy], utomhusundervisning [outdoor teaching], handlingsburen kunskap [action-based knowledge], hälsa [health], förskolegård [preschool yard], skolgård [school yard], gröna skolgårdar [green school yards], skolträdgård [school garden], byggd miljö [urban environment], upplevelsebaserat lärande [experience-based learning], fysisk aktivitet [physical activity], natur [nature], barn [children], ungdomar [youth], lärande [learning], cognition [cognition], systematisk översikt [systematic review], meta-analys [meta-analysis], översikt [review, overview], narrative översikt [narrative review], hälsofrämjande skolor [health-promoting schools).

English keywords

Outdoor education, outdoor learning, physical activity, place-based learning, nature, green areas, forest schools, health, green education, school gardens, learning, school grounds, built environment, special needs, disabled, disability, cognition, academic performance, academic achievement, systematic review, meta-analysis, narrative review, health promoting schools.

Search for literature

In the search for literature we have used PubMed, ERIC, Google Scholar as well as lists of references in relevant systematic reviews. Literature and suggestions have also been received from representatives of Utenavet (see www.utenavet.se).

Appendix 2. Effects and outcome measures of various forms of outdoor teaching

From Fiennes et al. (2015).

Outdoor teaching via field visits	**Outdoor teaching in the form of outdoor adventures and in the wild**	**Outdoor teaching in school yards and projects in the local community**
- Memory - Social skills - Learning	- Attitudes - Values - Self-concept - Independence - Self-control - Personal efficiency - Efficiency in group - Group harmony - Cooperation - Communicative skills - Academic competence - Commitment - Fitness (oxygen uptake, strength, balance)	- stronger self-confidence - Improved processing skills in natural sciences - Better understanding of design and technology - Increased pride of local community - Higher motivation for learning - Improved sense of responsibility - More play and movement - Increased motivation for healthier eating habits - Increased motivation for exercise and physical activity

Appendix 3. Outcome measures concerning effects of contact with nature among children and youth

Outcome measures used in the Gill-survey and number of original studies about the effects of contact with nature among children and youth (Gill, 2014).

General effects/advantages	**Specific effects/advantages**	**Number of original studies**
Health (physical, mental emotional)	- Physical activity - Mental and emotional health - Healthy eating habits - Motor development	16 11 3 2
Well-being	- Psycho-social health - Quality of outdoor play	1 2
Cognition	- Learning in natural sciences - Environmental knowledge - Language and communication	4 2 2
Social	- Social skills	4
Emotional/behavioural	- Self-control - Self-confidence - Self-concept	2 1 1
Ethics/norms and values	- Environmental awareness - Sense of nature - Knowledge of space	13 5 4

Appendix 4. Outdoor teaching and its effects

Several reviews focus on adventure and wild life programmes. These programmes are not regarded as relevant to the present research review from a Swedish perspective, in view of the Swedish school model. Nevertheless, the effects of such programmes may be of interest. The table below displays results from both included and excluded reviews.

Main author, year and type of study	**Form of outdoor education; outcome measures**	**Results and discussion**
Cason (1994) Meta-analysis	Wild life adventure. Normal school-population and at-risk youngsters. Self-concept, self-control, clinical scales.	Average effect measure of .31, 12.2 % averaged improvement among participating youth, which corresponds to an improvement of 62.2 % compared to non-participants. Longer duration of programme and younger participants gave higher effect measures.
Hattie (1997) Meta-analysis of 96 separate studies	Adventures. Normal school-population and at-risk youth and young adults. Leadership, self-concept, academic performance. Personality, inter-personal skills, social skills, adventurousness / boldness.	Average effect measure of .34 at the end of the programme. Effect measure at a later follow-up .17. Outcome measures (at later follow-up within parenthesis): leadership .38 (.15), self-concept .28 (.23), academic performance .46 (.21), personality .37 (.14), interpersonal skills .32 (.17), adventurousness .38 (-.06). Highest outcome measures are related to self-control: independence .47, self-confidence .33, self-efficacy .31, self-awareness .34, determination .42, inner control .30, decisiveness .47.
Rickinson (2004b) Systematic review of 150 separate studies	Adventures. Normal school-population, young delinquents, young with emotional and behavioural problems.	Strong positive effects on attitudes, values, interpersonal and social skills of outdoor teaching based on adventure excursions. Positive effects also on academic performance, behaviour, lower risk of relapse into crime for youngster with criminal background, and stronger self-image. No correlation was found between adventure excursions and raised environmental awareness among the students.

Neill (2008a) Overview of 7 reviews	Adventures. Normal school-population aged 5-18 years. Some children had special needs. Personal and social development.	Programmes had moderate short-term effects of .35. Some evidence was also found for long-term effects. 64 % of the participants in the adventure programmes showed significant effects compared to non-participants.
SMCI Associates (2013) Systematic review	Outdoor programmes. Wildlife adventures. Young persons with a crime record, high-risk and disadvantaged youngsters.	Positive effects for youngsters who have been convicted of crime and high-risk youngsters. Lower risk of relapse into crime. Positive effects on personal and social skills. Better chances of getting a job for the youngster who took part in the programmes.
Neill (2008b) Meta-analysis	Adventures in urban areas. Normal school-population.	Adventure programmes have low to moderate positive effects on common outcome measures, such as self-concept, lower risk of behavioural problems, better collaborative skills.
Higgins (2013) Systematic review of several meta-analyses	Adventures in urban areas. Normal school-population.	The review indicates clear and all-pervading positive effects on academic learning and over-arching outcome measures, such as self-confidence. Students taking part in the adventure programmes made progress that corresponded to an average of three months of ordinary school work. The average effect measure was .23 with a variation between .17 and .61, i.e., the effects were low to moderate. Higher effects were accomplished in programmes with longer duration (at least a week) that were nature-based. Other programmes also showed positive results.
Gillis (2008) Systematic review of meta-analyses, 44 separate studies	Adventure programmes without over-night staying. Normal school-population, some young persons (aged 11-25 years) with special needs.	Average effect measure was .43. Moderate positive effect measures were found for self-efficacy (.48), positive behaviour (.37), personality (.29), self-awareness and self-respect (.26), and academic performance (.26).

Coalter (2010) Unknown number of studies	Walks in forests and mountains without over-night staying. Normal school-population, young persons convicted of crime, high-risk youth, youngsters with ADHD.	The review indicates positive effects on physical health, physical activity, including the cardiovascular system, skeletal muscles, the endocrine system, and the immune system. Few studies have payed attention to social and economic effects of programmes based on walks in forests and mountains. The review also identified some negative effects of walks in forests and mountains, although they were not very serious (e.g., youngsters who had soiled their trousers).
Gill (2011) Systematic review, 61 separate studies	Outdoor teaching in green environments.	There are strong indications that children and youth who are regularly exposed to nature developed better environmental awareness and a stronger feeling for nature in the local community as adults. Living close to green spaces had a strong positive correlation with physical activity, mental health, and better emotional control among children with or without special diagnoses. Children who took part in outdoor teaching in green environments improved their learning and developed healthier eating habits compared to other children. Relatively strong indications were found that schools with green outdoor teaching and schools with garden programmes had students who developed better social skills compared to other schools. Moreover, the students at these schools improved self-control, knowledge and self-awareness. Play in natural environments developed preschool children's motor skills and fitness more than children at other schools without natural environments in close proximity to the school yard.
Davies (2013) Review of 58 separate studies	Creativity. Normal school-population.	This review demonstrates strong support for outdoor teaching in promoting the students' creative ability, e.g., in the form of better cooperation in groups. Relatively strong evidence was found for improvement among students as concerns motivation, participation during lessons, contentment with teaching, concentration and attention when taught out of doors.

		Evidence was also found for creative environments – often indicative of outdoor teaching – promoting the emotional and social development of children and youth.
Bowen (2013) Meta-analysis of 197 separate studies	Adventure therapy. No distinct group.	Effect measure .47 for adventure therapy compared to alternative therapy (.14) and a control group (.08).
Cooley (2015) Systematic review, 11 separate studies	Outdoor activities in urban areas. Population from college/ university. Outcomes connected to group collaboration.	The review showed evidence that the students developed skills related to group collaboration, and that these skills remained after the programme was finished. However, there was no support for the students being able to use the skills in other contexts after the short training programmes.
Stott (2013) Systematic review, 35 separate studies	Adventurous expeditions abroad, 14 days or more. Older teenagers and young adults.	Personal development, better self-confidence as well as physical and social stability, coping with challenges and overcoming difficulties. Improved social competence, self-awareness and self-reflection. Improved environmental knowledge environmental awareness and appreciation of nature.
Barton (2010) Review of 10 separate studies	Physical activity and exercise in green environments. Adults. Self-esteem, control of temper.	Activities in green environments improved self-esteem and control of temper in both men and women. The best improvement was found in terms of self-confidence among participants with a psychiatric diagnosis. The average effect measure for improved self-esteem was .46 and for control of temper .54. The review found positive effects through physical activity and exercise in green environments. The effects diminished after the programme was finished, but there were some positive effects also in the long run.
Fiennes (2015) Systematic review of 58 separate studies	Learning outdoors. Great Britain.	Practically all studies reported positive effects on school-related factors derived from outdoor teaching. Effects diminished at later follow-ups, but improvement of self-control remained in the long run. Programmes that went on for a longer time (e.g., with over-night stay) had grated effects than short-time programmes/interventions.

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The environments or contexts that teachers choose for their pedagogical activities – in the classroom as well as out of doors – are important for successful schoolwork. The purpose of this research review is to collect and describe current scientific evidence as to how outdoor teaching can influence learning and academic performance among children and youth.

The most important conclusion is that there exists extensive and rather strong evidence that outdoor teaching creates positive effects on pedagogical activities as well as children's and youngster's development. This pertains especially to effects on physical activity and factors related to personal and social development. The evidence is strong enough to consider implementation of outdoor teaching on a larger scale at all levels of the educational system.

This work is based on a scrutiny of results and conclusions from scientific and systematic reviews where the authors have gathered and analysed research which illuminates effects of outdoor teaching, physical activity and contact with nature during childhood and youth on academic performance.

The research review has been produced in Sweden in a collaborative effort between Forum for Outdoor Education at Linköping University, Department of Urban and Rural Development, Swedish University of Agricultural Sciences (SLU) and Movium Think Tank, which has a national responsibility for developing and communicating knowledge about purposeful outdoor environments for children and youth.

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