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Farm Education

– sustainability, food and education

Doctoral Dissertation

Pia Smeds

Luke

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University of Oulu Graduate School

Academic dissertation

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Acknowledgements and Foreword

My grandmother, Geraldine, and grandfather, Alvar, had cows when I was young. I remember that I was often helping my grandmother to feed the cows, mix their fodder and getting as a thank you, one of those rough licks by the long tongue of an affectionate cow. (Or, maybe she just wanted to see how I tasted.) I still remember the scent of the cows and the hay, hearing the buzzing of the flies. I remember the warmth of the big animal, its heavy breathing and coarse fur, and remember the anticipation and the joy of taking care of the calves with soft big ears and silky smooth muzzles. My grandmother used to do the milking by hand. I tried it once, but all the milk ended just up my sleeve. Milking was not my thing, I guess. In those days, the milk was kept cold in a well, with crystal clear and ice cold water, just by the barn, and transported early in the morning half a kilometre on a hand-drawn wagon for picking up by the milk truck. And, of course, I grew up on this fresh, unpasteurized and unhomogenized creamy milk. We also used the cream from the milk to make butter, but I did not really fancy the taste of it, as it was a bit different from the butter in shops. But it was well-suited for baking. During the summers, my whole family participated in the hay harvest, as it was vital to get all the hay stacked so it would dry nicely and after it was perfectly dry to get it into the barn. Usually it was during the hottest days of the summer, and we children loved to play in the hay and enjoy the picnic that we had brought with us. The adults probably did not enjoy it that much, as they were sweating and working as fast as possible to get everything done in time before any surprise summer rain would ruin the hay harvest. The adults' joy after a job well done was eminent after hard work. It was time for a small harvest celebration where everybody participated.

This scenario took place every summer when I was a child, only 35 years ago, a blink of an eye ago. Today's world is quite different for children. Many children will grow up not experiencing, knowing, understanding or sensing where their food comes from. Not knowing what work is included in food production, not knowing all the love and caring that is included in taking care of animals and plants to gain a good harvest. Not knowing the value of food. These children will have difficulty in making sustainable food choices, as they have no experience or comprehensive knowledge on what aspects responsible food production includes. How can I help these children gain the same insight, emotion and value for food and food production as I have?

This is the background and leading motivation based on which I started my development and research assignment. As the study takes me further on my personal educational journey, I find out that Farm Education is more than just teaching children where their food comes from. Farm Education starts to reveal sides to it that trigger my interest even further. Children in need of special or supported education perform better on tests when allowed to participate in education on a farm. They even outperform so-called academically gifted children that have participated in traditional education. Pupils experience that they feel more energetic after a farm visit, and that this feeling carries

on to other subjects in school. At the same time, my fellow researchers report that school tiredness and the frequency of learning difficulties are increasing, the same aspects that Farm Education seems to prevent. School tiredness and learning difficulties are major reasons for young people dropping out of the educational system. This reveals the true power of Farm Education, as well as of many other authentic learning environments. Authentic learning environments, at least on farms, might support pupils' learning and motivate them to stay in school to such a degree that they will continue their education and find a job, and in this way avoid educational dropout. This could support their personal identity as a learner and a human being as well as reconnect them to nature and their personal relation to natural processes such as the route of food. Farm Education could in this way not only support the individual but also society by saving it from the tremendous costs associated with educational dropout. In the summary and the articles I will give a better insight into how I have defined Farm Education, the effects of it and what might be the causes for these effects in such an authentic learning environment. I hope you will enjoy this journey in the world of Farm Education as much as I have.

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In Vasa, Nowember 2017

Pia Smeds

Abstract

Pia Smeds Natural Resources Institute Finland

This work addresses two central societal issues: food and learning. Personal experience and first-hand knowledge are becoming scarce amongst today's children, which might affect their food-related behaviour and future decisions as consumers and policymakers. The incidence of learning difficulties has increased and an increased number of pupils require special education. At the same time, headlines are declaring an increase in young people's ill-health and educational dropout.

In this work, I am studying how the learning environment affects learning of "the route of food", both qualitatively and quantitatively. I explore the phenomenon from the views of environmental education as well as biology, not forgetting pupils' personal learning preferences. An interdisciplinary angle is applied by using both pedagogical and biological research findings and theories for background. I have developed an educational model based on international, as well as my own findings on an optimal learning environment and the learning preferences of different pupils. The authentic learning environment of Farm Education, as a result, is based on environmental education theories, other educational thoughts and research results. Farm Education is in this work understood as the route of food from field to table. This work explains the background and definition of Farm Education, but also what learning in an authentic learning environment could be. As a research strategy, I have used experiential mixed methods with interventions. A total of 318 participants, including students from the countryside and cities, their teachers and farmers were included in the study.Mixed methods indicate in this work that I have used both qualitative and quantitative data collection and analysis methods, with the main intention of being as true as possible to the phenomenon studied. Data collection methods I have used are questionnaires, pre-, post- and delayed learning tests, interviews and subject-produced drawings for data collection and for analysing methods inductive content analysis, visual content analysis and statistical analysis with SPSS.

Results show that learning in the authentic environment of the studied phenomenon is effective and supports equally academic achievers ranging from low to high ability. Pupils experienced learning as effortless and appreciated that they could study the phenomenon to be learnt comprehensively, firsthand and in different ways, compared to learning in a classroom. The delayed learning test was carried out five months after the interventions. It revealed that low academic achievers that learnt in an authentic learning environment gained significantly higher grades than high academic achievers that had learnt in classroom settings. Pupils in the 5th and 6th grade of primary school had several misconceptions regarding farms, farming and farmers, even though they had studied the theme in school in 4th grade. The effect of media on pupils' conceptions

could be seen in the results. An educational farm visit decreased effectively such irrational elements. When comparing experiences of educational farm visits between pupils from the countryside and cities, there were no notable differences. Based on this sample, the educational models that have been developed in this work can be seen as effective and motivating ways of learning.

In conclusion, the use of Farm Education as an authentic learning environment strengthens pupils' understanding and learning of "the route of food" and enables responsible and healthy consumer behaviour. Farm Education may also decrease learning difficulties and increase wellbeing in school, and by this prevent educational dropout. This will need further research on a larger sample and additional research on how emotions and cognitive features are connected.

Keywords: mixed methods, intervention, learning environment, context-based learning

Sammanfattning

Detta arbete fokuserar på två samhälleligt centrala frågor: mat och lärande. Allt fler barn saknar personlig erfarenhet och förstahands kunskap om matens rutt, vilket kan påverka konsumtionsbeteende och beslutsfattning angående matrelaterade frågor. Inlärningssvårigheter har ökat i grundskolan och allt fler elever är tvungna att delta i specialundervisning. Samtidigt ökar oron för ungas ohälsa och marginalisering.

I detta arbete granskar jag både kvalitativt och kvantitativt hur läromiljön påverkar lärandet av temat matens rutt. Jag betraktar frågan ur både miljöpedagogikens och ur en biologisk synvinkel, utan att glömma elevernas personliga läropreferenser. Jag har utnyttjat en tillämpad forskningsstrategi genom att utnyttja bakgrundsfakta och – teorier från pedagogiken och biologisk forskning. I mitt arbete har jag utvecklat undervisningsmodeller baserade på internationell forskning, samt mina egna resultat, för en optimal läromiljö. Läromiljön ska stöda det valda undervisningstemat och olika elevers läroprocesser och – preferenser. Resultatet av detta är Matfostran (*Farm Education*), i en autentisk läromiljö, som baserar sig på miljöpedagogiken och andra pedagogiska teorier, synvinklar och forskning. Matfostran (*Farm Education*) beskrivs i detta arbete av teorier och forskning relaterat till lärande av matens rutt från jord till bord. I arbetet klargörs och definieras Matfostran (*Farm Education*) och dess funktion som läromiljö, dess bakgrund, samt hur eleverna upplever lärandet där. Jag har utnyttjat en experimentell mixed methods forskningsstrategi med interventioner. I interventionerna deltog 318 elever från landsbygd och städer, samt deras lärare och lantbruksföretagare. Mixed methods betyder i detta arbete att jag har utnyttjat både kvalitativa och kvantitativa datainsamlingsmetoder samt analysmetoder, med målsättningen att vara så trogen som möjligt till egenskaperna av fenomenet som undersöks. Jag har använt mig av frågeformulär, för-, efter och försenad studie, intervjuer och teckningar. I analyseringen av materialet har jag använt mig av induktiv innehållsanalys, visuell innehållsanalys och statistikprogrammet SPSS.

Om resultaten kan jag konstatera att lärande i en autentisk miljö är effektivt och stöder både svaga och starka elevers lärande. Eleverna anser att lärande kräver mindre ansträngning och de värdesatte att de kunde granska undervisningens tema själva, ur ett helhetsperspektiv, och på många olika sätt jämfört med lärandet i klassrummet. Den försenade studien gjordes fem månader efter interventionerna. Denna studie påvisade att svaga elever, som hade studerat i en autentisk lärmiljö, hade signifikant högre kunskapsnivå, än de starka elever som endast hade studerat samma fenomen i klassrummet. Eleverna i årskurs 5 och 6 hade flera felaktiga uppfattningar angående lantgårdar, lantbruk och lantbrukare, fast de hade studerat temat i skolan. Speciellt kunde man se medias inverkan på resultatet. Ett lantgårdsbesök rättade signifikant till dessa missuppfattningar. Vid jämförelse av urbana och rurala elever, kunde man inte se någon större skillnad mellan elevernas erfarenheter av lärande i lantgårdsmiljö. De utvecklade mo-

dellerna har utarbetats enligt läroplanen och med detta sampel påvisats vara effektiva och en motiverande undervisningsmetod.

Slutligen, utnyttjandet av Matfostran (*Farm Education*) som metod stärker barns och ungas förståelse för och lärande om matens rutt och möjliggör på så vis ett ansvarsfullt och hälsosamt konsumtionsbeteende. Matfostran (*Farm Education*) metoden kan möjligen även minska inlärningssvårigheter och öka skoltrivseln, och på detta sätt förebygga marginaliseringen. Detta kräver dock ett större elevsampel, samt även fortsatt forskning om kopplingen mellan känslor och lärande.

Tiivistelmä

Tämä työ pureutuu kahteen yhteiskunnallisesti keskeiseen kysymykseen: ruokaan ja oppimiseen. Yhä harvemmalla lapsella on omakohtaista tietoa ja kokemusta ruoan reitistä, mikä voi vuorostaan vaikuttaa omakohtaiseen ruokakäyttäytymiseen kuin myös tulevaisuuden päätöksentekoon ruokaan liittyen. Oppimisvaikeudet ovat lisääntyneet peruskoulussa ja yhä suurempi määrä oppilaita on tehostetun tai erityisen tuen piirissä. Samaan aikaan lisääntyy huoli nuorten heikentyvästä terveydestä ja syrjäytymisestä.

Tässä työssä tarkastelen miten oppimisympäristö vaikuttaa oppimiseen ruoan reitistä, niin laadullisesti kuin määrällisesti. Tarkastelen aihetta niin ympäristökasvatuksen kuin biologian näkökulmista, unohtamatta oppilaan henkilökohtaisia oppimismieltymyksiä. Olen käyttänyt soveltavaa tutkimusotetta hyödyntämällä niin kasvatustieteellistä kuin biologista teoriataustaa. Työssäni olen kehittänyt opetusmallin perustuen kansainvälisiin sekä oman tutkimukseni tuloksiin optimaalisesta oppimisympäristöstä, joka tukee opittavaa aihetta, oppimisprosessia kuin myös erilaisten oppilaiden oppimismieltymyksiä. Tuloksena on määritelmä miten ruoan reitti osana opetusta kytkeytyy eri teoriataustoihin ja tutkimuksiin. Tälle määritelmälle käytetään tässä työssä nimikettä Ruokakasvatus (*Farm Education*). Ruokakasvatus tarkoittaa tässä työssä oppimista ruoan reitistä sen autenttisessa oppimisympäristössä, maatilalla, ja pohjautuu ympäristökasvatukseen sekä kasvatustieteen näkemyksiin ja tutkimuksiin eri tieteen aloilta. Ruokakasvatus (*Farm Education*) ymmärretään tässä työssä menetelmänä, joka käsittää oppimisympäristön, ympäristön tekijät ja käytännön aktiviteetit mahdollistaen relaation oppijan ja opitun välille. Työssä selvitetään ruokakasvatuksen (*Farm Education*) oppimisympäristön tausta ja määritelmä kuin myös millaista oppiminen kyseisessä oppimisympäristössä voi olla. Työssäni olen hyödyntänyt kokeellista monimenetelmäistä (*mixed methods*) tutkimusstrategiaa, jossa olen hyödyntänyt interventioita. Interventioihin on osallistunut 318 oppilasta, maaseudulta ja kaupungeista, sekä heidän opettajiaan ja maatilayrittäjiä. Monimenetelmäisyys (*mixed methods*) tarkoittaa tässä työssä sitä, että olen hyödyntänyt laadullisia ja määrällisiä aineistonkeruumenetelmiä sekä analysointimenetelmiä, jotka parhaimmalla tavalla luovat ymmärrystä tutkimuskysymyksilleni. Aineistonkeruumenetelminä olen käyttänyt kyselyitä, ennakko-, jälki- ja viivästettyä koetta, haastatteluja ja piirustuksia. Aineiston analysoinnissa olen käyttänyt induktiivista sisällönanalysointia, visuaalista sisällönanalysointia ja tilastollista analysointia (SPSS ohjelmistoa).

Tuloksista voi todeta, että oppiminen opetettavan ilmiön autenttisessa ympäristössä, on tuloksellista ja se tukee niin heikkojen kuin lahjakkaiden oppilaiden oppimista. Oppilaiden mielestä oppiminen oli vaivattomampaa autenttisessa oppimisympäristössä ja he arvostivat sitä, että opittavaa aihetta pystyi tarkastelemaan kokonaisuutena, omakohtaisesti ja monella eri tavalla, verrattuna luokkahuoneessa oppimiseen. Viivästynyt koe toteutettiin viisi kuukautta interventioiden jälkeen. Kyseisessä kokeessa autenttisessa oppimisympäristössä opiskelleiden heikkojen oppilaiden tietotaso, oli huomattavasti

korkeampi kuin niiden kiitettävien oppilaiden, jotka olivat oppineet samasta ilmiöstä luokkahuoneessa. Alakoulun 5- ja 6- luokkalaisilla on monia virheellisiä käsityksiä maatiloista, maataloudesta ja maatilayrittäjyydestä, vaikka he ovat opiskelleet aihetta koulussa. Etenkin median vaikutuksen pystyi huomaamaan tuloksissa. Maatilavierailu muokkasi virheellisiä käsityksiä huomattavasti realistisemmiksi. Kun verrataan kaupunkilaisia ja maaseudun oppilaita, ryhmien kokemukset oppimisesta maatilalla eivät eroa toisistaan. Työssä kehitetyt mallit on työstetty opetussuunnitelman mukaisiksi ja todistettu tällä otannalla tuloksellisiksi ja motivoivaksi opetusmenetelmäksi.

Ruokakasvatus (*Farm Education*) menetelmän hyödyntäminen opetuksessa vahvistaa lasten ja nuorten ymmärrystä ja oppimista ruoan reitistä ja mahdollistaa näin vastuullisen ja terveellisen kulutuskäyttäytymisen. Ruokakasvatus (*Farm Education*) menetelmä voi myös vähentää oppimisongelmia ja lisätä kouluviihtyvyyttä ja näin ennaltaehkäistä syrjäytymistä. Tämä vaatii nykyistä laajempaa tutkimusaineistoa sekä syventävää tutkimusta tunteiden ja oppimisen linkitykseen.

Contents

1. Introduction

In earlier times the Finnish school system could be proud of good results in many international assessments (Martin, Mullis, Foy, & Stanco, 2012; Mullis, Martin, Foy, & Drucker, 2012; PISA 2003, 2006). Pedagogues from all over the world came to study our educational system to find out what our secret was. These results are now noticeably dropping within mathematics, science and reading (Mullis & Martin, 2015). Simultaneously, more and more pupils are expressing their decreasing motivation towards school compared to other countries (Kämppi et al., 2012; Martin et al., 2012). The differences between pupils have grown and especially the grades of boys have plummeted (Mullis & Martin, 2015). The number of pupils within intensified and special support has also doubled during the last ten years from 6% in 2003 to 14% in 2013 and to 16,4% in 2016 (Statistics Finland).

Learning environments might be optimized for teaching, not for learning. Nordin-Hultman (2004) brings forward the fact that the traditional classrooms are created by pedagogues to optimize the teachers teaching. This is often done according to their background regarding how they understand learning is best achieved. Such a learning environment does not take into account how the pupils learn best or what their learning preferences are. Nordin-Hultman sees that many learning problems could be avoided by adjusting the learning environments to pupils' needs instead of the teachers' needs. She sees that a multifaceted learning environment encourages learning, while a uniform learning environment restricts learning. Haapasalo (2004) concludes the same, as he states that a pupil's learning difficulties are often based on teachers' teaching difficulties.

This work is exploring the deductive approach of learning and tossing Bloom's inductive taxonomy upside down. According to Bloom (1959, taxonomy revised by Anderson and Kratwohl 2001), an educational psychologist, the pupils need to first memorize, learn and understand concepts, whereafter they can start applying, analysing and evaluating. As a result, the pupils are seen as creating freely based on their earlier-gained knowledge. Bloom represents an inductive approach, from detail to a general understanding. In this work, pupils start their learning experience at the creation level, where they are allowed to freely, and with the guidance of the farmer, create an understanding of the phenomenon and its interactions with its surroundings. Thereafter, pupils evaluate, analyse and apply their experiences. As an outcome, pupils have memorized and classified the concepts and their learnt into their schemata. Quite in the opposite order to what Bloom suggested.

Education in today's schools is mainly inductive and pupils need to put together the multidimensional puzzle of the world from small bits and pieces of knowledge (Kohonen, 2001, p. 41). For example, when pupils are taught about food in an inductive form of education, they learn in biology that cows produce milk, what cows eat and about calving. During another biology lesson, some months later, they might learn about biodiversity and at another about crop production. Next semester they might learn during a his-

tory lesson about agricultural history, culture and traditions. Some lesson in between, they might learn in chemistry about how milk is processed before it is sold in shops. In health sciences, some years later, they might learn about healthy eating and allergies and in mathematics about economics and how to be an entrepreneur. In the end, there will be splintered knowledge of various subjects during the pupil's educational journey. A deductive form of education is based on the assumption that real life is not divided into different subjects. It is a comprehensive image. This deductive approach is one of the aims of the national core curriculum (NCC 2016), to move from splintered knowledge to comprehensiveness.

A deductive study of a phenomenon or subject means that the pupil is allowed to study it and its complexity, including interactions and details, in its genuine environment (Paper I). For example, on a farm the pupil is able to study the phenomenon of milk as a part of its authentic environment. The pupil can study the cow, its life, what it eats, animal behaviour, animal husbandry, farm culture, farm economics, ecology, and how the milk is transporter further for processing, all in its authentic environment. The pupil does not have to make an effort to understand what pieces of knowledge belong to the phenomenon, as they are experienced at the site and anchored to the mind through all senses. Earlier research has also found this to be an effective way of learning (Dahlgren & Szczepanski, 1997; McRae, 1990; Palmberg & Kuru, 2000). Bear in mind that experiencing does not rule out theoretical learning. A good learning environment enables pupils to learn that each action, or inaction, has a consequence. In this work it will be possible to follow the study of Farm Education, its evolution, and definition and how it successfully can be implemented as part of education in comprehensive school to fulfil the criteria of the national core curriculum (NCC 2016). These aspects are further studied in papers I and III.

This study is based on the theoretical background of environmental education (EE). EE, as it is understood today, has a background in the Belgrade Charter (UNESCO-UNEP, 1976) and the Tbilisi Declaration (UNESCO, 1978). The former describes the common understanding of EE and the latter includes additional recommendations for education on all levels in both formal and informal education. In this study, I have been working with the background of EE as seen in Paper I (Palmer & Neal, 1994; Palmer, 1998), not to forget the guidelines and theoretical backgrounds from the national core curriculum. EE in this study is seen as a learning process that together with the learning environment promote a comprehensive understanding of the chosen phenomenon, skills, experience as well as values related to the chosen phenomenon and its environment. This type of education is no innovation, but rather an old tradition in the Nordic countries that needs to be reawakened. Even though this study can be seen to be based in EE, it includes several other aspects that complement the study. The evolution of Farm Education can be read in papers I, II and III.

1.1. Motivation

As mentioned earlier, the theme for this work is a based on a changing society, where children are facing educational challenges due to structural changes and where they are growing up, disconnected to where their food comes from. Since 2006 about 60% (Statistics Finland) of all small schools have been shut down, and pupils have been concentrated in larger complexes in city and municipality centres. This has led to that in 2015 21% of all Finnish pupils needed transport to their schools (Association of Finnish local and regional authorities). Pupils spend an increasing time on school buses instead of studying or exercising, and many will have difficulty getting enough daily exercise. This is troublesome, as exercise (Olson et al., 2006) and good oxygen uptake is directly linked to the ability to solve cognitive tasks and problem-solving (Wikgren et al., 2012). The Finnish school system is facing an educational challenge.

These children are also facing a postmodern globalized world full of splintered and detached knowledge. Based on this background, the theme for this work was chosen to be farming and the route of food, and more closely the route of milk. A more detailed motivation for this choice is the fact that the number of farms has decreased heavily during the last decade (Niemi & Ahlstedt, 2006) and many farms have closed their doors to the public due to hygiene risks. Nowadays, few children have parents, grandparents or relatives that have a farm. Therefore, it can be assumed that most pupils have little personal experience of what farms and farming are. If there is little or no natural connection to primary food production, then children's knowledge of farms and farming might be based on what they learn through secondary sources. A further motivation is that food is something that affects everyone every day. We make choices on what we eat several times a day and food is consequently something that is easy to relate to. We are not only eating to stay alive in the Western countries, but we often make a statement or show a belonging to a group or a way of life by our food choices. Food is an everyday item that is chosen based on emotion, what we like and prefer. Furthermore, this choice needs to fulfil the needs of our physical body. Healthy eating habits promote a healthy mind by providing nutrients for optimal development of both body and brain functions. In other words, mens sana in corpore sano, a healthy mind in a healthy body is vital for optimal learning and personal development. Even though healthy eating is important, there are many trends and recommendations on what healthy eating is. Thus, it is important to educate children on what affects the healthiness of foodstuffs and by this give them tools to make personal choices. Critical thinking, values and knowledge based on personal experience are such essential tools. Critical thinking and understanding consequences is quite important when different media sources portray one diet or foodstuff as better than another. On the other hand, school food is in many Finnish municipalities one of the areas where the municipalities are trying to save as much as possible. This has led in several municipalities to the use of an increased amount of half- and whole-fabricated foods and reheated foods, in an attempt to save on cooking costs. These types of foods are often highly processed and can be of lesser

nutritional value. Such foods might affect both pupils' behaviour as well as learning in school, as children do not get nutritionally rich food to sustain their optimal growth. As children at a young age develop preferences for foods, this use of processed foods might lead to children becoming accustomed to the taste and consistency of fabricated food instead of real food. When taste buds are habituated to such foods, then these will be the foods that children prefer to eat also in the future. Therefore, school lunch should not be overlooked as just a meal to fill a stomach, but as a learning experience to gain knowledge of good and healthy eating habits as well as gaining nutritionally sound food for optimal growing and brain function to promote learning. Pupils' conception of farms, farmers and farming was studied in Paper II.

Choice of food not only affects our body and mind, it also affects the environment, social and cultural aspects of society as well as local, regional and global economics. From the point of sustainable development, it is important to understand these diverse effects of one's actions, in this case one's choice of food. Food production has an effect on the landscape. With no production, fields will soon start to grow scrubland and thereafter forests. Organic and conventional production has different effects on biodiversity, on crop cycles, production and usage of fertilizers, pesticides and herbicides as well as the accumulation of these in nature and the food chain, not to mention our physical bodies and possible health-related issues. Farms, especially small farms, maintain a social and cultural function in preserving the farmer's role in society as food producers as well as in maintaining traditions and genetic diversity in crops and animals. Active farms also portray an important function in local and national food security. Food security is important due to climate and other factors that might decrease production in different areas, and farms can in this way form a production buffer. Active farms, both small and large, influence the local economy, especially if the food is bought and used in the area where it is produced. This might lessen the carbon footprint of production, as well as link the product socially and culturally to the region. This needs an understanding and a comprehensive image, which has been studied in Paper III.

Consequently, it is vital to understand the route of food and its interactions with different aspects of society and environment for sustainable development on all levels as well as for personal health and to be able to make personal choices based on critical thinking and actual facts, not fiction. Education as well as society can be seen to have a crucial role in children's as well as our society's future development.

1.2. Research questions and aims

By this work I want to encourage the development of our school system learning environments, as well as give the scientific world input regarding how structural changes in agriculture have affected today's children's understanding of farms and farming. These thoughts will form the base for Farm Education, a theoretical and practical guideline for education on the route of food.

The theoretical background for this study can be found in outdoor education, environmental education, and constructivism, thoughts of the American educator and philosopher, John Dewey (1859–1952), as well as biology. Methodology was experiential with a mixed methods approach, which enabled use of the strengths of both qualitative and quantitative methods. Interventions were used to study the effect of different learning environments. The mixing took place in both data collection and analysis. The main data collection methods were interviews, questionnaires, learning tests and subject-produced drawing. Urban participants were from Helsinki (n=85) and Vasa (n=157) schools and rural participants from Jokioinen (n=76) schools. All were aged 11–12 years. Participating pupils of Paper I were from Finnish-speaking schools, II and III were from both Finnish- and Swedish-speaking schools. Analysis methods used were inductive content analysis, visual content analysis, and statistical analysis with SPSS with included tests for significance. The theoretical, methodological and empirical aims of this work are as follows:

1) The theoretical aim discusses Farm Education and how it relates to research and educational theories.
2) The methodological aim discusses and evaluates mixed methods as a tool in educational research, based on my experience from these studies.
3) The empirical aims are divided into two main themes:
    i. Empirical aim I: Effect of Farm Education on pupils' conceptions of and attitudes towards farms and farming
    ii. Empirical aim II: Cognitive effects of Farm Education

2. Evolution of Farm Education

To be able to better understand the concept of Farm Education, on-Farm Education in an authentic learning environment, I will in this chapter draw a theoretical framework that is based on etymology, educational politics as well as on research and related theories for a theoretical background.

2.1. Definition of learning environment

Learning environments are physical or virtual environments that are used for and to support a chosen educational event. The new NCC 2016[1] will take teaching and learning towards authentic learning environments and the possibility to study a phenomenon from different perspectives in its genuine environment.

> *The ordinance states that learning environments ought to be interactive and that learning outside the school facilities should be seen as an educational resource.* (The ordinance of the Finnish Government (422/2012) 2-4 §, page 17)
>
> *The learning environments should make creative solutions possible and allow a analysing phenomenon from different perspectives. Furthermore, when developing and choosing learning environments, consider that the pupils are allowed to gain new knowledge and skills also outside school facilities.* (page 28)
>
> *In addition to school facilities and school grounds, nature and the built environment should be used in education.* (page 28)
>
> *Different teaching and learning methods and evaluation methods allow pupils to show their proficiency in different ways.* (page 29)

Comprehensive learning means that the same phenomenon can be studied from different perspectives within the same subject or between subjects (Paper I). NCC 2016 rec-

[1]The pedagogical learning environment is defined by the Finnish National Board of Education and published in the national core curriculum (NCC). The National Board of Education bases the NCC on theoretical considerations and feedback from stakeholders (schools, municipalities, researchers, etc.), but also political interests. NCC is further used as a guideline in municipalities and schools, when the local curriculum is formed. NCC 2016 was confirmed in 22.12.2014 and will be introduced in schools in autumn 2016.

ommends that comprehensive teaching and learning is carried out at least once a year, for example at a camp school or during study visits.

> *Multidisciplinary learning themes should be planned and carried out based on local resources and possibilities. Learning themes offer a good opportunity for collaboration between school and society. The teachers' and pupils' motivation increases when the subjects taught get a local connection, are up-to-date and of societal importance.* (page 30)

When developing learning environments and learning situations inside or outside school facilities, one has to bear in mind all these factors to be able to develop a successful learning environment. This work has been conducted during the NCC 2004 and therefore I also relate to its definitions as they have guided the development of the interventions.

> *The pedagogical environment, or learning environment, is the environment where the education takes place, including physical, psychological and social elements. The physical pedagogical environment includes the school building, facilities and educational and learning material.* (page 16)

> *How the physical and social learning environments are formed, is affected by both cognitive and emotional factors of the pupil, as well as by factors affected by social interactions.* (page 16)

Learning is a sensitive cognitive process that can be affected by physical, psychological and social elements of the learning environment. The interventions of this work will focus on the physical learning environment, but I will relate this to the effects on the other elements where appropriate. In the development of the learning environments of the interventions, the main guideline was as follows:

> *The learning environment needs to support the pupil's growth and learning. It needs to be physically, psychologically and socially safe and support the pupil's health.* (page 16)

It is the teacher's responsibility that the pupils are able to gain a qualitative education and that they are safe on all levels. Therefore, teachers have checked the interventions and approved that they fulfil the needed criteria, and encouraged me to carry out my research together with their pupils and under their supervision.

2.2. Definition of authentic and environment

The concept *authentic* has its origin in Greek *authentikós*, meaning original, genuine or primary (Merriam-Webster, 2012). An authentic environment can therefore be seen as an environment that is truthful to its origin; it is not invented or developed to suite a secondary purpose. For example, the original purposes of a farm is food production, maintain a specific culture and traditions and to be the home of the farmer and his/her family. A farm that keeps farm animals as a show for visitors is merely a zoo. Such a farm lacks its original purpose, production, and serves a secondary purpose of a zoo and can therefore not be called an authentic environment.

The word *environment* has its origin in French *environer* which means "to surround, enclose or encircle" and the suffix *–ment* refers to "the result or product of action". The French concept, *milieu*, can be understood as a combination of two words, where *mi* is meaning "in the middle" and *lieu* "place". The concept of environment has different meanings depending on its associated theme or phenomenon (built environment, social environment, physical environment, inner environment, natural environment, study environment or working environment). In general, the concept of environment, as related to nature, is often seen to be divided as the cultural environment that man has put his mark on and into the natural untouched environment or nature. In common tongue, environment is often seen as an equivalent to nature or the green living part of the environment (Barry, 1999).

2.3. An authentic learning environment

Pupils that visit an authentic environment are guests that have been given the opportunity to learn about a phenomenon in its genuine environment. I do call pupils guests, as this describes that the pupils are visiting an environment whose main function is not to be a learning environment, but to serve the phenomenon or a larger activity of which the phenomenon is a part. For example, an active dairy farm is an authentic learning environment for learning about *the route of food*, but an open farm, a visitor's farm, with different farm animals on display, cannot be understood as one, as it does not contain the chosen phenomenon of productive farming activities. If the phenomenon to be studied is *different farm animals*, then a visitor's farm could serve as an authentic learning environment. If a visitor mistakenly assumes a farm-like setting is an active farm, this confusion might lead to misconceptions amongst pupils. Such a misconception could be that *productive* farm animals should be kept together in small numbers and that their main purpose is to be friendly and cute, as on a visitor's farm, instead of living the life of a productive animal in quite different conditions with the main aim of producing food. Sadly, the former romanticized scenario is also often promoted by media and children's books and encourages misconceptions (Gardner, 1980; Palmer, 1998; Stenbacka, 2011). These conceptual irrationalities can best be clarified in cognitive confrontation (Vosni-

adou, 1994), meaning that pupils are allowed to visit an active farm and personally experience what it is or what it is not.

The first specific condition for an authentic learning environment is therefore a realistic environment for the phenomenon to be studied. Consequently, the second specific condition is that an authentic learning environment requires activities typical for the environment. For example, typical activities for a dairy farm is taking care of animals, growing fodder, cleaning the barn and other aspects of dairy production, as economics, and the life on a farm. Not to forget that the NCC guides what type of authentic learning environment, phenomenon and activities are to be preferred. The third specific condition is genuine actors. A genuine actor is a person who is an expert on the activity or activities of the phenomenon studied. The actor has probably worked with the activity for many years and is quite familiar with all the processes, causes and actions. Actors of an authentic environment are characterized by dedication, truthfulness, and intention. A farmer is the genuine actor of a dairy farm and farming is his or her livelihood. If a guide takes on the role of the farmer, the guide will probably not be able to transfer the same knowledge, expertise and authority as the farmer would. It is a case of quality in education, as quality of the learning experience can make the difference between successful and unsuccessful learning. Bear in mind, the teacher is the pedagogical expert responsible for the educational aims and pupils' behaviour, and the actor is the expert that offers his or her expertise and working place or home for a visit.

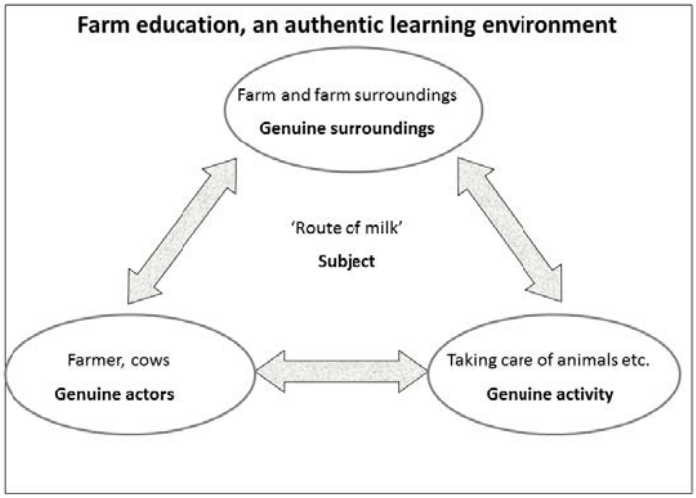

Figure 1. The three components that make Farm Education an authentic learning environment: genuine surrounding, genuine actors and genuine activity (Paper III).

In conclusion, an authentic learning environment comprises typical activity for the environment, and is carried out by a person(s) that is expert on the theme or phenomenon in a surrounding characteristic of the activity (Figure 1).

2.4. Learning in an authentic learning environment

Learning in general is affected by different features and therefore it is natural to study it from different aspects. All aspects have one element in common: it is understood that the learners undergo a change on a personal level through learning (Boström, 2004). Typical studies on learning are grouped into phenomenological, behavioural, neurological (Schmeck, 1988) and sociocultural (Säljö, 2000) approaches. In the phenomenological approach, it is thought that the individual's personal experiences cause a change that leads to learning. Studies on phenomenology focus on the learning process from the individual's personal perspective in a specific situation. The behavioural approach understands learning as a planned learning situation that leads to a measurable result. The neurological approach studies learning as experiences that causes changes in the cortex of the brain. Learning is understood to result in an increased number of connections between neurons and formation of networks in different parts of the brain cortex. These connections are understood to be affected by earlier experiences, sense receptor sensitivity, emotions as well as the learning situation. The sociocultural approach sees learning as a social phenomenon where the learners are steered to a desired change. Learning is a social phenomenon when learners learn through a common dialogue (Boström, 2004).

Learning in an authentic learning environment can further be studied from different research aspects. Research has found that learning in the outdoors has different qualities than learning indoors (Dahlgren & Szczepanski, 1997), and it can be an effective place for learning (Palmberg & Kuru, 1998; Bogner, 1998). Field trips have even been found to be as good or even a more effective way of learning than learning in a classroom (Bitgood, 1989). These effects have been seen in the development of cognitive skills (Eaton, 2000 in Dillon et al., 2006) and in the outcomes of academic assessments (SEER, 2000; Kern & Carpenter, 1986 in Dillon et al., 2003). Reasons for these good results can be found in the different learning opportunities that a learning environment outside the school, in a genuine environment, can offer. A genuine environment offers the possibility *to learn hands on*, to experience what you are learning by physical participation in the learning process (Mabie & Baker, 1994). The pupils are allowed to gain knowledge through an active experimental process. For example, when pupils are learning about the route of food, they can do physical work at the barn, they can take fodder to the cows, smell the fodder and the cows, feel the texture of different fodder, hear the farmer describing the life cycle of the cows and at the same time observe the different stages of the life cycle from calves, heifers to cows. At the end of the route of food, pupils are allowed to taste the food they make, smell the food, make the food as well as see and hear about the food. This will result in *firsthand experiences* that have been

found to be important in forming personal opinions, values and attitudes (Palmberg & Kuru, 2000; Frederiksen, 2001; Balschweid, 2002; Ballantyne & Packer, 2009).

Such learning includes not only different methods but also supports the use of different senses for learning (Dahlgren & Szczepanski, 1997), which is an advantage for pupils that have learning preferences that are not promoted by ordinary education (Vermunt, 1996; Kolb 1999). Each pupil's learning-related preferences can be understood to be of biological and sociocultural origin (Boström, 2004, 2011) and affected by biopsychosocial factors (Bandura, 2001; Halpern, 2012). This means that learning is not only affected by biological and outer physical elements, but also by inner individual preferences. Here, biological individual preferences indicates that individual features, including physical, psychological and chemical elements, affect our preferences for how we learn best (for example, visual, audio, or kinetic learning). Social and sociocultural indicates methods that our surroundings, as parents or teachers, has taught or recommended us to use. These preferences for learning are parts of the procedure of how the brain processes information from its surrounding.

Researchers (Boström, 2011) call for a more multifaceted school. In a multifaceted school, each pupil would be able to learn according to his or her learning preference. Pupils' also need to also learn in other ways than their preferred learning method and most pupils use more than one preference for learning. Learning preferences that are especially promoted by learning outside the classroom is besides the traditional audio-visual learning of a classroom, social learning, kinetic learning as well as experiential learning (Paper III). The strength of an authentic learning environment is in the multitude of learning preferences that can be used for gaining knowledge and skills.

Another advantage in learning in an authentic learning environment is its energy efficiency through comprehensiveness and deductive reasoning. In inductive reasoning, the pupil continuously needs to update his or her schemata, revise and make new connections or alter old knowledge (Kohonen, 2001). This can be energy consuming, as the pupil must rearrange and reform old knowledge. In deductive reasoning, the pupil is immediately given the frames for the phenomenon to be studied. The pupil can thereafter study different pieces of the phenomenon and connect it straight to his or her schemata, without energy-consuming mental rearrangements or processes. Deductive reasoning can be seen as an energy-effective and a comprehensive method for learning. This coincides well with the results of Paper III where pupils describe that it is easier to learn outdoors; where all groups of academic achievers gained good test results when they were allowed to learn in an authentic learning environment compared to a traditional classroom.

In addition to the comprehensiveness of learning in an authentic learning environment, pupils are allowed to use different senses for gaining knowledge. All pupils have different strengths to how they learn best. It might be connected to different learning styles, but also to different senses. An authentic learning environment allows pupils to use all their different senses for learning (McRae, 1990; Dahlgren & Szczepanski, 1997). This might ease the learning process, if the pupil's innate learning preferences are linked

to senses that are promoted by the authentic learning environment, or by the fact that activation of many senses causes a repetitive message through different sensory channels and by this enhancing the learning process. From this point of view, the learning environment might possess an immense effect on those pupils' learning that do not innately have strong learning preferences for traditional classroom learning methods or prefer to use other senses for learning than those promoted by common education.

From a historical point of view, the Nordic countries have long traditions using what is referred to in this study as authentic learning environments. Authentic learning environments are no new innovation, rather the reawakening of an old tradition. In the 18th century, Carl Linnaeus (Carl von Linné), Swedish researcher and professor at Uppsala University, took his students on regular botanical field trips to study plants in their actual environment. Authentic learning environments have been, and still are, quite actively used when students are studying toward a profession, but have often been forgotten in primary and secondary schools. This can be troublesome, as pupils might have difficulty in connecting a theoretical fact to their everyday life, if this connection is not clear. It is also more motivating for the pupils if they experience that what they learn is connected to their life and that they can use what they have learnt, compared to memorizing facts for a test. "Those things which can best be taught outdoors should there be taught" is L. B. Sharp's dictum (quoted by Donaldson and Donaldson, 1958 p. 17). L. B. Sharp supported experiential learning and thought that children with narrow experiences of nature and outdoor environments could not fully understand what they were taught or what they read about in school (Knapp, 2000). Pragmatist John Dewey (1938/1997) stated that learning needs to be meaningful in the present and connected to the learner's local environment. The knowledge needs to have value in the present. It is impossible to foresee what the future will be like, when today's pupils have grown up to take charge of their world. However, by allowing pupils to understand the possibilities of their everyday life, the school can prepare them for future challenges. Solutions to future challenges are as solutions to today's challenges; implementations of knowledge and experience together with creativity. By learning to act and solve today's challenges, we will prepare pupils for future challenges. The message to pupils needs to be that they learn for an existing and real purpose, not for a test or a distant future. The knowledge that the learnt is meaningful and that the pupil can use it to tackle and accomplish a task, increases his or her self-efficacy (Bandura, 1997). A high self-efficacy prepares the pupil better for solving future dilemmas or completing laborious tasks, when he or she has learn to trust his or her abilities during school.

Dewey also saw the connection between theory and practice as important. He thought that these concepts should not be separated in the learning process. Dewey believed that the school should not exist as an island, separated from society. He spoke for an active relationship and communication between school and society. Dewey's thoughts have later been proved accurate by international researchers (Jolly and Krogh, 2010). And now, the NCC confirmed in 2014, follows in his footsteps, almost one hun-

dred years later. Teachers are now encouraged to take a step out of the school with their classes into society and society is urged to take part in education.

> *Teachers should systematically use different teaching methods and learning environments and strive on a regular basis to move their education outside the classroom. The teacher should create possibilities for project-based work and comprehensive learning and cooperation both within school as well as with actors outside school. Cooperation and communication between adults in school and the surrounding society strengthens pupils' communication and cooperation skills.* (p. 26)

The importance of society and the interaction between school and society is quite clear in the new NCC. Local society is mentioned 20 times and society 202 times. Society is seen as a richness that strengthens pupils' communication and cooperation skills and teaches cultural diversity and multilingualism. Teachers are urged to awaken pupils' interests in local society, to help them understand how society works and how pupils can influence it as well as how to use practically their theoretical knowledge gained in school, such as maths, when in the real world, in local society.

When connecting education to the real world, it is easy for the pupils to understand why they are learning and in what ways the knowledge they learn in school can be applied. Learning for good grades creates another dimension: learning for life. Learning becomes meaningful, as the pupils are given the possibility to see how theory from school lessons coincides with the real world. Theoretical facts gain a concrete meaning and a purpose and facts becomes knowledge with a value. When knowledge gains in value, it will be remembered and the pupil is able to apply it in everyday life and in the future. Again, knowledge with no or little value or meaning for the pupil will often be forgotten. Dewey (1938/1997) points out, as do the new NCC, the democratic function of education and the comprehensive understanding of pupils as learning individuals. He sees that pupils need to participate in different societal activities to be able to grow and become responsible and aware citizens of a democratic society. Education should be future-oriented and promote creativity and action to form a base for democratic thinking and humanity.

Learning from each other and learning together through dialogue and action, is one of the benefits of learning in an authentic learning environment. Pupils do learn social skills through collaborative learning together with peers, by engaging in discussions with their teachers and farmers (Jolly, 2009; Jolly & Krogh, 2010). This is the basis for the constructivist conceptions of learning that assumes that knowledge is individually and socially constructed by learners based on their understandings of experiences in the world, and not passively transmitted from the teacher to the pupil. Education should be comprised of experiences that facilitate knowledge construction (Davis et al., 1993). Social interaction as part of the learning process is an element that pupils brought up when evaluating their learning experience in an authentic learning environment and it is

also a learning method that the Finnish national curriculum encourages. The constructivist learning conception (Ausubel, 1963; Davis, et al., 1993) forms the base for the NCC 2016.

Experiential learning theory explains learning as "the process whereby knowledge is created through the transformation of experience. Knowledge results from the combination of grasping and transforming experience" (Kolb 1984, p. 41). This learning process can be seen as circular and having four stages (concrete experience, reflective observation, abstract conceptualization and active experimentation) that follow each other. The learning process is sometimes seen as a spiral, where the subject deepens during each spiral cycle. Learning can start at any of the four stages, depending on the learner's learning preferences (Kolb & Fry, 1975). Kolb's learning cycle has been further developed by Honey and Mumford (2000). In Paper I, you can further read how the pupils gained personal and experimental minor learning cycles within the general learning cycle of the phenomenon to be studied. I see this process as the growth of a climbing plant, growing upwards with tendrils clinging and fastening to surfaces. The plant is the growing knowledge and understanding and the tendrils are the anchors, the minor cycles of learning, fastening and stabilizing new knowledge. These minor learning cycles are therefore quite important as they deepen and fasten the knowledge from the major learning cycle, or spiral.

3. Connection to research from other disciplines

Science is divided into disciplines, but the world is a transdisciplinary phenomenon. In the following chapter I have pointed out some research results that explain or help in understanding the results of this work. Learning, as a biological phenomenon, is when biological aspects affect cognitive processes. Biological aspects are, for example, how a memory is constructed and how outer essential elements, as oxygen, might affect learning. Memory and memorizing, its construction and processes, is an essential part in learning and I have therefore chosen to study it and its mechanisms a bit further. According to Blooms taxonomy, memorizing and remembering is the first step in the learning process. The brain is the organ that is first affected negatively if oxygen supply is inadequate, which is why I do also briefly look at the possible effect of indoor air and oxygen between learning in a classroom and learning on a farm in an authentic learning environment.

Arvid Carlsson, Paul Greengard and Eric Kandel received the year 2000 Nobel Prize in Physiology or Medicine for their pioneering work in mapping the signal transmissions in the nervous system (Nobel Media, 2000), which increased the interest in neurological aspects of learning. In short, they were able to explain, on a neurological level, how short- and long-term memory functions (Kandel, 2001). Kandel's work at Columbia University is to explain how short- and long-term memory functions. From an educational point of view, it is the teacher's aim to activate long-term memory functions. Only when the knowledge is contained in the long-term memory, then the learning process has achieved to make a persistent individual change that signifies real learning. Knowledge that is only limited to the shorter memory storage, is available for a short period of time, and thereafter discarded, for example, after it has been used for passing an exam. There are different definitions for memory storage, depending on how long a memory is stored, but I will not go further into that. Kandel has, together with colleagues, been able to show how the psychological and biological aspects of memory coincide. In their experiments, they used sea slugs (*Aplysia*) with large nervous cells that are easy to work with. These nervous cells have the same structure as the cells of the human brain, only in a larger version. Also, the cellular and molecular processes of *Aplysia* coincide with the mechanisms of short- and long-term memory amongst vertebrae and the same molecular strategies are used in both implicit and explicit memory storage methods. Examples of implicit memory are motor skills (biking, walking) and of explicit memory the semantic memory, where facts and knowledge is contained as well as the episodic memory, where happenings and experiences are stored.

The storage of a memory starts by alteration in synaptic strength between two nervous cells (Kandel, 2001). An alteration in strength can be caused by a sensory stimulus, for example touching or smelling a cow. The strength of the synaptic contact between nervous cells becomes as strong as the amount of sensory stimuli that is delivered to the synapse (Sand et al., 2004). The more sensory stimulus, the stronger is the memory attached to the memory construct. The use of several senses when learning

about a subject may, in other words, allow pupils to learn or memorize more effortlessly, as the synaptic strength between two nervous cells increases.

Memory can roughly be divided into short- and long-term memory. Short-term memory, including working memory, can contain information for a short period. Depending on the theoretical point of view, short-term memory and long-term memory have different definitions, but here I am discussing them together according to Sand and colleagues (2004). The beginning of the storage process of short- and long-term memories is the same. The difference between these memory types is, according to Kandel (2001), that where short-term memory synapses are strengthened through repeated stimuli, when storing a memory, long-term memory requires the activation of genes in the nervous cell that synthesize proteins. These proteins are used to produce completely new synapses and hence increase the amount of synapses between nervous cells.

Oxygen is abundant on earth and is essential for most multicellular life forms, as it is for humans. Of human organs, it is the brain that is the first organ to suffer from oxygen insufficiency. A good oxygen uptake is therefore crucial for survival and normal brain function; why it can be supposed that optimal oxygen supply is vital for optimal learning. Optimal oxygen supply for the brain can be secured by enough oxygen in the air of the learning environment (ventilation in classroom, or being outside in the fresh air) and by exercising (Olson et al., 2006). Aerobic exercise supports oxygen uptake of body and brain by increasing lung capacity for oxygen intake and increasing the amount of capillaries transporting oxygen to cells (Sand et al., 2004). Research has also found this positive connection between voluntary exercise, learning and long-term memory (Olson et al., 2006). A good oxygen uptake may be either in your genes or a result of exercise. Research has found that in comparison between groups with low and high oxygen uptake, the group with high oxygen uptake managed better to solve complicated cognitive tasks. Mechanical and simple tasks were equally managed by both groups, but the tasks that required problem solving and creativity were managed significantly better by the group with high oxygen uptake (Wikgren et al., 2012). This test was done on an animal model, but similar results have been found amongst people. Studies have shown that physically active elderly persons are not only healthier but also manage cognitive tests better than peers that do not exercise (Colcombe & Kramer, 2003; Koch et al., 2011). Exercise alone does not guarantee positive cognitive development. Research has found that only fresh air, unpolluted air, has positive effects on learning. Exercise in heavily trafficked areas does not promote cognitive development but rather increase inflammation of the brain (Bos et al., 2013). Free play in fresh air during breaks between lessons is therefore quite important for learning and takes us into another subject of planning school yards large and motivating enough for engaging all pupils in free play of their preference. Swings and football are not for all pupils, there needs to be room for creativity and imagination to inspire free play. It is not only the learning environment that needs to be taken into account for pupils' learning preferences. Also pupils' free time in between lessons needs to be multifaceted to serve different exercise preferences to

increase voluntary exercise. Schools would be able to increase pupils' oxygen uptake and lung capacity and by this supporting pupils' learning.

The fresh air outside as well as exercise is important, but even more important is that the air of the learning environment is fresh and includes at least a sufficient amount of oxygen compared to carbon dioxide. Sadly, this is not always the case in classrooms. Carbon dioxide concentration in the outdoors is in general 350 ppm, but due to insufficient ventilation concentrations in classrooms may rise higher than 2,000 ppm and even up to 3,000 ppm during a lesson (Myntti, 2005). Such high carbon dioxide concentration might cause headaches, tiredness, as well as concentration problems (STM, 2003, 2009). Research has found that cognitive performance drops as carbon dioxide concentration increases. Already a rise from 600 to 1,000 ppm affects cognitive performance negatively and at 2,500 ppm it is significantly reduced (Satish et al., 2012). The Ministry of Social affairs and Health holds 1,500 ppm as a threshold value for tolerable indoor carbon dioxide level (STM, 2003). When comparing these values, one can notice that when carbon dioxide concentration doubles, compared with the outdoors, the cognitive performance is already affected negatively. A threshold value is achieved when the natural carbon dioxide amount is fourfold. This amount may be exceeded in classrooms causing learning difficulties due to headaches, tiredness, as well as concentration problems (Myntti, 2005). Two thirds of schools have reported indoor air problems in a query by the Teacher's Union (OAJ 2012). In 2015 there were 2,397 comprehensive schools (Statistics Finland), and of these 1,438 schools suffer from indoor air problems, according to percentage of the query.

Stress has been found to be linked to learning problems (Hannaford, 1995). Outdoor time again, has been found to reduce stress and calm the mind (Polvinen, Pihlajamaa & Berg, 2012), which may support concentration and learning. When studying the effects of environmental enrichment, comprehensive learning in society, the importance of individual preferences and the effect of fresh air and exercise on learning, one finds that an authentic learning environment in a surrounding with fresh air may have an immense effect on pupils' learning. Especially amongst those pupils that have some level of learning problems. In the end, it might be that it is the learning environment that has a problem, not the pupil.

4. Methodological orientation

Qualitative results are good and give a wide and deep analysis of learning in the outdoors, but for giving such learning a value that can be understood by persons that are not familiar with education, such as politicians, you need measurable quantitative results. Inspired by the promising qualitative studies, I started to develop an instrument for measuring pupils' learning results as well as the interventions. Soon I noticed that I will need to use different methodologies, both quantitative and qualitative, to gain the best results for this work, as learning is a multifaceted phenomenon. Therefore, I chose a mixed methods approach for my studies (Cresswell et al., 2003; Johnson & Onwuegbuzie, 2004).

4.1. Research ethics

When doing research or work with or concerning children, ethical questions are of utmost importance. As a researcher and a teacher, I am bound by ethics in both professions. Interventions, educational material, teaching methods and the analysis have been chosen and employed with pupils' best interests in mind. Interventions were shaped to promote pupils' positive personal growth, both psychological and physical, their integrity (Ruoppila 1999), as well as to meet the aims of the NCC. Before the study, the parents or guardians of the pupil had to sign a form that stated that the pupil was allowed to participate in the study. They were given information on the study, its aims, methods and situations where the pupil would be evaluated, as well as on the length of the study, how the collected data is analysed, and how the anonymity of the child and the family is secured in all stages of the study (Ruoppila 1999).

As a researcher, I seek an understanding of the phenomenon I am studying, an understanding of the world I am investigating, and an answer to my research questions. Even though I think that I have taken into account all possible aspects of a successful research project, there are still some features that may stop my study: the human aspect of interest. The teacher might not be interested. He or she might feel that the topic is unimportant or uninteresting. The principal of the school might feel that it is too troublesome to participate and to arrange transportation to the farm. The parents might feel that it is too dangerous for their child to participate in a farm visit. Last but not the least, the pupil might not be interested in participating in the research. The intervention period was two weeks, and any of these incidents could at any point of the study result in a participant's or a whole class's dropping out from the study. Two interventions were discarded from the study due to such factors. One class had problems fitting the interventions within their timetable, and one class had just too many pupils that thought that it was much more fun to bully each other than to participate in the intervention. This unpredicted behaviour of the participants, their teachers or parents, makes this type of research laborious. As infuriating as this is for the researcher, it is the participant's right

to decide for how long they want, or do not want, to participate in the study (Hirsjärvi et al., 2009).

4.2. Research strategy

The research strategy of this study was to use a mixed methods approach and experimental interventions in investigating how learning in different learning environments shape pupils' conceptions of the learnt and the persistence of the learnt. To gain an understanding of how the learning environment affects learning and its persistence, as well as conception of the chosen phenomenon, an experimental design with interventions in different arrangements was formed and a mixed methods research approach was applied.

Paper I describes the background and can be seen as a pre-study for Paper II and Paper III, which will take the study a step deeper in understanding the effect of the learning environment. The former explores the use of mixed methods for investigating rural and urban pupils' preconception and experiences of farms, as well as develops the basis for the educational model used in the latter two papers (Figure 2). The latter two papers focus on comparing three different arrangements of learning environments: a control group with education in classroom and two experimental designs with classroom and farm environments and one with exclusively a farm environment (Figure 3). Teaching and learning methods were optimized for all learning environments according to resources in each environment. Factors that are kept as constants are time (three lessons during two weeks), teacher (me), methods for collecting (questionnaires, interviews, subject-produced drawings) and analysing (SPSS, inductive content analysis and quantification, visual content analysis) data and geographical background of pupils.

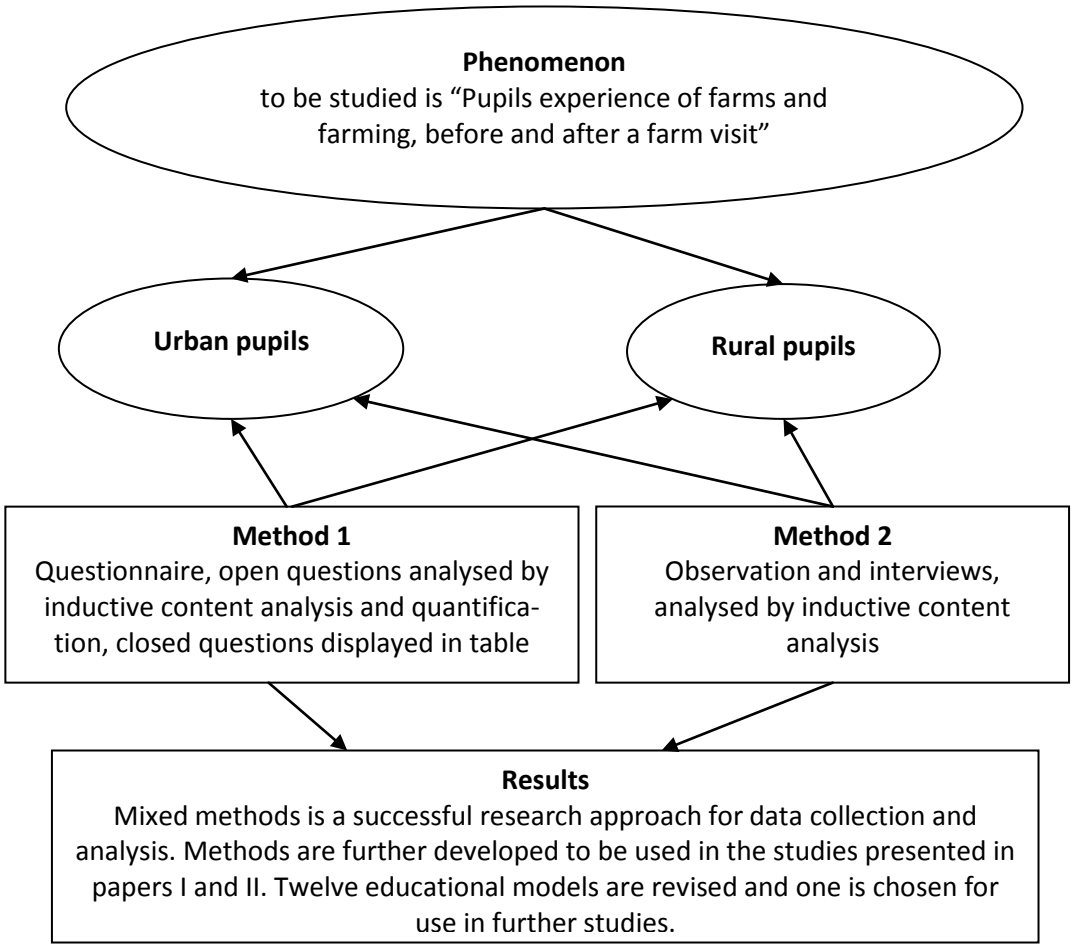

Figure 2. The research strategy and methods used in Paper I.

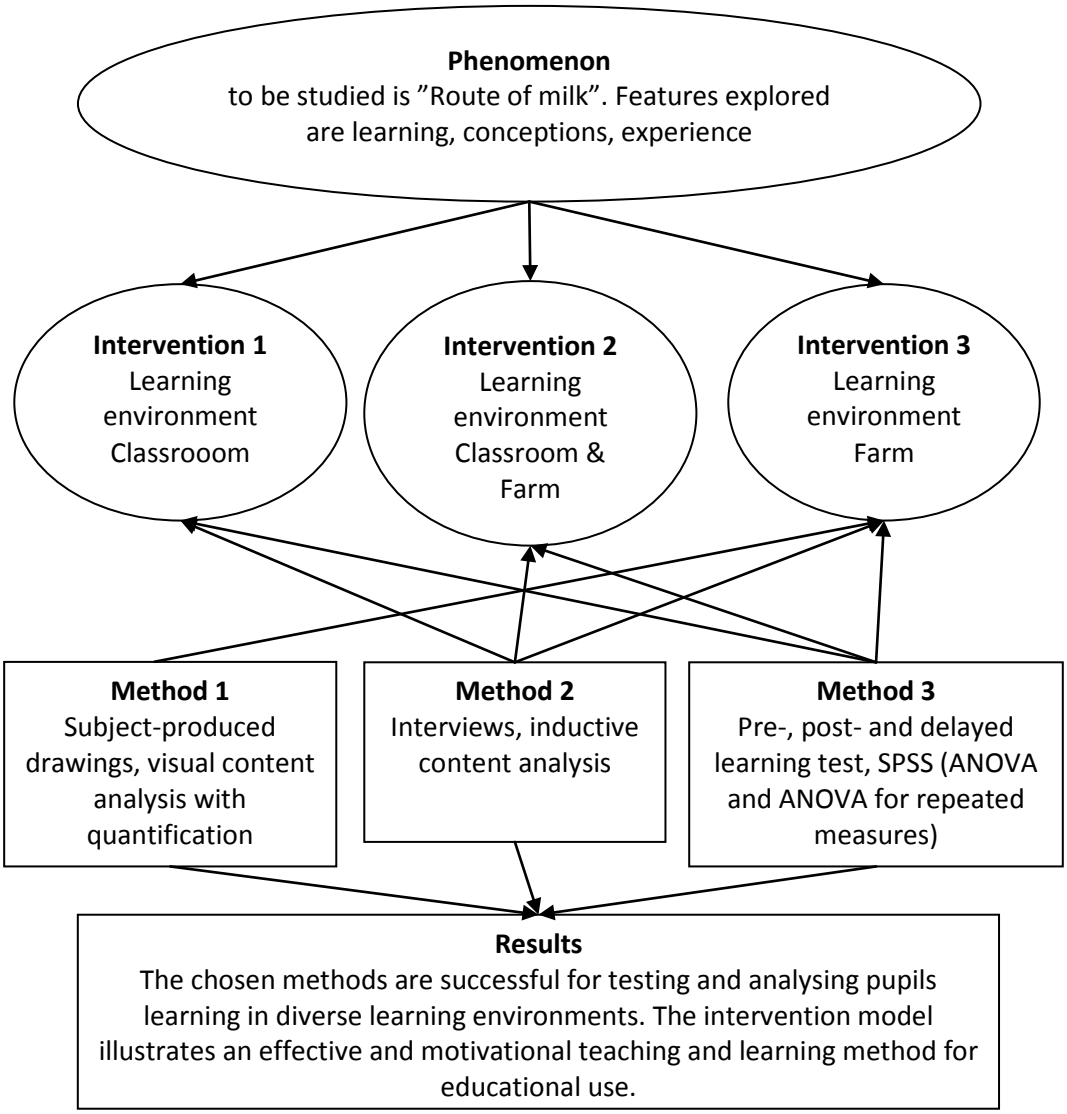

Figure 3. An illustration of a joint research strategy for papers II and III.

The methodology is chosen to be as close as possible to evaluation methods used in school (questionnaires, learning tests, and drawings). Interviews are not today a typical evaluation method in schools. This method required that I had to become the teacher to gain the pupils' confidence and to earn an openhearted discussion with chosen pupils. As I have earlier worked as a teacher and participated as a teacher in several camp school, this was quite a natural role for me. The methods for analysing the data were chosen according to the data collection methods used, as well as to what method interprets the material to achieve the best understanding. Therefore, I chose inductive con-

tent analysis, visual content analysis as well as the use of SPSS (ANOVA and ANOVA repeated measures). Experimental research is the backbone of biological research and it also fits well within educational research, when comparing the effect of different interventional designs.

I chose experimental design as it allowed me to develop and study the effect of a learning environment, that to my understanding would be an optimal learning environment, including teaching and learning methods, and allowed me to compare it to today's more traditional learning environments.

4.3. Mixed methods

My main aim was to study the chosen research problem from as many aspects as possible, which was why the mixed methods approach was a natural choice. A decade ago, mixed methods research was, to some degree, a debated research method and referred to as integrating, synthesis, quantitative and qualitative methods, multi-method, and mixed methodology (Bryman, 2006; Tashakkori & Teddlie, 2003). But today, this approach is frequently used in diverse disciplines in international journals. The strength of a mixed methods approach is that it enables utilising both qualitative and quantitative methodology when investigating complex research problems from different aspects. The mixed methods approach has a pragmatic worldview in which the researcher bases the exploration of the research problem on the assumption that collecting multiple types of data delivers the best understanding of the problem (Cresswell, 2009). A questionnaire alone would have given a good image of pupils' conceptual knowledge in the pre-, post- and delayed test, but it would not have delivered the multifaceted answer to why the learning results were significantly better in authentic learning environments. Interviews alone, would only have given an image of how pupils experience learning in the different learning environments, not measurable results. Subject-produced drawings alone would have given an image of how pupils understand farms, farming and farmers, but not a deeper understanding. Choosing methods with great care, understanding their possibilities and limitations, gave me a possibility to study the chosen phenomenon from different viewpoints and provided a deeper understanding.

Mixed methods is divided into three general approaches: sequential, concurrent, and transformative mixed methods (Cresswell, 2009). The sequential approach indicates that the chosen data collection methods follow the other in time. Concurrent, again, indicates that the chosen methods are applied simultaneously. The transformative approach is used to explore the phenomenon through a theoretical lens and may apply any of the two earlier mentioned approaches. In my work, I decided to use the sequential approach, as it was best suited to the chosen methods, amount of labour and timeframe. Interviews at the same time as the pupils were producing the drawings would have been possible and could have potentially given a deeper insight into a particular drawing. But due to the fact that I was carrying out the research alone, this was not possible with a class of 22 pupils. If I would have chosen to do interviews concur-

rently with the subject-produced drawings, the 21 pupils would probably have done something quite different than drawing farms, farming or farmers while I was interviewing, and I would have ended up with only one good drawing and one interview for Paper II. This is one of the challenges with this type of research, as it requires extensive data collection, making it laborious. It does also have high demands on the researcher, as the researcher needs to be familiar with analyses of both text and numerical data and their restrictions.

4.4. Interventions

Interventions and their development process were long and consisted of a considerable amount of background work and testing before they were utilized. Background work included reading numerous articles, educational material as well as educational theories. The development of the interventions started in Paper I, where ten educational programmes were developed on five different themes: 1) Rural landscape and diversity, 2) Rural environmental history and culture, 3) Empowerment of rural-urban interaction, 4) Sustainable choice of food and ecological footprint and 5) Food security (Figure 4). After a thorough evaluation it was clear that the most successful of these programmes was number four, Sustainable choice of food and ecological footprint. This programme was further developed to an intervention consisting of a three-step lesson called "The route of milk" to be used in papers II and III.

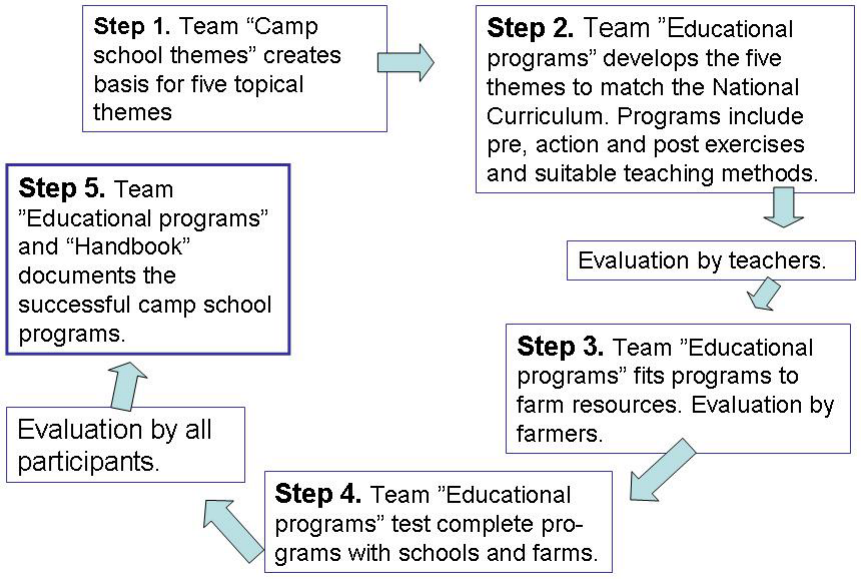

Figure 4. Development of educational programmes in Paper I.

The development of the interventions was based on the NCC (2004) for identifying phenomenon that are relevant to education and that teachers would be interested in applying in their teaching and because all education in Finnish schools follows its guidelines. The NCC also gives guidelines on what learning conceptions are preferable, as well as learning methods. Constructivist conceptions of learning (Davis et al., 1993) were chosen as a foundation, as it is one of the bases for NCC and it was quite well-suited for the outdoor education perspective. Experiential learning theory (Kolb, 1981, 1984) was chosen as it is, along with constructivist conceptions of learning, an aspect of NCC and also well-suited to outdoor use. Outdoor education theory (Knapp, 1996) was chosen for being well-suited to the farm environment and the environmental education model (Palmer & Neal, 1994; Palmer, 1998) as it attractively brings together different aspects on how education in the outdoors could be built up.

The interventions in papers II and III consisted of three separate lessons held within the timespan of two weeks. Each lesson lasted for two hours with a short break of 15 minutes. The phenomenon to be studied of the first lesson was the field, including grain and hay production as well as biodiversity, history and the effect of agriculture on the landscape. The phenomenon to be studied in the second lesson was dairy farming. During this lesson, pupils learnt about a cow's yearly cycle, about farm life, about ethics and animal wellbeing. The phenomenon to be studied in the third lesson was dairy products from the consumer perspective, and in the authentic learning environment pupils were allowed to make butter, scones and a dessert from milk products. During this lesson, pupils learnt about different dairy products, their production and about economic issues in dairy farming. At the beginning of each lesson, I went through with the pupils the route of milk at the beginning of each lesson, as far as we had gotten on it from the last time, and at the end of the lesson we revised what we had talked about during the lesson. The lessons formed an educational spiral, from field to table, deepening the learnt at every lesson.

Three intervention groups in two different learning environments were developed for teaching the phenomenon 'the route of milk: a) classroom, b) classroom and farm, and c) farm. The learning content and the educational aim within all groups were the same. Group A is traditional classroom learning, including its teaching and learning methods and materials. In the classroom intervention I used teacher-led education, group work, individual work and discussion as teaching methods: In other words, I tried to keep it as inspiring and multifaceted as possible. Materials used were ICT, games and booklets with tasks. Group B is a combination for exploring possible synergy effects between traditional classroom education combined with a visit to an authentic learning environment. These pupils participated in the complete programme of group A and from group C they were allowed to participate in farm work and taking care of cows and calves. Group C participated in learning only in authentic learning environments on the farm. All theory and practice of the subject were delivered to them in the genuine surroundings by genuine actors and activities. Teaching methods were the same as in group A, but included also kinetic learning and learning through action. The aim was to try to

keep as many background factors, in this case teaching methods, as similar as possible, to rule out the effect of specific methods. As teaching methods were adjusted for each learning environment, they still differed somewhat between the groups, but teacher-led studying was the mainly used teaching method in all groups. Teaching materials were different between the two learning environments, for example, ICT and books were used in the classroom context to teach the same thing that could be taught via practical tasks and observation on the farm. Materials used in lessons in the classroom were Farm Education material for schools produced by farmers unions (MTK, SLC), "the route of milk" game on the internet, group activity (link agricultural products with grain), and a DVD on dairy farming. The on-farm lessons consisted of teacher- and farmer-led discussions, tour of the farm, observing, group activities (biodiversity, feeding cows and calves, baking), and participation in different group and separate tasks on the dairy farm as well as baking and making milk-based foodstuffs in the kitchen.

4.5. Participants

Participants of the educational programmes development process in Paper I included 13 in-service elementary school teachers, 11 farmers and 10 experts on agriculture and education. They were chosen according to their interest in developing such programmes and for being experts in their area. Participants of the research component were 161 rural and urban pupils in 5^{th} and 6^{th} grade. Pupils were chosen on the basis that their school and teachers were positive about participation in the designed farm visits and that the schools were either from a rural or an urban area. Participants in Paper II were 51 pupils and for Paper III 106 pupils from 5^{th} grade and from four different urban primary schools from the same town. This provided diversity in educational culture but maintained a constant geographical background. Every intervention included pupils from at least two separate schools. Background features were kept as uniform as possible by strictly following the intervention, piloted in Paper I. The time used for the interventions was kept constant and I carried out the interventions for all groups, which diminished the amount of possible background factors that could affect the result.

4.6. Data collection methods

The data collection methods were chosen to be as close as possible to the evaluation methods used in schools, such as questionnaires, learning tests, and drawings, as these would be familiar to the pupils. Interviews were chosen as complementary data collection methods, even though it is not a typical evaluation method in today's schools.

4.6.1. Questionnaires

Questionnaires are a cost-effective and fast way of gathering information from a large population. It sounds easy, but to achieve this goal requires some work. A successful

questionnaire needs to be well developed, tested and carefully evaluated before distribution. Each question must be designed according to the research questions and phrased to match the group they will be applied to; in this case 11- and 12-year old children. In other words, the work that needs to be applied to data collection with questionnaires is in the planning, development and evaluation phase, prior to distribution. The questionnaire in question was tested on 17 pupils.

The aim of the questionnaire in Paper I was to gather knowledge on rural and urban pupils' expectations and experiences of learning in rural farm settings. The questionnaire consisted of ten closed and open questions and it was distributed before and after the farm visit. The closed questions consisted of a three-step Likert scale consisting of three faces; happy (☺=agree with the statement), indecisive (😐=neither agree nor disagree with the statement) and sad (☹=disagree with the statement). Each statement could also be answered by the pupil as an open question in their own words. The following seven questions were open-ended and pupils could freely answer using their own words. Open-ended questions are more laborious than closed questions when analysing, but they provide a more diverse material to work with. As I wanted to find out about the different expectations and experiences that pupils have of farms, open-ended questions were quite fruitful in getting a diverse image of the phenomenon under investigation. I do also experience that closed questions can easily be too leading and narrow in their scope, and therefore I used them to a minimum.

4.6.2. Pre-learning, post-learning and delayed test

In Paper II, I wanted to look more deeply into the effects of farms as learning environments. I wanted to find out the cost-effectiveness and value of learning in such an environment. For this purpose, I developed a test based on a similar model that is used in school to evaluate pupils' knowledge. The structure of the test was therefore simple and familiar to the pupils, which strengthened the validity and reliability of the research. Usually, a test is administered after a lesson, to evaluate what pupils have learnt. In addition, I also wanted to know what the pupils already knew prior to the lesson, just to get a control result or a baseline for their pre-intervention knowledge. With these two tests, one before the start of the intervention and one straight after, I could evaluate the direct effect of the intervention, in other words, how much the pupils remember of the learnt in the short term. As learning, when it is most effective, changes pupils' schemata on a more permanent level, I also wanted to know how the interventions affected the permanency of the learnt. Therefore, I also administered a delayed test five months after the end of the intervention.

The test consisted of two parts. In the first part pupils were asked to describe the meaning of farm-related concepts and in the second part to describe a farm-related process. Concepts were five, both abstract and concrete, and related to the route of milk (heifer, bovine colostrum, free-stall barn, calving, and pitchfork). In the test, the pupils were also asked to describe the process (the route of milk) in their own words. All

three tests were identical and included the same concepts and process (Vosniadou, 1994; Vosniadou, Ioannides, Dimitrakopoulou, & Papademetriou, 2001). Sample items from the tests can be found in Paper III.

As a method, this is quite fruitful as it enables a vast material for interpretation. First of all, after marking the test results according to a key, it is possible to study the direct learning results of the interventions as well as the persistency of the learnt. Secondly, you are also able to study the incorrect answers as well as the zero-answers of the different interventions. This is quite fascinating, as it gives an insight into the learning experience and effect of the interventions.

4.6.3. Interviews

I have used interviews in all three papers in addition to other methods. Interviews gave a deeper insight into the phenomenon under investigation and by this a better understanding. As a sole investigation method, it would not have been possible to give the width that questionnaires are able to deliver. In combination, these are quite effective for presenting a quite wide and deep insight into a phenomenon, regarding a chosen aspect and with regard to the researcher's interpretation. In Paper I, my aim was to characterize pupils' experiences of farms and the interviews were done during the farm visit, as open interviews. This was quite a fruitful method for gaining an immediate response to pupils' experience of the farm visit. It was a combination of both observing and interviewing active situations. A positive aspect of this method was the reality of the situation and to be able to capture pupils' immediate responses. The downside was that I was only able to observe and interview a small number of pupils during their visit. For papers II and III, I chose to use semi-structured interviews after the farm visit and interventions. To increase the validity, the interviews were carried out in a familiar setting at school on a school day after the farm visit, as personal recorded interviews (Cohen et al., 2000; Eskola & Suoranta, 2000; Hirsjärvi & Hurme, 2001). In Paper II my aim was to find out more about urban pupils' images of agriculture and to find out what has influenced their attitudes. Interviews together with subject-produced drawings allow the researcher to gain better insight into pupils' reasoning (Boylan et al., 1992; Fung, 2002). As attitudes and interest towards a phenomenon can be seen to be linked, the interviewees (n=8) were chosen to represent a diverse as possible group according to their interest to participate in the farm visit. In Paper III, the aim was to uncover qualities that have an influence on learning in the different learning environments of the interventions. Pupils were chosen according to the same principle as in Paper II. Pupils had participated in the intervention that included both lessons in classroom and on-farm. Sample items from the interview can be found in Paper III.

4.6.4. Subject-produced drawings

Drawings are quite common as part of education in different subjects in school, but also quite suitable as a research method. For example, drawings allow pupils that are not

excellent writers to express themselves (Fung, 2002). After studying several articles on the theme, I decided to go through with the method as subject-produced drawings has been found to work very well for pre- and post-assessment to measure the effect of interventions (Flick,1990), in studying of attitudes and knowledge (Knight & Cunningham, 2004), and conceptions and misconceptions (Ganesh, 2011) of different phenomenon. The phenomenon selected for student drawings was expectations of what a farm is like and what they think they will find there.. I asked them to draw freely on a blank paper, without guiding, hints or talking to other pupils; what they expected to find there. I wanted to learn their personal conception of a farm, not what their peers think a farm is like. I decided not to ask them to draw a farmer, as this could have just given me stereotypical images connected with the concept as in the *Draw a scientist test* (DAST) (Boylan et al., 1992).

This method was quite interesting and useful. In this experiment, I used interventions as a complimentary method. Next time, if I choose to include subject-produced drawings as a data collection method, I will probably ask pupils to write an explanatory story to accompany their drawing. This would probably ease the interpretation of the drawing and give a more diverse image of their interpretation of a farm. Interviews were also quite useful, but they were restricted to a chosen number of interviewees.

4.7. Analysis methods

Mixing of methods was also done in the analysis stage. I used a mixed methods research approach with qualitative (inductive content analysis and visual content analysis) and quantitative analysis methods (SPSS with ANOVA and ANOVA for repeated measures, as well as quantification together with qualitative methods). The background for this mixing is the same as earlier, to gain the best understanding of the phenomenon studied. Another aspect is that quantitative results give a more easily presented image of the effects for persons that are not familiar with the phenomenon, for example, national and municipality politicians that decide on funding for different learning environments. Qualitative results again tell more about the effects of the research and about participants' experiences. Both types of results are equally important and aid the researcher to understand the researched phenomenon on a broader and deeper level.

4.7.1. Inductive content analysis

Content analysis is a good method for describing a qualitative material. It can be done either as an inductive or a deductive analysis. The main difference between these two approaches is that deductive content analysis is done based on a theory or assumption and the collected material is analysed according to this. Inductive analysis is done based on the collected data and concepts used are derived from this material. The latter is useful when there are no or little earlier studies to be used as a basis for studying the phenomenon and when the material needs logical reasoning and interpretation. I chose

inductive content analysis for Paper I and Paper II, as it is also sensitive to context, systematic and objective, and by this supports a trustworthy qualitative conclusion for the phenomenon under investigation. The analysis consists of three phases: preparation, organization and reporting (Elo & Kyngäs, 2008).

In the preparation phase, the researcher makes logical sense of the data and central concepts are selected to be base units. The organization phase consists of open coding, creating categories and abstraction. Open coding indicates that concepts are recognized to describe the content of the material. Similar concepts are grouped under the same code (e.g. “fun” and “enjoying”). Abstraction includes constructing a common presentation of the data through forming categories, such as a main category, generic category and sub-category. The reporting was done in a figure with different level categories (main, generic, sub) and through quantification of results. A more detailed description of inductive analysis can be found in Paper I. Reliability and validity of this analysis method is similar to other research methods. The validity is improved by genuine citations from original data (Patton, 1990). I found inductive content analysis to be a most useful method for analysing data from interviews. It was a simple, logical and creative method for making sense of data.

4.7.2. Visual content analysis

Drawing and creating pictures is a common teaching and learning method in school; the reason I decided to try it out. Drawings in research with children have been of interest for over one hundred years, since researchers thought that drawing pictures is equivalent to writing for young children (Barnes, 1892, cited in Ganesh, 2011). Visual content analysis (VCA) is a variety of content analysis where the data is a visual image instead of a text and it is commonly used in media studies (Bock et. al., 2011) and for drawings (Ganesh, 2011; Rose, 2007). The procedure is still similar as described in the earlier section for inductive content analysis by reducing the collected material, in this case visual, to codes instead of verbal units that can be quantified and statistically analysed. Similarly, the codes in VCA need to be robust and categorical to a drawn element and not overlapping with another code.

Quantification of VCA was done to define frequencies of different categories of the material. Quantification also allowed the study of possible differences between girls and boys and if there were any differences before and after the farm visit. Results of the quantification were further statistically tested for significance by Pearson's chi-squared test (Ranta et al., 1991; Fung, 2002), where 20% of expected frequencies need to be higher than 5 and every expected frequency at least 1 (Ranta et al., 1991). Strengths of VCA include that it is a standardized method, and when correctly accomplished it provides reliable and valid results (Bock et al., 2011). Validity of analysis was verified, in Paper II as in Paper I, by intercoding (match 93%) as well as by including actual pictures from the material.

VCA was an easy and straightforward analysis method, as I was familiar with inductive content analysis. As a visual person, I enjoyed greatly deciphering the drawings and making sense and coding the material. Drawings provided a completely different insight into pupils' thinking, compared to texts. For example, the drawings did include much more emotional factors than texts. As I see it, drawings allowed pupils to express themselves in a more multifaceted manner than texts, as texts are usually more related to the spoken language where drawings can be seen to be related to a personal image of the phenomenon.

4.7.3. Statistical analysis

Statistical analysis was done with SPSS to gain some quantitative results. This type of analysis was mainly used in Paper III to give a measurable result in easily understandable numbers on the effect of different learning environments. As the test to be analysed was a typical school test, it was also analysed as such. A key was developed for both concepts and the process to be described and test answers were marked against this key. The marks were further checked for normal distribution (Kolmogorov–Smirnov test) and for equality of error variances (Levene test). When the material had passed these tests it was time for an analysis with SPSS. Methods chosen were analysis of variance (ANOVA) and ANOVA for repeated measures. ANOVA measures any significant differences between the groups at a given time and ANOVA for repeated measures analyses the effect of learning environment through time. *Post hoc* testing (Scheffe) was used for determination of any significant differences. ANOVA for repeated measures also needs a sphericity-check for violation of the material. If needed, the results would be applied with Greenhouse-Geisser corrected degrees of freedom (Huck, 2000). Test answers were also analysed qualitatively by inductive content analysis to gain a better insight into pupils' learning and understanding of concepts (Vosniadou, 1994, Vosniadou et al., 2001).

Statistical analysis requires a very good understanding of both the statistical program used and the collected data. Personally, this type of analysis is the most time consuming for me. I have done all of the analysis for my thesis, however, I am far from a statistical expert. Thus, I have put forward a lot of time and effort in understanding both the material and the program from a statistics point of view and had my results checked by expert statisticians. For these reasons, I feel quite confident with this analysis method. I recommend that researchers that are interested in statistical analysis not to be intimidated by the complex statistical program, but to give it a try by taking a course or joining a team that has experts in the area. In my opinion, a combination of quantitative and qualitative results provide great added value when these methods are used properly.

4.8. Validity and reliability

We are part of the world we explore, and no research can be understood as entirely unbiased. Any research where a human is present in any of part of it is subjective to

some degree. One could argue that quantitative research is an absolute science, where results are based on solid and unarguable numbers. But, what to measure and what to not measure, the scale, as well as chosen background factors to be used, have been chosen according to the researcher's preferences. As such, it cannot be seen as objective research. But, by recognizing and understanding this, the researcher is able to minimize any validity or reliability issues and take them into account when reflecting on the results of the research. The validity was increased by the awareness of these aspects and by reflection upon them in all stages of the research, from planning to implementation and analyses.

Interventions that have been used for these papers have been thoroughly developed and tested. Their aim had to fulfil educational aims as well as research aims, and was therefore as controlled as possible from these points. The mixed methods research approach can be seen to have increased the validity of the study by applying multiple data collection and analysis methods. Mixed methods enabled the study of the phenomenon on different levels, both on a broad level with many participants as well as on a deep level with only a few participants. This enables, in my opinion, a more comprehensive understanding of the phenomenon that I studied. All methods were tested before applying them.

Reliability in an inductive content analysis and visual content analysis can be achieved by intercoding. This indicates that several researchers open code the same data. The result of categories and abstractions are thereafter compared (Burla et al., 2008). Even the most experienced researchers make mistakes and misinterpretations, which is why it is suggested that 80% is a satisfactory number for reliability in content analysis (Gottschalk, 1995). Intercoding reliability in papers I and II were 85% and 93%, respectively, and categories were adjusted accordingly. Reliability was increased by detailed reporting of the analysis phase and validity by presenting actual texts and drawings from the material collected (Elo & Kyngäs, 2008, Patton, 1990). In my opinion, a manual analysis of qualitative material increase the validity compared to an analysis done by a program developed for such analysis. A manual analysis does not have a problem with misspelled words or words that are spelled similarly but have a completely different meaning that programs might or might not react to. Even so, I would certainly use a program for vast materials, as the greater the material, the bigger the risk that researcher get tired or miss a unit.

4.9. Reflection over used methods

When planning a research strategy, one would love to go heads on and find ground breaking new answers that will either save the world or make one famous, as in the movies. But, one has to bear in mind that a through planning of a rigorous research strategy is the most important part of the whole process. One also has to realize that everything does not always go as smoothly as it does in Strömsö (Finnish lifestyle television concept, where everything always works out smoothly and results are breathtak-

ing). Planning is time consuming, but it is worth all the effort in the end. One main question guided me in designing my research strategy: What do I want to learn? I wanted to understand: gain a comprehensive understanding. I felt that reading research articles and books, and torturing my professors with questions, did not get me any further. Finding the right approach and methods was not easy. I studied numerous research approaches, data collection and analysis methods, before I ended up using the ones I did.

Interventions, an experiential research approach, were a self-evident choice. Interventions were used to provide a snapshot of how pupils learn in an authentic learning environment; the effect on a pupil that has studied most of his or her school life in a classroom. Interventions would not give me an answer to how pupils' learning would develop, if they were allowed to learn in such an environment on a regular basis; it would have been too time consuming. My research strategy would give me some understanding of the process. I decided also to do a classroom intervention on the same subject, to have a group to compare with and a combination of these, to study their synergy. The latter, a combination of studying in a classroom and thereafter visiting a farm, is the method that would best fit into an ordinary school's work. I found that short interventions are a good method to study the effect of a learning environment, even though the designing, testing of the design and executing it, is time consuming. To do the study in a school that uses authentic learning environments on a regular basis would have been interesting, but there were none to be found at a comfortable distance. Now, when this study is done, I do think that these short interventions in ordinary schools give a better image of what authentic learning environments may achieve for education and different learners.

When deciding on data collection and analysis methods, I needed to fit the methods to interventions as well as my aims. I soon noticed that there is not one solitary method that would give me a completely satisfactory answer. I realized that I needed to develop a battery of methods. Most qualitative methods would give me a good diverse set of insights, but only a few participants, as such methods are often quite time consuming. Quantitative ones would give me the opposite: a vast number of participants, but with less information. Another aspect I had to bear in mind, was that the methods used needed to be familiar and easy enough for the participating children. This is where I decided to choose a mixed methods approach. The main aim of mixed methods is to be true to the object studied, which also suited perfectly my intention of finding an understanding.

In the end, I decided to use questionnaires, a learning test consisting of a pre- and post-learning test and a delayed test, subject-produced drawings and interviews (Figure 5). Using these quantitative and qualitative tests, I started to gather the bits and pieces for my puzzle and build the picture that illustrates my understanding.

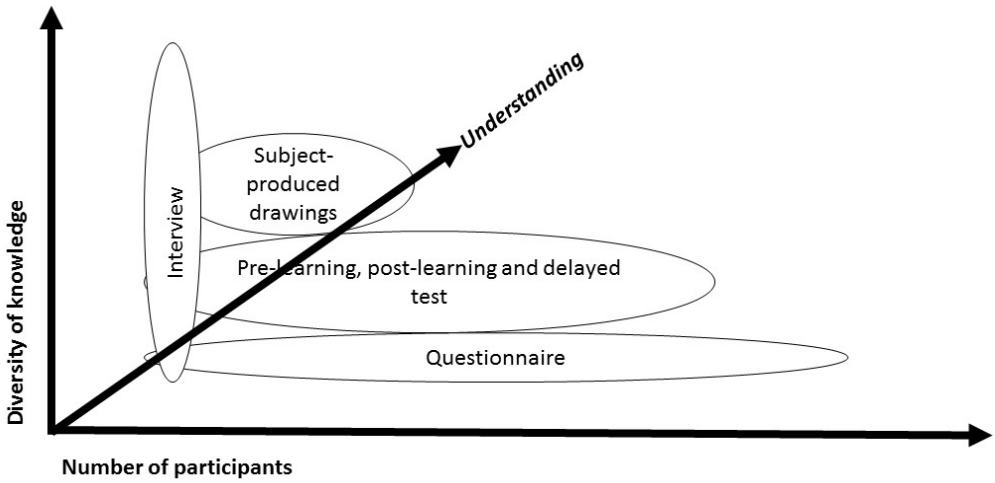

Figure 5. Mixed methods. This figure shows the amount of knowledge and the amount of cases the different methods gather, and how these sum up and results in an increasing understanding of the research question.

I started with questionnaires (Paper I). Questionnaires were applied to gain a general idea of the studied subject. As pupils are not used to long and detailed questionnaires, I had to keep the questionnaire simple, clear and short. The results were not deep or diverse, but gave an idea of how pupils in general experience learning in farm settings. Results from the questionnaire formed the basis for further designing of the following methods, as I began to become familiar with some of the main themes and gained a vague framework for my puzzle. Subject-produced drawings (Paper II) were the second phase in my quest for understanding. Pupils were asked to draw a farm before and after a farm visit. The drawings offered diverse knowledge, where questionnaires only generated general knowledge. But, without the questionnaire, I would not have had a theme for the pupils to draw about. There were fewer participants in this method, but together with the results of the questionnaire, I was able to study how good this group represented the general expectations and experiences. The drawings deepened the knowledge gathered from the questionnaire. But, there were still gaps to be filled after the questionnaire and the subject-produced drawings. The interviews continued the second phase and took knowledge gathering to the deepest and most diverse level. Through interviews I was able to get explanations of and answers to questions that had arisen while analysing the material from the other methods. This is why I placed interviews at the end, where a carefully chosen group of pupils allowed me to gain a deeper understanding of learning in an authentic learning environment.

The learning test and interviews form a separate combination that is not linked to the questionnaire. The learning test collects data on *how* pupils learn and the interview *why* pupils learn. This last illustration of these two methods is probably the best exam-

ple on how qualitative and quantitative methods can fulfil each other (Figure 5). The learning test gave me numbers on how the pupils' gained knowledge varied in different interventions and through time. However, it did not give me an understanding of why these numbers varied. The interviews allowed me to gain deeper insight into pupils' learning emotions and experiences in the different interventions. By combining these results I developed an understanding of learning, what factors affect it positively or negatively, and how pupils experienced it. The added value of mixed methods is the comprehensive understanding it might bring, and to my understanding brought, my study.

5. Conclusions and recommendations for future research

In conclusion, everything in our culture is a product of a specific time, place, and environment, which also applies to education (Nordin-Hultman, 2004; Säljö, 2000). In this work I have compared the education product of our time (classroom) and developed a possible future complementary education product based on earlier research, theories and results of experiential interventions (Farm Education). The theoretical aim has been to establish a theoretical framework for outdoor education in a farm surrounding. The methodological aim was to explore the use of a mixed methods approach with quantitative and qualitative methods, both in data collection (interviews, questionnaires, learning tests and subject-produced drawing) and the analysis phase (inductive content analysis, visual content analysis, and statistical analysis with SPSS). The empirical aim of this work has been guided by a practical orientation to explore different effects of learning in outdoor settings, compared to traditional classroom education. This comparison of learning environments was achieved by using experimental interventions. Participants were all aged 11–12 years and from different geographical areas in Finland (Helsinki n=85, Vasa n=157, and Jokioinen n=76) and from Finnish- and Swedish-speaking schools.

The theoretical, methodological and empirical aims of this work are as follows:

1) The theoretical aim discusses Farm Education and how it relates to research and educational theories.
2) The methodological aim discusses and evaluates mixed methods as a tool in educational research, based on my experience from these studies.
3) The empirical aims are divided into two main themes:
    a. Empirical aim I: Effect of Farm Education on pupils' conception of and attitudes towards farms and farming
    b. Empirical aim II: Cognitive effects of Farm Education

Theoretical aim: Farm Education

The theoretical aim was to explore how on-Farm Education is explained by educational theories. Farm Education as a theory has been developed based on educational models and theories (Ausubel, 1963; Kolb, 1981, 1984; Knapp, 1996; Palmer & Neal, 1994; Palmer, 1998; Davis et al., 1993), educational philosophers' (Dewey 1938), earlier research (e.g. Mabie & Baker, 1994; Dahlgren & Szczepanski, 1997; Jolly, 2009; Jolly & Krogh, 2010) and outcomes of this work (papers I, II and III). Outdoor education theory (Knapp, 1996) allows Farm Education to use both indoors and outdoors of farms for educational use, whereas the Environmental Education Model (Palmer & Neal, 1994; Palmer, 1998) allows it to focus on three different levels of learning (learning about the subject, learning in the subject's real environment, learning to comprehend the subject) to achieve first-hand knowledge, understanding, and skills through active participation. Farm Education is accordingly defined on this basis as an authentic learning environ-

ment (Paper III) that requires a genuine surrounding together with genuine activity and actors that are truthful to the subject to be learnt.

Active participation is also part of the constructivist view of learning (Davies et al., 1993) which sees learning as building of knowledge based on earlier knowledge and understanding; in other words adding to earlier schemata. Further on, as knowledge can be seen to add to earlier knowledge, it can also, according to Kolb's experiential learning theory (1981, 1984), be seen to be added in spirals that are built of different phases (abstract conceptualization, active experimentation, concrete experience, and reflective observation). Farm Education allows pupils to enter this learning spiral at any point, but it also promotes the creation of minor learning spirals parallel to the major learning spiral (Paper I). Farm Education supports both low- and high academic achievers (Paper III) by allowing pupils to enter the learning cycle at their own natural point of preference and allow deepening knowledge at will. Farm Education supports learning of different academic achievers by promoting meaningful learning (Dewey, 1938). A subject to be learnt becomes meaningful when it has a value in the present. To gain such a value the pupil needs to form a relationship to the subject (Krogh & Jolly, 2012) and make it meaningful. (Please see Chapter 2 for further discussion on the development of Farm Education)

Methodological aim: Mixed methods

The methodological aim was to find methods that are best suited to study the phenomenon of education in a farm surrounding. The mixed methods approach (Cresswell et al., 2003; Johnson & Onwuegbuzie, 2004) is a pragmatic approach that explores a chosen phenomenon with both qualitative and quantitative methods. The mixed methods approach assumes that various types of data provide the best understanding of the phenomenon to be explored (Cresswell, 2009). The mixed methods approach was successfully applied in this work both in data collection as well in the analysis phase. (Please see Chapter 4 for further discussion on methodology.)

Empirical aim I: Effect of Farm Education on pupils' conceptions of and attitudes towards farms and farming

The number of farms has decreased significantly since 1995 due structural changes within agriculture. Therefore, it was of interest to explore how today's children, who are tomorrow's decision makers, perceive farms and farming. The method used was experiential interventions and data collection was done qualitatively (observation, interviews, drawings) and quantitatively (questionnaire) (papers I and II).

Both urban and rural pupils' agricultural perception was equally positive towards a farm visit, independent of place of living or knowledge level (Paper I), which is consistent with earlier research (Frick et al., 1995). No correlation between the number of earlier farm visits and interest to participate in Farm Education was found (Paper II). The analysis revealed differences. For example, urban pupils expected romantic values, variation to ordinary school/life, peace and quiet where rural pupils expected new knowledge or skills (Paper I). When focusing on one group, the urban pupils (Paper II), irrational elements were found in 38% of pupils' preconceptions of what Finnish farms and farming is, before the farm visit. After the farm visit, this number of irrational elements had declined to 4%. When pupils were interviewed to explore the reasons behind these irrational elements, they mentioned media (television shows, cartoons, advertisements) as a source of agriculture knowledge. Researchers have found similar results from the effect of media (Stenbacka; 2011) and other sources in the pupils' surroundings (Gardner, 1980; Palmer 1998). When pupils lack personal experience of a phenomenon, they build their schemata of the phenomenon based on information from their surroundings. These mental images and understanding might therefore be irrational, untruthful and foster false traditionalism. Such false traditionalism, or romanticism, is for example the belief that cows are mainly milked by hand or that farms lack modern technology (Paper II). An effective method to clear conceptual irrationalities is confrontation (Vosniadou, 1994), in other words, through personal experience and first-hand knowledge. Personal experience has been underlined by several researchers (e.g. Ballantyne & Packer, 2009), as well as Dewey (1938/1997), based on the fact that learning needs to be connected to one's surroundings.

Farm visits increased pupils' positivity towards farms to 80% (Paper I); similar results to earlier research (Balschweid, 2002). Motivated learning was a value that was thought of as a main outcome of a farm visit (Paper I). Pupils had also clearly made a relationship with the farm and farming, the subject taught, as after the visit they presented themselves and their classmates carrying out activities in drawings of the farm visit. Working together for a common purpose is social learning, to learn together and from each other, which not only creates a relationship to the subject, but also between the co-learners. This coincides well with Farm Education and other researchers' views (Krogh & Jolly, 2012) on how learning becomes meaningful.

Empirical aim II: Cognitive effects of Farm Education

Cognitive effects of Farm Education were studied to gain a measurable and qualitative value of learning in an authentic learning environment. Cognitive effects of Farm Education were explored by three consecutive interventions on a farm, in a classroom or a combination of both. Repetition is known to be the mother of study as repetition is known to support long-term memory by neurological research (Kandel et al., 2001), which is why repetition was applied to strengthen the outcome. Data collection was done by quantitative (pre-learning, post-learning, and delayed testing) and qualitative (interviews) (Paper III) methods.

One of the major achievements of Farm Education on an academic scale is the better long-term persistence of the learnt (five months after intervention), which can especially be seen in the result that low academic achievers who had participated in Farm Education had a significantly higher average grade compared to high academic achievers that had learnt solely in class (Paper III). In general, Farm Education can be seen to have several positive cognitive effects. Farm Education was found to support pupils of all academic performance levels, from low academic achievers to high academic achievers (Paper III). Farm Education is novel in being able to support both low and high academic achievers at the same time. The Finnish school has a good supportive system for low academic achievers, but lacks a supportive system for high academic achievers, which is why implementing innovative educational approaches such as Farm Education would increase equity of learning.

Pupils reported that one of the main reasons why they appreciated participating in Farm Education (compared to learning in a classroom) was the gained novel knowledge (papers I, II and III) and that it was easier to concentrate, better air, they gained personal experience and first-hand knowledge, as well as learning in context (Paper III). The former two qualities of learning on a farm (easier to concentrate, better air) can be seen to be connected as good oxygen and carbon dioxide balance is needed for optimal functioning of nerve cells that participate in cognitive processes (Satish et al., 2012). Cognitive performance decreases significantly when carbon dioxide concentration rises from 600 ppm (parts per million) to 1000 ppm (Satish et al., 2012), compared to 350 ppm of outdoors. Concentrations of carbon dioxide within classrooms may rise above 2000 ppm due to insufficient ventilation (Myntti, 2005), causing tiredness and concentration problems.

The latter three (personal experience, first-hand knowledge, learning in context) qualities of learning have been found to be important in earlier research (McRae, 1990; Palmberg & Kuru, 2000; Paper I) and theories (Dewey, 1938; Kolb 1984). Pupils found it easier and more motivating to learn when they were able to experience what they are learning in reality, using all senses (Dahlgren & Szczepanski, 1997). Pupils also experienced that they learnt more than usual (compared to traditional education) (Paper III). Seeing everything in reality gave them a comprehensive image of the subject as well as its interactions, which might explain a significantly better understanding of farm-related concepts and processes amongst pupils' learning on farms compared to pupils' learning

solely in class (Paper III). Pupils did not only learn more, but they also had a higher conceptual understanding and showed less primitive, wrong or empty answers (Vosniadou, 1994) compared to peers that only studied within traditional education (Paper III).

Not only what they learnt, but how they learnt was therefore of importance, according to pupils (Paper III). Different learning preferences that Farm Education supported were social cooperative learning, kinetic learning, practical learning, and visual learning. Teaching and learning methods have in research been found to be of larger motivational importance than the subject itself (Granström, 2007), why a learning environment that supports different methods can be seen to be of a higher educational value than an environment that only supports a few methods from a pupil's point of view. In addition, all pupils have individual learning preferences (Boström, 2004) that steer their optimal learning methods. Therefore, all pupils do not find Farm Education supportive to their learning.

A future school would optimally integrate different teaching and learning methods to support pupils with different learning preferences (Farm Education, other education forms and traditional classroom education). This would not only support different learning preferences but also pupils of different academic levels. Even though, all aspects of Farm Education are yet to be revealed. The connection between emotions and cognitive processes is a feature that has risen during all three papers, and needs further studies to be clarified.

Future research

Research is often carried out within one specific field, within one discipline. In my work, I have mixed methods within data collection as well as analysis. A mixing of disciplines in a transdisciplinary research would possibly bring new novel understanding to different phenomenon of education. Cresswell (2009) states that mixed methods are based on the assumption that multiple types of data would bring the best understanding of a phenomenon. I argue that this could also bring a better understanding of phenomenon of our world, such as education. The world is not divided into disciplines, only science is.

Pupils found learning on a farm to be more effortless, more qualitative and fun. They experienced the joy of learning. Joy of learning is a complex phenomenon (Rantala & Määttä, 2010). Even though learning itself was found to be effortless, it required a great deal of effort, activity, and processing from the pupil. The effortlessness or easiness was built up by the combination of different aspects that supported their learning. In other words, the cognitive process was supported by aspects of the authentic learning environment, of which some have been elucidated in this work. Joy of learning can in this study be seen to be built of these aspects. Joy of learning is also seen as a prerequisite for lifelong learning. This means that pupils need to have experienced and maintained joy of learning when young (Sanderoth, 2002). Therefore, it is important to maintain supportive learning emotions that will result in academic wellbeing, higher motivation and joy of learning, if we want to support a society that continues learning, renews itself and keeps a high educational standard. But again, we need to keep studying the

multifaceted concept of joy in learning, to be able to support it correctly amongst different learners.

Research suggests interaction between emotions and learning, as well as of wellbeing and learning or learning difficulties. As there is ample research done on test anxiety, there has been little research on other emotions linked to academic performance (Pekrun, 2006). Today, one is able to find more and more such articles, as the interest towards the connection between learning and emotions is increasing amongst researchers. International assessments have found that Finnish pupils have lower academic motivation than many other countries. Low motivation can be seen to affect academic wellbeing. Low wellbeing in school has, together with learning difficulties, been found to be linked to educational dropout and related problems (Korhonen, Linnanmäki & Aunio, 2014). There are undoubtedly many different reasons for low school motivation, where learning difficulties are certainly one, but this will also require further study to be elucidated. We will need to clarify what the emotional and motivation mechanisms of Farm Education in an authentic learning environment are. Can the academic emotions further explain the good results of Farm Education? This still needs to be discovered.

As a conclusion, Farm Education is no philosopher's stone. Farm Education is honouring the learning process of each individual, and by this, also seeing the learner as an individual learner with specific preferences. Farm Education is honouring the phenomenon that is subject for learning and the connections to its surroundings and connections to nature, society and culture

6. Summary of the papers

The following chapters will provide insight into how Farm Education has evolved during research and development. The first paper discusses findings during the Eco Learn project and the development of rural camp schools. This is for me, personally, a significant paper, as Eco Learn was *the* venture that hurled me from the science of biology to pedagogics. In the second paper further studies pupils' conception of farms and farming and how these might have emerged, as well as how pupil misconceptions might be remedied. In the third paper, I study how farms and farm surroundings function as authentic learning environments. I have compared different learning environments and evaluated their effect on learning as well as made an evaluated guess on reasons for these effects. Overall, it has been a magnificent journey that has broadened my view and allowed me to study the forces that stir in education and steer future consumers.

These three papers will form a continuum that each take the reader one step further toward understanding Farm Education, as well as on a methodological level: from experiences at camp schools to discussion of cognitive results. The titles are as follows:

1. Rural Camp School Eco Learn – Outdoor Education in Rural Settings
2. Farm Education and the Effect of a Farm Visit on Children's Conception of Agriculture
3. Farm Education and the Value of Learning in an Authentic Learning Environment

6.1. Paper I

Smeds, P., Jeronen, E., Kurppa, S., & Vieraankivi, M. -L. (2011). Rural camp school Eco Learn: Outdoor education in rural settings. *International Journal of Environmental and Science Education, 6*, 267–91.

This first paper is an introduction to what learning in the outdoors on a farm could be like, how pupils and teachers experience learning in farm settings and what theories are linked to this type of learning. In the development part insight into the formation of educational programmes will be presented. The paper presents where the evolution of Farm Education started: in a research and development project on rural camp schools called Eco Learn.

Research questions for this paper were as follows:

1) What kinds of expectations do urban and rural pupils have for studying and learning in outdoor rural settings?
2) What kinds of experiences do urban and rural pupils have while studying and learning in outdoor rural settings
3) What kinds of experiences do teachers have in outdoor education in rural settings?

The paper discusses the background of outdoor education in Finland and elsewhere, as well as how it can support education in school. The importance of the learning environment is realized and the theoretical background is woven of the constructivist learning conception, environmental education, Kolb's learning cycle within the setting of outdoor education. Using this theoretical background as a backbone, a five-step development cycle for educational programmes was established. This cycle, or spiral, is a cornerstone for all Farm Education programmes. It is a process that communicates with all parties that are involved in Farm Education. In this way, the product, the educational programme, is tailored to fit both the farm resources as well as the needs of the class or school that is going to use the programme. The outcome of such educational programmes is studied by observation with interviews and questionnaires that are analysed by inductive content analysis. Inductive content analysis is also used in the following papers and therefore it is thoroughly presented here to provide a foundation for for all three. The results section of this paper shows that urban and rural pupils have quite different expectations for learning in farm surroundings, but their experiences are quite similar. The original theory is also elaborated a bit further by minor learning cycles that formed during the general learning cycle.

My work consisted of planning the research, and all the development from practical arranging, finding farmers to developing both programme process as well as the programmes themselves. This was a laborious task, but I had a lot of help from Marja-Liisa Vieraankivi, who worked as an assistant in the project. Sirpa Kurppa designed the general project plan, gave me feedback throughout the study and commented on the paper. Eila Jeronen functioned as my supervisor, gave feedback on the paper and good advice. Composing the paper was solely my task.

6.2. Paper II

Smeds, P., Jeronen, E., & Kurppa, S. (2015). Farm Education and the Effect of a Farm Visit on Children's Conception of Agriculture. *European Journal of Educational Research, 4 (1)*, 1–13.

The aim of the second paper was to take the discussion of Farm Education a step further, as well as learn the use of new methods. In this paper, I am looking more specifically at what conception urban pupils have of farms, farmers and farming and what sources might be the sources of these conceptions as well as how the misconceptions might be remedied.

Research questions for this paper were as follows:

1) What conception do urban pupils in the 5th grade have of Finnish agriculture?
2) How does a farm visit affect this conception?

The theoretical background discusses what an authentic learning environment is and is not, and reflects how it is connected to the history of Nordic education praxis as well as environmental education. Authentic learning environments are further elaborated and linked to the national core curriculum. The research strategy is experiential with intervention and pupils' conception is studied by pre- and post-assessments. Interventions are based on and further developed according to the process that was developed in Paper I. Subject-produced drawings were used to gain knowledge of pupils' conception of agriculture before and after the farm visit and interviews were used to clarify the results of drawings. Drawings were analysed by visual content analysis and quantified to be more comparable between the pre- and post-assessment. Inductive content analysis was used for interviews, as it was found to be robust and effective analysis method in Paper I.

As a summary of the results, there were quite a few misconceptions amongst the pupils before the farm visit. Bear in mind that these pupils all have had lectures in school on what farms and farming is, and should have therefore had a realistic image of the phenomenon. These misconceptions could in several cases be seen as contributed by media. This raises concern for pupils' future active roles as a consumers: how will they be able to make responsible choices regarding food, if their conception of it is blended with fiction? This raises the importance of education and Farm Education in authentic learning environments as imperative for a future sustainable society.

My work for this paper consisted of planning the research strategy, interventions, finding a farm and participating schools as well as to carrying out the research, data collection, analysing the material and writing this paper. Eila Jeronen functioned as my supervisor and, together with Sirpa Kurppa, provided helpful comments on the paper.

6.3. Paper III

Smeds, P., Jeronen, E., & Kurppa, S. (2015). Farm Education and the Value of Learning in an Authentic Learning Environment. *International Journal of Environmental and Science Education, 10 (3)*, 381–404.

This paper studies the effect of learning in an authentic learning environment and a traditional classroom. Learning environments, their quality and effect on cognitive processes and outcomes is an important field in today's cost-effective society. Paper III continues the theoretical evolution of Farm Education from Paper II. New methods are as well included in this paper to gain new knowledge methodologically as well as to use the best-suited method for data collection and analyses.

Research questions for this paper were as follows:

1) Is there a difference in long-term persistence on concept and process levels between learning in a classroom and in an authentic learning environment or their combined effect?

2) How do pupils experience learning the same subject in an authentic learning environment (a farm) as compared to a classroom?

This paper continues the discussion on-Farm Education by binding neurological aspects to learning as well as educational theories. The research approach was again chosen to be mixed methods with experiential interventions. Mixed methods is a laborious and demanding research approach, as it requires extensive data collection as well as quantitative and qualitative understanding of data and methodology. Interventions are based on Paper I, but contents and teaching methods are further elaborated to fit the chosen phenomenon in the two different learning environments. Interventions were developed to consist of three concurrent lessons. Data collection was done by pre-, post- and delayed learning tests and interviews. Test analyses were done by SPSS with Analysis of variance (ANOVA) and ANOVA for repeated measures and interviews were analysed by inductive content analysis. On-farm authentic learning environments proved as commendable learning environments for different types of academic performers and it promoted long-term persistence of the learnt. Pupils' also experienced it as a motivating and effective method for learning. When comparing outdoors and indoors, one has to bear in mind that fresh air (low level of carbon dioxide[2]) and enough exercise has a positive effect on the learning process and academic achievement.

My work for this paper consisted, as in the others, of preparing the research and development part from the start to the end, as well as data collection, analysis and methodology. Writing of the paper was also solely my task. I am thankful to my supervisor Eila Jeronen and Sirpa Kurppa for helpful comments on the paper.

[2] Carbon dioxide concentration of fresh air is in general 350 ppm, but may in classrooms with poor ventilation rise as high as 2000–3000 ppm (Myntti, 2005). A carbon dioxide concentration of 1000 ppm affects cognitive performance negatively (Satish et al., 2012).

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