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Farm Education and the Value of Learning in an Authentic Learning Environment

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Farm education is a newly emerging field of research that utilises authentic learning environments, environments that combine a subject of academic study with its real-world surroundings, actors, and activities – in this case, the practical context of a farm. The aim of the study was to investigate the effects of various learning environments (farm, classroom, and synthesis of the two) on learning and how pupils experience it. Mixed-methods research with experiential interventions was used, and data collection used interviews and pre-learning, post-learning, and delayed tests. The analysis, performed with SPSS software, employed ANOVA and ANOVA repeated-measures design and inductive content analysis. Pupils showed significantly better learning results when allowed to study in authentic learning environments on farm. They experienced learning in an authentic learning environment as easier and found that they learnt more there than in the classroom. They concluded that the reason for this was that the subject to be learnt could be studied comprehensively and first-hand in its original surroundings, including processes. Farm education proved to be a versatile learning environment that encourage learning and support learners who differ in their learning preferences. It supports pupils with moderate learning difficulties, as well as talented pupils, thanks to being allowed to study many aspects of the subject for learning, at their own pace. Including authentic learning environments in education increases long-term retention of what has been learnt and improves understanding. Those involved in teacher education, teachers, and schools alike are urged to take this into account when planning and carrying out education.

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

INTRODUCTION

Finnish pupils achieve high rankings in international comparison, in 'programme for international student assessment' (PISA), 'trends in international

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mathematics and science study' (TIMSS), and 'progress in international reading literacy study' (PIRLS) tests (Martin, Mullis, Foy, & Stanco, 2012; Mullis, Martin, Foy, & Drucker, 2012; PISA), but many pupils in Finland indicate that they do not enjoy school as much as pupils in other countries do (Kämppi et al., 2012; Martin et al., 2012). Also, learning difficulties are on the rise amongst Finnish pupils. In 1998, about 3.7% of all pupils received special-needs education (Kumpulainen & Saari, 2006), and that number had doubled by 2005, when the figure was 7.3% (*ibid*.). In 2010, it had increased to 8.5% (Tilastokeskus).

L. B. Sharp, a pioneer of outdoor education, has stated that pupils cannot fully understand what they are learning without experiencing it (Knapp, 2000). The learning environment and its various elements, actors, and activities all have an important function for learning. The Finnish national core curriculum (NCC, 2004) states that the main aim of a learning environment is to support pupils' learning, and teachers are advised to use multiple learning environments. Research has found the use of learning environments in natural surroundings to be particularly supportive of learning (McRae, 1990; Palmberg & Kuru, 2000¸ Szczepanski & Dahlgren, 1997). A natural environment supports the use of several senses in learning (Szczepanski & Dahlgren, 1997) and allows pupils to study subjects in relation to their actual environment, interactions, and culture (Smeds, Jeronen, Kurppa, & Vieraankivi, 2011). Studies have proved farms to be important learning environments for elucidating various topics, from farming and gardening to social issues and sustainable development (*ibid*.; Krogh & Jolly, 2012, Smeds, 2012).

Nordin-Hultman (2004) points out that learning environments are created by pedagogues in accordance with their understanding of learning. Teachers equip and furnish their classrooms to support their teaching and thereby determine how the pupils are allowed to learn. Nordin-Hultman underscores that the pupil is in continuous interaction with his or her environment, and with the elements and objects of that environment. The environment and its possibilities shape the pupil and the pupil's actions. For instance, problems with concentration may indicate that the environment does not support concentration; concentration problems may be caused by the learning environment. Haapasalo (2004, p. 19) asks a similar question about mathematics education, whether 'learning difficulties' are 'mostly the teacher's teaching difficulties'. Haapasalo argues that difficulty in learning may arise when the teacher has not established teaching methods appropriate to support the learning of a pupil who has problems in grasping, for example, mathematics. Boström (2004, 2011) and Boström and Lassen (2006) draw attention to the fact that individuals' learning-related preferences are half biological and half learnt. While some preferences are innate, the learnt half of a person's learning preferences is rooted in earlier learning experiences, in how the pupil has been taught to learn (e.g., by teachers, parents, or a coach), and in specific educational cultures and contexts.

Aim of the research

The quality of learning environments and their significance in their functions and effect on cognitive processes and outcomes is an emergent field in educational research. The aim of the research described here was to study whether the learning environments matters when year-5 pupils (11-year-old) are learning 'the route of milk'. This subject was chosen for two reasons: it is part of the NCC, and the number of active farms in Finland has decreased dramatically during the pupils' lifetime (Niemi & Ahlstedt, 2006). The latter may result in limited personal contact with agriculture, the food chain, and nature (Smeds et al., 2011). Research has found agricultural knowledge to be low (Mabie & Baker, 1994; Trexler, 2000), and views of relations between humans and nature may even come from television and other

media (Palmer, 1998). Farms as learning environments, farm education, are defined further in the next section of the paper. They are considered in terms of the following research questions:

1. Is there a difference in long-term persistence on concept and process level between learning in a classroom and in an authentic learning environment or their synergy?
2. How do pupils experience learning the same subject in an authentic learning environment (a farm) as compared to a classroom?

Theoretical background

Learning is a multifaceted concept, and understanding it when forming learning environments and learning situations is clearly important. In this paper, we consider both neurological and biological explanations, together with more traditional aspects of learning. This allows us to explore and explain the possible effects of the various learning environments from a broader perspective. Learning itself has been given an abundance of definitions, from different schools of thought and philosophies of education, but all of the definitions have one element in common: the learner changes personally via learning (Boström, 2004). Learning is an interdisciplinary phenomenon that is typically divided into phenomenological, behavioural, neurological (Schmeck, 1988) and socio-cultural (Säljö, 2000) aspects. Neurological aspects of learning are gaining interest amongst researchers, especially since 2000, when Carlsson, Greengard, and Kandel won the Nobel Prize in physiology or medicine for their findings on signalling in the nervous system (Nobel Media, 2000). Their work has been able to explain how short- and long-term memory works on the neurological level (Kandel, 2001). Education is designed to influence long-term memory, as memories and information stored here may last a lifetime (Sand, Sjaastad, & Haug, 2004). Long-term memory creates completely new synapses, while short-term memory only enhances a synaptic contact, especially in the hippocampus (Kandel, 2001). Researchers studying animal models argue that environmental enrichment may increase learning and long-term memory (Bruel-Jungerman, Laroche & Lampon, 2005). Researchers who have used outdoor surroundings for education (see, for example McRae, 1990; Szczepanski & Dahlgren, 1997) have noticed positive effects of environmental enrichment on cognitive processes when pupils are allowed to use multiple senses for learning. This has been discussed also by Smeds and colleagues (2011), who studied the effects of farm education on rural 'camp schools'. Voluntary exercise (Olson, Eadie, Ernst, & Christie, 2006) and a good oxygen uptake (Wikgren et al., 2012) have shown similar positive effects on learning and long-term memory in animal models. A good oxygen uptake correlated especially well with success in complicated cognitive tasks and problem-solving (ibid.). Research has found that senior citizens with a physically active life are healthier and do better in cognitive tests than senior citizens who live a more passive life (Colcombe & Kramer, 2003; Koch et al., 2011). Exercise and a good oxygen uptake are clearly linked – exercise increase oxygen uptake, and a good oxygen concentration in the blood is vital for optimal functioning of nerve cells (Sand et al., 2004), which, for example, are involved in learning and long-term memory storage.

Farm education

Farm education is about using farms as authentic real-life learning environments. The experiential interventions in this study make use of a farm as an authentic learning environment that enables pupils to benefit from the above-mentioned findings. A multifaceted learning environment, such as this, also encourages

learning, whilst a uniform learning environment restricts learning (Nordin-Hultman, 2004). Further, the interventions are based on following conceptions and theories of education.

Learning is defined in experiential 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). Experiential learning theory sees learning as circular and consisting of four stages: experience, reflective observation, abstract conceptualisation and experimentation (Kolb, 1984). The cycle can also be seen as a spiral that deepens the knowledge at every turn. The spiral was further developed by Smeds and colleagues to consist of spontaneous minor learning cycles within the learning spiral. Outdoor education theory (Knapp, 1996) specifies the importance and possibilities of contextual learning, outside the classroom. Outdoor education, education for sustainable development (ESD), and environmental education (EE) are related concepts so are hard separate, even here. Here we define environmental education according to Palmer and Neal (1994) as 1) education about the environment to build awareness and understanding; 2) education in (or from) the environment, and 3) education for the environment together with a sustainable future. Outdoor education points to the possibilities afforded by using different learning environments for different topics, while ESD and EE use the environment for a specific goal, to educate for a sustainable future or about environmental issues. The Finnish national curriculum (2004) is based on the constructivist learning conception (Ausubel, 1963; Davis, McCarty, Shaw, & Sidani-Tabbaa, 1993). Experience, and the interpretation of experience, is central to the constructivist view of learning. Knowledge is seen as a fact that cannot be transmitted, therefore learners are assumed to construct their knowledge based on individual and social experiences (Davis et al., 1993). Consequently, NCC (2004) underlines the importance of individual constructivist learning processes, active participation, nature values as well as a sustainable environment (NCC, 2004). The foundation for the interventions is composed of the environmental education model (Palmer, 1998; Palmer & Neal, 1994), the experiential learning theory (Kolb, 1981, 1984), constructivist conceptions of learning (Davis et al., 1993), and the NCC (2004). For more information on the development and testing, see Smeds et al. (2011).

In farm education, authentic learning environments allow pupils to learn the subject being taught in its genuine and original surroundings, including the actual actors and activities, with their interactions (see Figure 1). All three parts must be present for an authentic learning environment to be present. For example, a farm with no farming activity or a cow and a farmer in the schoolyard cannot be seen as an authentic learning environment. Subjects enriched by being taught in an authentic learning environment encompass normal phenomena of the surroundings or a typical activity – for example, the use of a farm in study of the route of food; details can be found in the work of Smeds et al. (2011) and Smeds (2012).

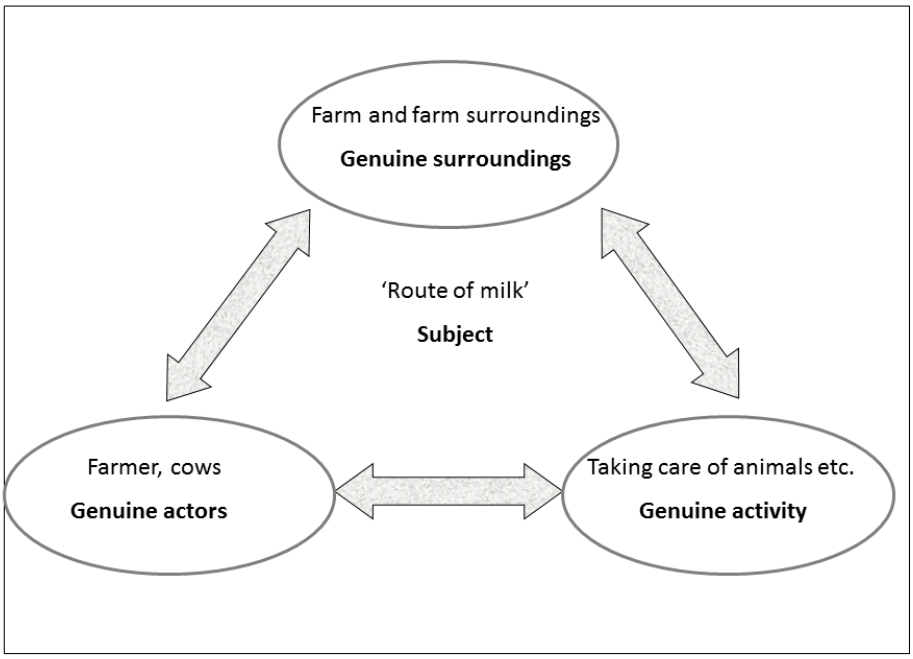

Figure 1. Farm education, an authentic learning environment. To depict farm education as an authentic learning environment, the school subject 'Route of milk' is depicted in connection with its interactions with its genuine surroundings, actors, and activities within the authentic learning environment.

Interactions within the learning environment allow pupils to experience the dynamics of the subject to be learnt (see Figure 1). Interactions may vary from social relations to triggering of senses and emotions to concrete acts. All of these should lead to greater knowledge of the subject. Interactions illuminate the interdependence among the actors and the activities of the genuine surroundings.

Learning in an authentic learning environment is further characterised by Dewey (1938), who states that learning needs to be meaningful in the present and be connected to the pupil's surroundings. Dewey also sees the connection between theory and practice as important and finds that these concepts should not be separated in the learning process. He holds that the relationship and communication between school and society should be active. Dewey's theory has been proved accurate by research on pupils' learning experiences in farm environments with affirmative results on that pupils experienced this as a motivating place and way of learning (Jolly, 2009; Jolly & Krogh, 2010; Smeds et al., 2011). In addition to gaining new knowledge and skills, almost all pupils reported social benefits from interacting with other pupils, with their teachers and the farmers in this context (Jolly, 2009; Jolly & Krogh, 2010).

Relationship-based experiential learning has been studied and developed in a farm environment (Krogh & Jolly, 2012). It merges research to several fields: pedagogy, psychology, health sciences, phenomenology, and brain research, and is a development of Dewey's and Kolb's learning models. In relationship-based experiential learning, the learning cycle starts with a pupil deciding to take on or resolve a practical task or issue. This hands-on activity allows the pupil to gain a personal relationship to the task through experience. That personal relationship forms the foundation and is required for understanding of the task and how it is related to its surrounding and also for the pupil's self-efficacy with respect to the activity (ibid.).

METHODOLOGY

The aim of our research was to study learning with experiential interventions in two distinct learning environments, an authentic learning environment and a classroom, along with any possible synergy effect. Because the subject chosen for this study is 'the route of milk', the authentic learning environment selected was a farm. The research design used in the study employed mixed methods (Cresswell, Clark, Gutmann, & Hanson, 2003; Johnson & Onwuegbuzie, 2004), with both quantitative and qualitative methods. These supported each other, providing added value, and by so doing increased the validity of the research. The interventions were used to study the effect of the differing learning environments on learning, with the data collection employing interviews and a pre-learning, post-learning, and delayed test. Analysis was performed with SPSS (ANOVA and ANOVA for repeated measures) and via content analysis (Cohen, Manion & Morrison, 2000).

Mixed methods

A decade ago, mixed-methods research was somewhat debated as a research method, but this approach – earlier referred to as integrating, synthesis, quantitative and qualitative methods, multi-method, and mixed methodology (Bryman, 2006; Tashakkori & Teddlie, 2003) – is frequently used for international articles today. Mixed-methods research enables utilising the strength of both qualitative and quantitative research when one is investigating complex research problems. It has a pragmatic worldview wherein the researcher bases the investigation on the assumption that collecting multiple types of data provides the best understanding of the research problem (Cresswell, 2009).

Mixed-methods strategies have steadily gained more interest amongst researchers (Cresswell & Plano Clark, 2007) since Campbell and Fiske (1959) first started to utilise multi-method work in their studies of the validity of certain psychological traits. From basic triangulation from quantitative and qualitative sources (Jick, 1979), mixed-methods research has evolved into three general strategies: sequential, concurrent, and transformative mixed methods (Cresswell, 2009). The main difference between sequential and concurrent mixed methods is the timing of their use of qualitative and quantitative methods. In the former, one follows the other (e.g., the researcher starts with a quantitative survey and continues with qualitative interviews), and in a concurrent approach they are applied at the same time. Transformative mixed methods is used to study the topic of interest through a theoretical lens and may utilise a sequential or a concurrent approach (ibid.). The challenges with this form of research is that it necessitates extensive data collection; it is laborious, demanding analyses of both text and numerical data; and the researcher needs to be familiar with both quantitative and qualitative research (ibid.). Our study used a sequential mixed-methods design. The design, with interventions and data-collection methods, is presented on a time scale in Figure 2.

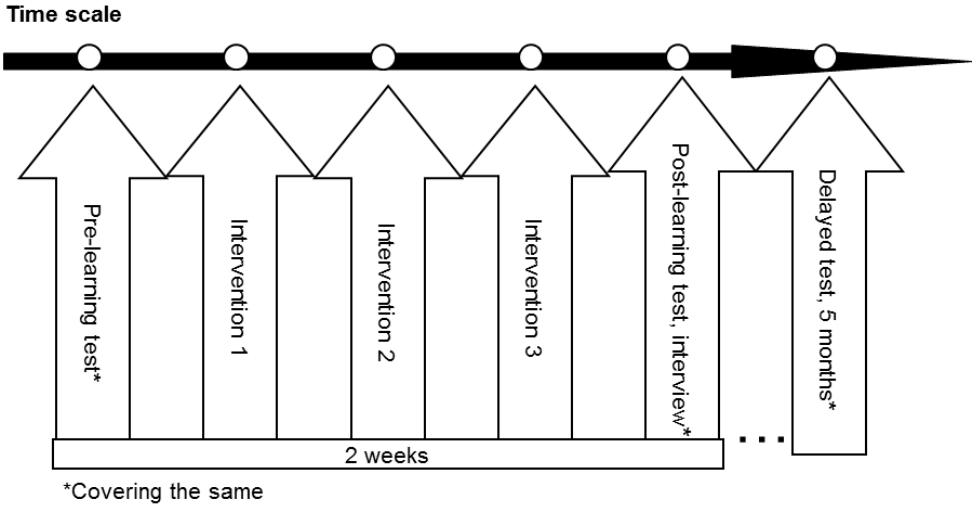

Figure 2. Methods on time scale. The research design with the interventions, including the data-collection methods.

Data were collected by means of pre- and post-learning and delayed tests, alongside sequential explanatory interviews. The methods (see Rogers et al., 2003) received equal weighting, and the sequential interviews were used to explain the information gained in the tests and deepen the insights. Mixing in this study took place in the data-collection phase and in comparison of pre- and post-learning and delayed tests' results with interview data (see Figure 2).

Interventions

The interventions used in the study are educational programmes based on topics in the school curriculum (NCC, 2004), constructivist conceptions of learning (Davis et al., 1993), experiential learning theory (Kolb, 1981, 1984), outdoor education theory (Knapp, 1996), and the environmental education model (Palmer & Neal, 1994; Palmer, 1998). The NCC was chosen as a base for interventions, since all education in Finnish schools follows its guidelines.

Three intervention groups were designed on the subject of 'the route of milk: a) classroom, b) classroom and farm, and c) farm. The first represents traditional classroom learning, including its learning methods and materials. Group B allowed exploring possible synergy effects between learning environments by combining traditional classroom learning with a visit to the authentic learning environment for the subject taught, a farm. Group C represents learning only in an authentic learning environment on farm, where theory and practice of the subject are combined in the genuine surrounding by genuine actors and activities.

The interventions were built up of three separate sequential lessons kept within two weeks. Each lesson lasted for two hours including a break (15 minutes). The topic of the first lesson was grain and hay production. During this lesson, pupils learnt about cow's fodder, how big an area is needed for feeding a cow, conventional and ecological farming, biodiversity and history. The topic of 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 topic of the third lesson was dairy products from consumer perspective. During this lesson, pupils learnt about different dairy products, their production and about economic issues in dairy farming. The lessons formed an educational chain, or spiral, from field to table,

deepening the learnt at every lesson and viewing the topic from a different angle (e.g. sustainable development, and ethics).

Teaching methods were optimised for each learning environment, as teaching and learning methods are closely linked and also depend on the learning environment. 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 The lessons in the classroom consisted of teacher led work (farm education material for schools), "the route of milk"-game on the internet, group activity (link agricultural products with grain), discussions and watching a DVD on farming on a dairy farm. The lessons on farm consisted of teacher and farmer led discussions, tour on farm, observing, group activities (biodiversity, feeding cows and calves, baking), and participation in different individual tasks on the dairy farm. Group B participated first in classroom education and thereafter in on farm education. The educational content and the aim with all groups were kept the same. The farm was situated 4 km from schools.

Participants

All 106 participants were fifth-year pupils from four different primary schools. All participating pupils were from the same town (medium-sized town with 60,000 inhabitants on the western coast of Finland), from schools of the same size (230–330 pupils), and with 2–3 foreign-language pupils per class. The use of four schools provided diversity in educational culture and enabled every intervention to include pupils from at least two schools. The idea of diversity of educational culture here refers to pupils having been studying at different schools, with different traditions, learning environments, teachers, and languages (Finnish or Swedish). Background factors' effects were diminished by strictly adherence to an existing, piloted education programme (Smeds et al., 2011), with the time used for the interventions kept constant and with the same qualified person carrying out the interventions for all groups.

Data collection

In the data collection, which, as was noted above, utilised pre-learning, post-learning, and delayed tests and also interviews, the aim of the tests was to study development of pupils' learning, along with how the concepts and the process were stored in pupils' long-term memory. The test, distributed before, after, and five months later than the interventions, was constructed in line with general principles for Finnish school tests. Therefore, the pupils were familiar with its concept, and that familiarity strengthened the validity and reliability of the research. The test addressed five concepts (heifer, bovine colostrums, free stall barn, calving, and pitchfork) and a process (describe the route of milk) that pupils had to explain in their own words (see Table 1). The concepts and process were the same with each test (Vosniadou, 1994; Vosniadou, Ioannides, Dimitrakopoulou, & Papademetriou, 2001). Sample items from the tests can be found in the table below.

Table 1. Sample items from the pre-learning, post-learning and delayed test

Concepts and process	Pre-learning test	Post-learning test	Delayed test
Heifer	'A female sheep'	'A female cow that has not had a calf'	'A female cow'
Bovine colostrum	'Some sort of milk'	'A very nutrtious milk for the calf'	'A milk for the calf'
Freestall barn	'A plant'	'A farm where cows are allowed to also go outside'	'A fenced area for cows'
Calving	'A baby-bird hatching'	'A cow gives birth to a calf'	'A cow giving birth'
Pitchfork	'A tool that looks like a rake'	'A tool used for feeding cows. Looks like a rake'	'A tool that you use for lifting fodder'
Route of milk	'cow-production-packing-shop'	'field-cow-milking-dairy-shop-table-toilet-wastewater treatment plant-sea-clouds'	'field-grain and hay-cow-milking-factory-shop-hor stomach-toilet-wastewat treatment plant-sea-air-field'

Note. The samples of the process 'Route of milk' do not show quotes, but a simplified version of actual description.

Interviews were chosen as an explanatory method in a sequential design for insight into how pupils experienced learning in different learning environments (see Table 2). The aim was to reveal qualities that, according to the pupils, have a positive or negative influence on learning in the various learning environments. Eight pupils (4 girls, and 4 boys) were chosen for interviews on the basis of their attitude (2 positive, 4 neutral, and 2 negative) to participating in a school day on a farm. These pupils had participated in the intervention group B that included education in classroom and on farm. Gender and attitude were chosen as criteria, as this enabled pupils' personal interest in farms and farming, if any, to be taken into account in the analysis. The interviewees were randomly chosen from the groups formed by these criteria. The interviews were semi-structured and carried out during school hours at the pupils' school, to increase validity (Cohen et al., 2000; Eskola & Suoranta, 2000; Hirsjärvi & Hurme, 2001). Sample items from the interview can be found in the table below.

Table 2. Sample items from the semi-structured interview

Interview questions	Quotes from interviews
Compare learning in classroom with learning on farm.	
differences	'. . .in class it is just talking, but there on the farm you are shown all different routes. . .' 'Nothing really.' 'It does not smell in class.'
similarities	'It does not matter where you learn. It is kind of learning anyway.'
Describe how you learned at the farm.	
field	'Too much to listen. . .' 'On the field you could easily understand what big is. . .'
barn	'It was quite school-like…' '. . .in the barn you learnt to know stuff.'
kitchen	'I learnt to bake and I can also now bake at home as I have the recipe.' '. . .in the kitchen you learnt to kind of do stuff. . .'
Did you notice something new about yourself or your classmates when you were at the farm?	'My classmates were first afraid that the cows would sort of lick them, or something, but then they got all excited. . .'

Analysis methods

Test responses were marked against a key and analysed. The marks were then checked for normal distribution (via Kolmogorov–Smirnov testing) and equality of error variances (Levene) and analysed with SPSS. Analysis of variance (ANOVA) and ANOVA for repeated measures were used for testing of the effect of learning environment through time, and post hoc testing (Scheffe) was used in further determination of significant differences. Sphericity was checked for violation, with Greenhouse–Geisser corrected degrees of freedom applied if this was required (Huck, 2000). Test answers were subjected to additional qualitatively analysis for the image they could provide of pupils' understanding of the concepts (Vosniadou, 1994, Vosniadou et al., 2001). Interviews were analysed via inductive content analysis, as it is sensitive to context, objective and systematic (see Table 3). The analysis consists of three phases: preparation (making logical sense of data and selecting of units), organisation (open coding, creating categories and abstraction), and reporting (main category, generic category and sub-categories. Sample items from inductive content analysis can be found in the table below.

Table 3. Sample items from inductive content analysis

Category	Generic category	Criteria	Quote
Learning method		Description of a way to gain knowledge	
	General methods		'…the farm was pretty good, when everything is shown and also told.'
	Learning by doing		'I learnt to make butter!'
	Kinetic learning		'We were allowed to move around…'
	Social cooperative learning		'We worked together…'
Qualities of learning		Specific qualities of learning on farm	
	Learning in context		'…at the farm we were shown where everything actually goes."
	Personal development		"I was surprised that I dared to feed the cows.'
Affective values		Issues that raised emotions	
	Positive values		'Calves were so cute!'
	Negative values		'It was too warm in the sun.'

Note. Keep in mind that the analysis as a process goes from right to left.

(For a detailed description of inductive content analysis, please consult the study of Smeds and colleagues (2011), and for background Graneheim and Lundman (2004), Tuomi and Sarajärvi (2004), or Elo and Kyngäs (2008).

Validity and reliability

As researchers, we are part of the world we research, and no research can be completely unbiased. The validity of our study was increased by our awareness of this and our reflection upon it in all stages of the study, from its planning to implementation and analyses. The planning and testing of interventions that fulfil educational aims had already been developed in collaboration with 13 teachers and tested with 161 pupils (Smeds et al., 2011). That further increases reliability and validity. Also, the mixed-methods research approach increased the validity of the study by allowing research informed by multiple data-collection methods (tests and

interviews) and multiple analysis methods (statistical analysis with SPSS and content analysis), thus offering a fuller image of the phenomenon studied. The tests were used for insight into long-term persistence of the learning and understanding, and interviews were chosen for explanation of the results found and for what they might reveal of how the pupils experienced learning. The test material was tested with 123 pupils and improved accordingly for greater validity. The interviews with pupils were semi-structured one-on-one interviews conducted in a familiar place by the researcher who had led the interventions, for good validity (Cohen et al., 2000).

Ethics

Ethics considerations are especially important when children are part of the study in question. Pupils, their guardians, pupils' teachers, and school headmasters received information on the study (its aim and methods, the process, the study's time frame, pupil participation, and evaluation) and were allowed to decide on participation individually (Hirsjärvi, Remes, & Sajavaara, 2009). A pupil had the right to decline to participate even if his or her guardian(s), teacher, and headmaster had agreed to participation (Ruoppila, 1999). All participants were granted 100% anonymity. Studies in which children are involved are required to support their healthy development and not involve any greater risks than a normal school day entails (ibid.). The theme, methods, material, learning environments, and values were strictly chosen on the basis of the Finnish national curriculum (NCC, 2004). The researcher conducting the interventions is also a qualified teacher and bound by both research and teacher's ethics, which ensure an ethical approach to all aspects of the research.

RESULTS

Results will be presented in this chapter: first the effects of background factors, and thereafter results according to research questions.

There were no significant differences found between Finnish- and Swedish-speaking pupils, so their results are discussed in combined form. Participating pupils were divided by their classroom teacher into three categories on the basis of their academic performance: high, average, and low academic performance (see Table 4). This information was used to study how pupils of each performance level performed in the delayed test in the different learning environments.

Table 4. The pupils' academic performance

	Intervention	High	Average	Low	Total
a)	Classroom	49% (18)	34% (13)	18% (7)	100% (38)
b)	Classroom + Farm	46% (16)	31% (11)	23% (8)	100% (35)
c)	Farm	36% (12)	49% (16)	15% (5)	100% (33)
Total number of pupils		46	40	20	106

Note. The number of participating pupils is given in brackets, and the percentage indicates how many in the relevant group belonged to the category in question

Table 4 shows that groups 'Classroom' and 'Classroom + Farm' contained more high-academic-performance pupils (49% and 46%, respectively) than did group 'Farm', in which most pupils (49%) belonged to the average-performance category. The girls (28) had higher academic marks than the boys (18), and boys' average

score in the pre-learning, post-learning, and delayed test was consequently one mark lower than girls'. There was no significant gendered difference between intervention groups.

Question 1: Is there a difference in long-term persistence on concept and process level between learning in a classroom and in an authentic learning environment or their synergy?

Authentic learning environments on farm increased permanence on concept level. Long-term retention at concept level was studied via comparison of the results of the three sets of tests: pre-learning, post-learning, and delayed. The average marks for all intervention groups, with standard deviations, are presented in the bar chart in Figure 3, below. The minimum score is 0 and the maximum 16, for a scale of 0–16.

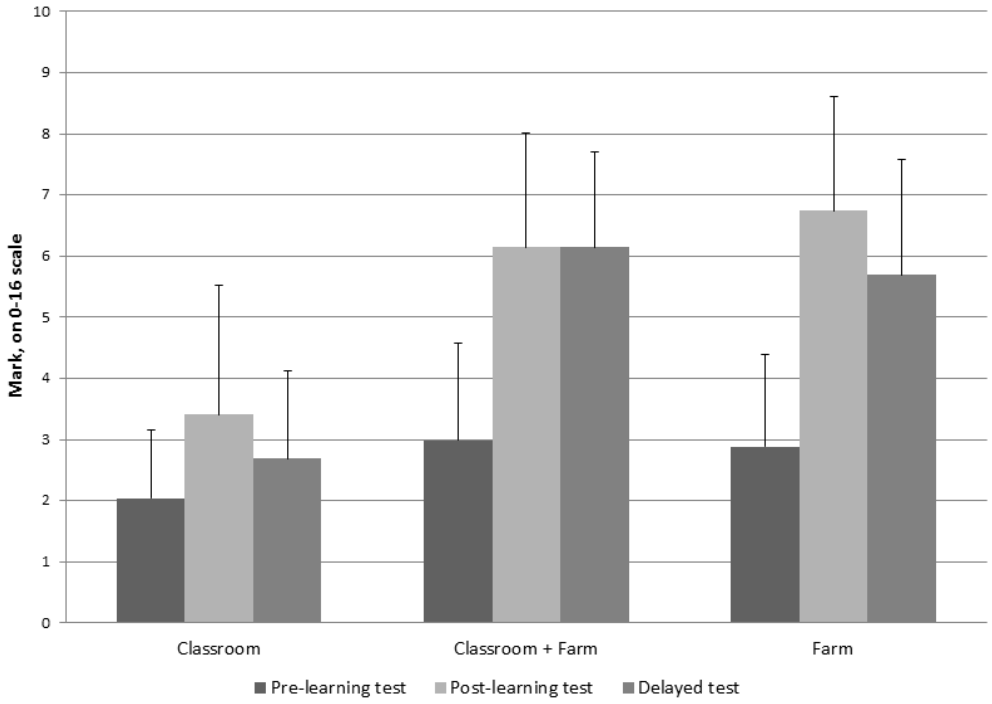

Figure 3. Average mark per group of intervention on a scale of 0–16. The error bars represent the average score with standard deviation for each intervention group ('Classroom', 'Classroom + Farm', and 'Farm'). The first bar each group represents the pre-learning test, the second post-learning testing, and the third the delayed test. 'Classroom' n = 38, 'Classroom + Farm' n = 35, and 'Farm' n = 33.

The pre-learning test measured the pupils' knowledge level before the interventions. No statistically significant differences were found between groups. The post-learning test measured the pupils' knowledge level directly after the interventions. An analysis of variance showed that there was a significant effect at the point of the post-learning test $F(2,103) = 40.34$, $p < 0.001$. Post hoc analyses applying Scheffe's post hoc criterion for significance indicated that there was a significant effect ($p < 0.001$), with the highest marks being received in the 'Classroom + Farm' ($M = 2.7$, $SD = 0.39$) and 'Farm' ($M = 3.3$, $SD = 0.41$) intervention groups relative to the group 'Classroom'. There was no significant difference between the 'Farm' and 'Classroom + Farm' groups ($M = 0.59$, $SD = 0.41$).

The delayed test measured the long-term effect of the learning – in other words, what pupils remembered from the intervention after five months. An analysis of variance showed that there was a significant effect of the interventions in the five-month-delayed test ($F(2,103) = 41.8$, $p < 0.001$). Post hoc analyses using Scheffe post hoc criterion for significance indicated that there was a significant effect ($p < 0.001$), with the highest marks being received in the intervention groups 'Classroom + Farm' ($M = 3.5$, $SD = 0.41$) and 'Farm' ($M = 3.0$, $SD = 0.42$) as compared to 'Classroom'. There was no significant difference between the intervention groups 'Farm' and 'Classroom + Farm' ($M = 0.45$, $SD = 0.43$).

The authentic learning environment on farm increased knowledge through time. Pupils' average development through time for the individual intervention groups could be studied when their results were compared via pre-learning, post-learning, and delayed tests (see Figure 4).

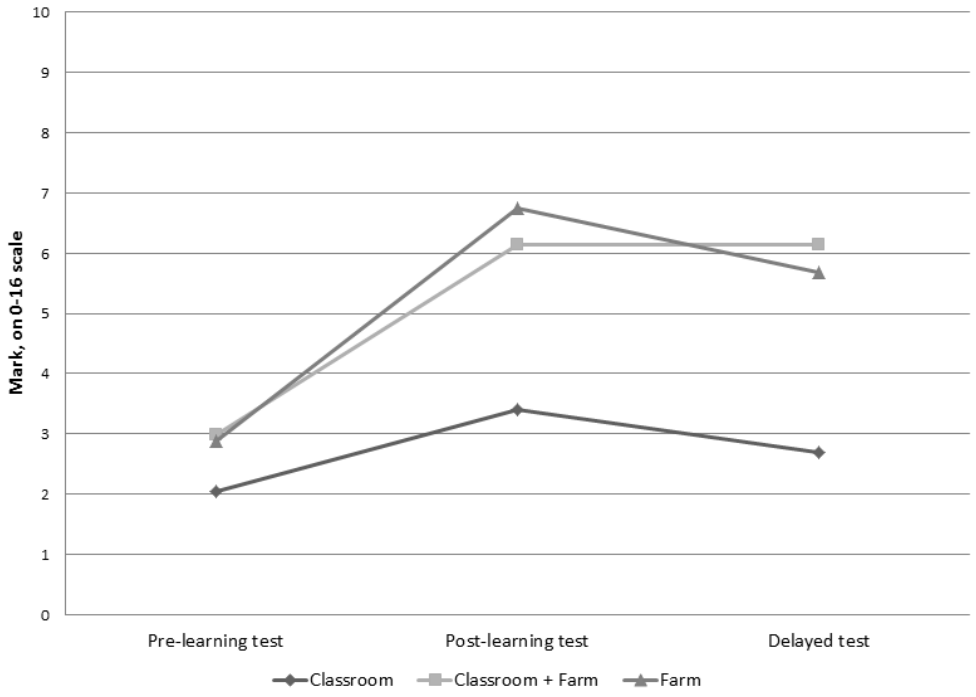

Figure 4. Average development through time. The pupils' average development, as measured by tests scores in pre-learning, post-learning, and delayed tests, through time for the individual intervention groups. The scale for the marks is 0–16. 'Classroom' n = 38, 'Classroom + Farm' n = 35, and 'Farm' n = 33.

Studying how pupils' test results develop through time yields insight into how their understanding of agriculture-related topics develops. There was a significant relationship through time between intervention groups and test results, $F(4,206)=21.0$, $p < 0.001$. Pupils in the 'Farm' and 'Classroom + Farm' groups had significantly higher results than those in 'Classroom'.

All groups of academic performers gained from learning in an authentic learning environment on farm. Long-term persistent of the content learnt was studied by means of the delayed test that was carried out five months after the end of the interventions. Possible effects of learning environment on permanence of the learning amongst different levels of academic performer were studied via splitting of the intervention groups (see Figure 5).

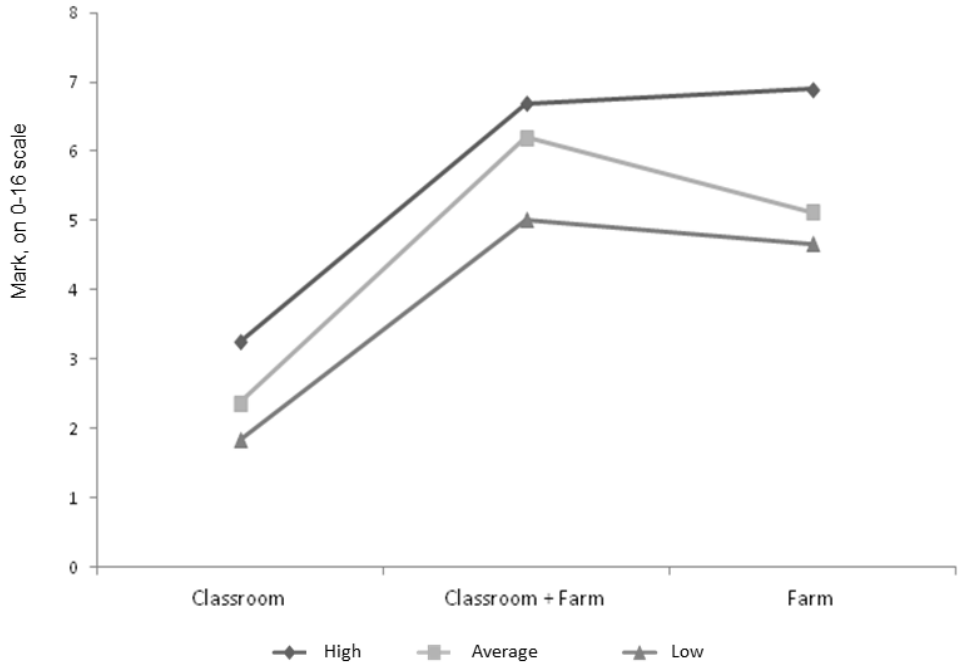

Figure 5. Mark in delayed testing. The average mark for the delayed test was used to measure the long-term persistence of the learning effect with the various learning environments amongst academic performers at each level (high, average, and low) within the individual intervention groups. 'Classroom' n = 38, 'Classroom + Farm' n = 35, and 'Farm' n = 33.

On account of the group sizes (see Table 4), no statistical calculations were performed and the figure is shown merely for the trends visible amongst various academic performers. Pupils of all academic performance levels got better average marks with learning environments featuring an authentic element. Low academic performers in the group with authentic interventions on farm had somewhat higher average marks than did high academic performers in the group with classroom interventions. As the difference was not statistically significant, interpretation of results at this level, with such small groups, should be undertaken only with great care.

The authentic learning environment on farm increased long-term persistence at process level. Studying pupils' understanding of 'the route of milk' through time illuminated how their understanding of the process develops. There was a significant relationship through time between intervention groups and understanding of the milk-route process $F(4,198)=10.46$, $p < 0.001$ (ANOVA repeated measures). Post hoc analyses with the Scheffe criterion for significance showed that pupils in the intervention group 'Farm' had significantly ($p < 0.001$) better development through time with regard to understanding of 'the route of milk' as compared to 'Classroom' (M = 1.07, SD = 0.16) and 'Classroom + Farm' (M = 0.75, SD = 0.16). There was no significant difference between 'Classroom' and 'Classroom + Farm' (M = 0.32, SD = 0.16).

Long-term persistence of pupils' knowledge of 'the route of milk' was measured by the delayed test done five months after the farm visit. Analysis of variance showed that there was a significant effect on permanence for the interventions $F(2,2102) = 17.54$, $p < 0.001$. Post hoc analyses utilising Scheffe post hoc significance tests indicated that there were significantly ($p < 0.001$) higher scores in the intervention groups 'Farm' (M = 1.41, SD = 0.25) and 'Classroom + Farm' (M = 1.04,

SD = 0.25) relative to the 'Classroom' group. There was no significant difference between the intervention groups 'Farm' and 'Classroom + Farm' (M = 0.38, SD = 0.25).

Zero-point responses were found mainly in the 'Classroom' intervention group. Responses that received no points in the delayed test were studied from the perspective of conceptual change and inductive content analysis. Three main groups emerged: primitive-answer, wrong-answer, and no-answer (see Table 5). The largest amount of primitive (6.7%), wrong (21%), and blank (35%) responses that received zero points in the analysis were found with the learning environment intervention group 'Classroom'.

Table 5. Zero point answers presented in delayed testing

	Classroom	**Classroom + Farm**	**Farm**
Primitive answer	**6.7%**	4.6%	1.3%
Wrong answer	**21%**	4.6%	16%
No answer	**35%**	7.0%	11%

Note. Answers shown as percentage of all answers received per intervention.

Further analysis revealed that typical zero-point answers involved attempts at explanation referring to a word or phrase with a similar spelling. For example hieho (meaning 'heifer') was suggested as sharing the meaning of hieno ('nice'). Other zero-point answers could be explained by synonyms for part of a compound concept (e.g., it was suggested that rå-mjölk, bovine colostrum, referred to färsk mjölk, fresh milk) and by pure guesses at farm-related concepts (e.g., pihatto, a freestall barn, was suggested to refer to 'nuori uros lehmä', a young bull). Primitive and wrong answers were found for all concepts in the test but especially in the explanations of the Swedish concept rå-mjölk along with its Finnish version, ternimaito (bovine colostrum). The most blank responses were found for the heifer and pitchfork concepts. For the 'Classroom' group, the most difficult concept was bovine colostrum, and that for the groups 'Classroom + Farm' and 'Farm' was the concept of calving.

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

We now consider how the pupils experienced participating and learning in an authentic learning environment (i.e., on a farm) as compared to learning in a traditional classroom. Eight pupils were interviewed by means of semi-structured personal interviews. The number in brackets identifies the interviewee.

The farm was a 4 km bicycle ride from the pupils' school, and most time during the farm interventions was spent outdoors. The pupils did not experience the bike ride as tiresome; they found it to have an invigorating effect lasting the rest of the school day or even school week. Three main categories were identified when analysing pupils' experiences of learning in an authentic learning environment on farm: learning methods, qualities of learning and affective values. Learning methods were further categorised into generic categories: general methods (observing, dialogue, and reflection), learning by doing (active participation, and own activity), kinetic learning (to be able to move around), and social cooperative learning (learning from others, and work together). Qualities of learning describe specific outcomes and qualities for learning on farm. Following generic categories were found: learning in context (first-hand knowledge, personal experience, connections between place, facts and processes, and meaningful activity), and personal development (change in values and attitudes, better self-image, higher self-efficacy, and new talents). Affective values were further categorised into sources for positive

values (caring for animals, and interesting and fun), and negative values (weather, allergies, and smell).

When pupils were comparing the qualities of learning in a classroom and learning in an authentic learning environment on farm, the results were quite varied. All pupils but one (3) described the learning in an authentic learning environment as having a positive effect on learning in school in general after the interventions. Four of the pupils (1, 2, 4, and 6) did not find any significant differences between the two types of learning, while the others found learning in an authentic learning environment completely different from learning in a classroom. One of them (6) experienced the former as environment-independent learning. The others (1, 2, and 4) added that they did learn more easily or better in the on farm authentic learning environment. In other words, these pupils experienced that they learn well in both learning environments, but the learning process was better supported on farm. 'There is no real difference, but it is easier to learn in the outdoors.' (2)

- 'Hard to say. The farm was quite good, when everything was shown and explained. That is good.' (4)

Two pupils (5 and 7) saw apparent advantages in learning in an authentic learning environment. They experienced that they learnt more and features that they would not have been able to learn about in a classroom. Qualities that pupils experienced as making the authentic learning environment a better learning environment were that it was easier to concentrate there (5) and that the air was fresh (7). Two pupils (2 and 8) experienced the opposite: they learnt better in a classroom, even though one of the latter pupils (2) commented that it was easier to learn outdoors. Arguments for learning in the classroom were that there are books there, it is easier to sit and write at a desk, and the classroom does not smell.

The personal experience, first-hand knowledge, and learning in context were mentioned by most pupils as positive qualities of an authentic learning environment as compared to a classroom. Pupils 1, 2, 3, 4, and 7 indicated that they learnt better when they were allowed to observe the subject they were learning in real life and in its original surroundings. In particular, processes and courses of action became more concrete, and the context helped pupils (1, 2, 3, and 4) to understand interactions and the 'big picture'.

- You wouldn't have to sit in a classroom, and you could be outside and get to know more closely what is taught.' (1)
- 'When you are in school and learn about the route of milk, in a classroom they just explain. But on the farm, there they showed everything that happens or where it goes.' (1)
- '[W]hen you read it from the book, you do not always understand it directly.' (2)
- 'Outdoors is much better, because you can see [it] there. And indoors, how you really did it. It does not matter how many times you read something; you can never understand how it is in real life.' (3)
- 'For example, when they tell us about milking, they take us to the milking station. And then they tell us how milk goes from there. Then we also use the milk for baking, and so, so it is pretty good. If you explain and also show, then it is impossible not to learn.' (4)

The authentic learning environment encompassed more practical tasks for learning than a classroom does, this was mentioned as learning by doing by four of the pupils (1, 2, 3 and 5) and as an activity by three pupils (6, 7 and 8) in the

interviews. Social co-operative learning (5 and 7) and kinetic learning (5) were other benefits of an authentic learning environment mentioned in comparison to learning in a classroom.

DISCUSSION

The Finnish national curriculum (NCC, 2004) encourages teachers to use various learning environments for teaching. In line with this, our study focused on comparing the two different learning environments (the classroom and an authentic learning environment on farm, along with their possible synergy) in terms of the permanence of learning of the concepts and processes and the pupils' experiences of learning in these learning environments. Having introduced the methodological approach (mixed methods) and research design (experiential with interventions); the participants (106 fifth-year, 11 year-old pupils, 55 of them girls and 51 boys, from four schools in the same geographical area); the data collection (involving pre-learning, post-learning, and delayed testing, along with interviews); the analysis (done via the SPSS software and content analysis); and the results, particularly those of the interviews, which were used as an explanatory supplement to the above-mentioned testing, with the eight interviewees chosen to form a heterogeneous group with regard to their interest to farms, we can now discuss the findings.

The results clearly illustrate that pupils' learning improves and the learning experience is literally tangible when lessons in an authentic learning environments are part of education. Literature on relationship-based experiential learning confirms why an authentic learning environment is successful (Krogh & Jolly, 2012): pupils are able to gain a genuine relationship to a task in its real, purposeful context. Without this relationship, pupils are not able to comprehend what they have learnt in full, and this negatively affects their understanding of processes, the long-term persistence of the learning, and the learning experience. The relationship that pupils are able to build with the task or the topic is of essence, because this makes learning personal and meaningful.

This is consistent with Dewey's (1938) conclusion that education needs to be meaningful for pupils and L.B. Sharp's thoughts on the importance of pupils' experience for full understanding of what is being learnt (Knapp, 2000). Without a personal relationship, the learnt remains meaningless and extraneous information that can be forgotten. The personal relationship links the three units of the authentic learning environment: the genuine surroundings, actors, and activities. To reach the same successful results as an authentic learning environment produces, the classroom itself needs to transform into an authentic learning environment or incorporate lessons in an authentic learning environment. A classroom transforms into an authentic learning environment when incidents and phenomenon that take place in the classroom are utilised for learning purposes – e.g., when a bird colliding with the classroom window makes various matters topical for learning (ethics, biology, and how to prevent such incidents).

Farm education and authentic learning environments have positive effects on pupils' learning

Understanding of processes such as 'the route of milk' and farm-related concepts was significantly better amongst pupils who had been learning solely in an authentic learning environment on farm. From the perspective of conceptual change, the authentic learning environment reduced primitive answers in the delayed test. Concepts, their meaning, and interactions became more comprehensible for pupils when they were allowed to learn about them in their real context, even for just one visit. The number of incorrect answers and blank responses in the delayed test was

considerably lower with those pupils who had participated in learning in an authentic learning environment, also. Long-term persistence of the learnt was significantly better amongst pupils who had been learning in a setting that included authentic learning environments. Pupils surmised that they learnt more readily and more in an authentic learning environment. One of the best elements of the authentic learning environment, according to the pupils, was that they did learn something new. Pupils of all academic performance levels attained higher marks when authentic learning environments were included in their learning. In other words, authentic learning environments support learning amongst both low academic performers who might need extra help in a classroom and high academic performers, who might not always be challenged enough in a classroom.

In contrast, the results show that learning solely within the classroom is associated with poor long-term retention of the learning content and understanding of processes, an effect seen in all academic performance groups. It is interesting that low academic performers learning in the authentic learning environment on farm showed higher average test results than high academic achievers in the classroom setting, five months after the interventions. Pupils with low academic performance, and possibly learning difficulties, clearly gain from learning in an authentic learning environment. One could speculate that more pupils with learning difficulties would be able to participate in normal education instead of special-needs education if appropriate authentic learning environments were to be included in education. That could improve these pupils' understanding of themselves in the role of a learner while also improving their self-image and self-efficacy, as well as their image amongst their peers and teachers. These effects would need to be confirmed via further investigation, especially on account of the small group size in our study. Research with a larger group could confirm that authentic learning environments may be able to save society considerable funds now devoted to special-needs education.

Natural repetition is important

The Latin proverb 'Repetitio est mater studiorum' (in other words, repetition is the mother of study) is supported by the work of Kandel and colleagues (2001), as long-term memory is enhanced by repetition. In our work, long-term memory was supported by three sequential lessons in interventions and by repeated stimuli to several senses in the authentic learning environment. Environmental enrichment has in animal models proved to increase learning and support long-term memory (Bruel-Jungerman et al., 2005). When pupils are allowed to use multiple senses simultaneously for learning, all activated sensory neurones transport information to appropriate parts of the brain. Multiple senses carry information on the same subject for cognitive processes. Sensory activation in learning situations has already been found to have positive effects on learning (Szczepanski & Dahlgren, 1997). It creates natural repetition for long-term memory and cognitive processes.

Qualities conducive to learning are present

Pupils were asked about 'learning qualities' of the various learning environments, for a more comprehensive view of the results. Pupils brought up personal experience, first-hand knowledge, and learning in context as valuable qualities found only in an authentic learning environment. Pupils appreciated that they were allowed to see what they were learning in reality, since that made the subject learnt about and its processes more concrete and gave a fuller picture of the subject and its interactions. These aspects have been found to be important in earlier research (ibid.; McRae, 1990; Palmberg & Kuru, 2000; Smeds et al., 2011) and theories

(Dewey, 1938; Kolb, 1984). Pupils' reflections on their learning confirm the importance of learning in authentic surroundings. Pupils reflected that social co-operative learning – for example, group work – was one of the strengths of learning in an authentic learning environment, as was kinetic learning (e.g., learning through being able to walk around while one is learning). Also, practical learning, through actions such as feeding cows, was brought up as a learning method but fewer times than visual learning (e.g., observing) was. Research has shown that the teaching and learning methods are of greater motivational importance than the subject learnt. Research amongst Swedish pupils has found co-operative learning to be the learning method that pupils experience as the most successful, yet, regrettably, it is the learning method least used by teachers (Granström, 2007). Earlier results echo our finding that authentic learning environments allow pupils to learn by using different senses (Szczepanski & Dahlgren, 1997) and in line with their individual learning preferences (Boström, 2004). Some pupils indicated that they learnt better in a classroom, which may indicate that learning preferences of some people are best supported in a classroom setting.

Teachers need to be taught how to teach in authentic learning environments

Education is a product of time, place, and environment (Nordin-Hultman, 2004; Säljö, 2000). Teachers, the educators, are taught at university about the best ways to teach and how the learning environment for this is best arranged in terms of place and other aspects of environment. They will most likely follow these guidelines in their teaching, applying what they have been taught is the best way to teach, in the environment they have been informed is best. Through this and other instruction, pupils learn how to learn, thereby accumulating half of their learning preferences (Boström, 2011). Accordingly, if pupils are not taught how to learn in other settings than a classroom, they will not be able to utilise all of the authentic learning environments' possibilities. Neither is this possible if the teachers have not been taught to teach in diverse learning environments. Teacher education has a crucial role in forming education practices, alongside views of what learning environments are 'best' for learning, what the 'best' teaching methods are, and how pupils learn 'best'. Specific teaching and learning methods are closely linked to specific learning environments and their equipment. Some learning and teaching methods are more appropriate in one learning environment than another: practical tasks are harder to perform in a classroom, and filling in worksheets might be troublesome in a learning environment without proper desks and chairs. The better results seen with authentic learning environments may be due in part to the different teaching and learning methods bundled with that learning environment and not solely due to the effect of the authentic learning environment as such.

Fresh air and exercise are important for learning

Fresh air and being able to concentrate better were cited as positive qualities of the authentic learning environment of the farm. Being outdoors reduces stress and is calming (Polvinen, Pihlajamaa & Berg, 2012), thereby affording a state that enables better concentration. The normal carbon dioxide (CO2) concentration outdoors is 350 ppm (parts per million), but CO2 concentrations in classrooms with insufficient ventilation can rise above 2,000 ppm and even reach 3,000 ppm during a lesson (Myntti, 2005). High carbon dioxide concentration causes headaches, tiredness, and problems with concentration (STM, 2003, 2009). Also, cognitive performance declines as CO2 concentration increases. Satish and colleagues (2012) have concluded from their research that there is a significant decrease in cognitive

performance when the carbon dioxide concentration rises from 600 to 1,000 ppm. At 2,500 ppm, cognitive performance is significantly reduced (ibid.). The threshold value for permissible indoor carbon dioxide levels in Finland has been set at 1500 ppm by the Ministry of Social affairs and Health (STM, 2003). Furthermore, research has proved that exercise and oxygen uptake improve cognitive functioning (Colcombe & Kramer, 2003; Koch et al., 2011; Olson et al., 2006; Wikgren et al., 2012), because a good oxygen concentration is vital for optimal functioning of the nerve cells involved in cognitive processes. Pupils learning outdoors, especially in nature, have a practically infinite supply of fresh air and oxygen, as they can get exercise. In our study, the pupils travelled by bike to the authentic learning environment, the farm, getting exercise and fresh air in the process. According to the pupils, this positively affected their energy in school after the intervention and even later in the week. However, while exercise, such as riding a bike in a rural setting with good air quality, does increase cognitive performance, this is not the case in an area with heavy traffic and poor outdoor air quality (Bos et al., 2013). An authentic learning environment that includes outdoor learning sessions with light purposeful exercise that is included in tasks or as part of travel to the learning environment, support pupils' learning and academic achievement.

Future research

Technology is often viewed with optimism as bringing development. At many schools, development of new learning environments is framed in terms of investments in information and communications technology (ICT), such as SMART Boards and interactive software, but researchers (Higgins, 2011; Kiilakoski, 2012) are not convinced of the superiority of technology in education. Higgins (ibid.) has stated that SMART Boards alone can be found in 20% of Finnish schools and in 90% of the schools in Great Britain and that there is no correlation with international learning assessment (PISA) results in these countries that would support the ICT. The Finnish national core curriculum (NCC) from 2004 is being revised, with the new national core curriculum to be brought into use in 2016. The NCC 2016 draft from November 2012 describes learning environments mainly as technology-based classroom learning environments. A few lines are devoted to nature-based learning environments. While ICT can be an asset when understood and handled correctly in current and future socio-technological systems, it should not be seen as a general remedy for education problems.

CONCLUSION

A remark from one of the pupils, cited above, serves as a good concluding remark on learning in an authentic learning environment: '[I]t is impossible not to learn.' This complements the dictum of L.B. Sharp that children need to experience what they are learning if they are to understand it fully (Knapp, 2000). An authentic learning environment is no lapis philosophorum for resolving learning difficulties, but a versatile learning environment does encourage learning and support learners who differ in their learning preferences. It may even, when properly planned and implemented, allow pupils with moderate learning difficulties to participate in ordinary lessons, while talented pupils gain at the same time, by being able to deepen their learning, thanks to being allowed to study many aspects of the subject for learning, at their own pace. Including authentic learning environments in education increases long-term retention of what has been learnt and improves understanding. Those involved in teacher education, teachers, and schools alike are urged to take this into account when planning and carrying out education.

'Tell me and I forget. Teach me and I remember. Involve me and I learn.'
Benjamin Franklin

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