Reaching a sustainable cultural landscape through pedagogical evaluation of technology

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Zusammenfassung – Ziel des LAMB-Projektes ist es, Schüler darin zu unterstützen, im Klassenzimmer erworbenes Wissen über die lokale Kulturlandschaft nach draußen in ihre aktuelle Umgebung mitzunehmen. Das Verknüpfen wissenschaftlicher Erkenntnisse mit Hilfe von GPS und mobilen Technologien stimuliert an technischen Spielereien interessierte Schüler, die realen Landschaften zu erkunden. Mobile Anwendungen sind besonders bei archäologischen Stätten nützlich, von denen man nur wenig sehen kann oder welche die Wahrnehmung und Interpretation langfristiger Veränderungen in der Umwelt erfordern, um ihre Bedeutung zu verstehen. LAMB vermittelt gleichzeitig verschiedene standortbezogene Informationen, wie z. B. Karten, Bilder oder Texte, sobald die entsprechenden GPS-Koordinaten empfangen werden. Es ermöglicht zudem die Visualisierung von Landhebungsprozessen mit Hife von Höhenlinien, thematischen Karten oder rekonstruierten Küstenlinien. Die Verwendung von technologisch anspruchsvollen Materialien in der Schulbildung entwickelt die Forschungskompetenz der Schüler und verbessert ihre Möglichkeiten, sich selbständig zusätzliches Wissen anzueignen. Auf Grundlage unserer Studie zeigen wir, daß LAMB die Möglichkeiten von Schülern verbessert, ihre lokalen Kulturlandschaft zu erkunden und sich mit ihr zu identifizieren. Das pädagogische Modell von LAMB verbessert die Fertigkeit der Schüler, sowohl die Interaktion zwischen Menschen und ihrer sich verändernden Umwelt wahrzunehmen als auch den menschlichen Einfluss auf die Landschaft zu verstehen.

Schlüsselwörter – mobiles Lernen, Archäologie, georeferenzierte Information, Kulturlandschaft, Umwelt

Abstract – The objective of the LAMB project is to link knowledge gained in the classroom to the local cultural landscape by taking education out into the actual environment. Mediating scientific knowledge with GPS and mobile technology encourages gadget-oriented pupils to explore real landscapes.
Mobile applications are especially useful in archaeological sites which have only a few visible elements, or which require perceiving and interpreting the long-term changes in the environment in order to understand their meaning.
LAMB presents simultaneously different location-based materials, such as maps, pictures and text when receiving targeted GPS coordinates. It also enables visualization of the land uplift process via contour lines and thematic maps or reproduced shorelines. Utilizing technologically sophisticated materials in school education develops the research skills of the pupils and enhances their possibilities to acquire additional knowledge independently.
Based on this study, we argue that LAMB enhances pupils' possibilities to explore their local cultural landscape and to identify themselves within it. We also argue that the pedagogical model of LAMB enhances pupils' skills to understand both the interaction between people and their changing environment and the human impact on the landscape.
Key words – mobile learning, archaeology, meaningful learning, craft process, geolocation, landscape studies, evaluation, environment

1. Introductory

Environmental competence has perceptual, cognitive, affective, behavioural and personal components (Pedersen 1999). With those components we evaluate, use, feel and cope with the environment, and at the same time learn about it. We also read the landscape through constant perception, cognition and action (Krogh et al. 2008).

Attaching the information students learn in a class to the cultural landscape gets new dimensions when the teaching is implemented with technology that is perceived as interesting and familiar by the students. An example of such technology is LAMB (PULU in Finnish), a mobile application designed for hand-held devices for on-site interpretation. LAMB is especially suitable as an interpreting tool in environments where traditional signs and paths would interfere with landscape perception. Between 2008 and 2012, LAMB has been used to teach pre-historical and historical environments for students in the Satakunta region in southwestern Finland. Field tests and an evaluation of the platform have been conducted in the municipality of Eura, located in the middle of the region. Eura has a rich and distinctive archaeological heritage due to the land uplift processes. The current work with LAMB system focused on two areas in Eura, the village of Kauttua and the surroundings of the village of Panelia.

In the Learning and Mobility (LAMB) project, a pedagogical model has been developed and tested for using information and communications technology (ICT) in functional and collaborative learning. The model is based on a socio-constructivist view of the learning process. This point of view includes taking meaning into consideration when planning and organizing teaching and learning. Meaningful learning (see Section 4) can be achieved by providing the learner with a suitable environment without mental or physical restrictions. Studying should be meaningful and relevant compared to the learning goals and also linked to the real world (Jonassen, Peck & Wilson 1999, Jonassen 1995).

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This paper first briefly presents the technical part of the LAMB project and after that focuses mainly different aspects of the pedagogical evaluation and research process of the project and the use of LAMB as a learning environment in different testing groups.

The history of the program and its use in the archaeological sector has been presented and published earlier, e.g. in CAA 2009-2010 and other IH-conferences (e.g., Ernst, Uotila, Paalassalo & Huvila 2013, Huvila, Uotila, Paalassalo, Huurre & Veräjänkorva 2008, Uotila, Huvila, Paalassalo, Helenius, Lindholm, Lääperi, Puolamäki & Wahlqist 2010, Uotila, Huvila & Paalassalo 2011). It has been shown that the LAMB learning environment can diversify and invigorate learning in many different ways. It enables taking education out of the classroom environment and into the real world, and gives pupils a more active role in the learning process. At the same time, benefits can be gained from teamwork and different kinds of learning.

2. The LAMB project to year 2012

The aim of the LAMB project is to develop a mobile digital guiding and learning platform. The premise of the project has been to provide students, tourists and professionals an opportunity to visit cultural and natural heritage sites by using a portable device as a travel guide and learning tool. The work started in 2001 and the first prototypes were tested in 2002-2003 using HP/Compaq tablet PCs (Vatanen, Uotila & Lehtonen 2010). The latest version was updated in spring 2012. The development of the current evolution version of the LAMB system has continued in cooperation with experts from the company Muuritutkimus, Turku University of Applied Sciences, Åbo Akademi University/Uppsala University, University of Turku, and the Municipality of Eura. The project has received financial support from The Finnish National Board of Education (e.g Uotila, Huvila & Paalassalo 2011).

The premise of the LAMB project is to take cultural heritage learning from classrooms out to the authentic heritage sites and to provide pupils and other users with enough general information and context for independent exploration of the sites. In the LAMB project, the mobile device is a tool that provides pupils with background information on the site they explore and guides exploration and discussions in the group to topics of pedagogical significance.

The system also has functionality for the creation and management of tasks and questions. The questions may be directly related to a particular environment and are intended to guide students to explore some specific aspects of that site. Depending on the chosen type of question, answers can be submitted in short written text, selecting an alternative from a list of possible choices (multiple-choice question), or by physically moving to a new location. It is also possible to use the system for other types of tasks, such as asking pupils to collect something found in the environment, planning a short presentation, or documenting something on site by taking a photograph or by recording audio.

The LAMB system is a pedagogical tool for the students, but it is also an assessment tool for teachers. The device collects data when students physically move around their outdoor environment. The movement of the students can be used to assess their interest in the different aspects of the landscape and route, and to detect possible challenges and problems with the routes. All of these observations can be used as starting points for the discussions with the students after the session. Data gathering can also be used for directly assessing the exercises. All answers to the questions presented during the walk are stored and are easy to collect from the client devices by using a USB memory stick.

The current versions of the client system have been built using Java Standard Edition. The platform was chosen because it is well established and available on most platforms including smart phones. Due to the portability requirements, the platform uses a minimal device-specific interface for accessing GPS data. At the moment, the system is running on mini-tablet PC and mini-laptop devices. The platforms provide usable screen size, workable interaction and performance for an affordable price. After the initial trials of letting the teachers edit the XML files, a Windows LAMB editor application was designed for planning of the routes.

The application consists of two parts: an editing program used for creating customized maps, routes, and interactive presentations for a cultural location, and a client program for end users that uses GPS input to present information created by the editor. The editor allows a pedagogue to create an interactive map by applying GPS data over a digital image. Images used to create a map could be artistic or historical maps of a particular location, modern geographically accurate maps, or digital photos of a map from a signpost or

tourism pamphlet. Once the map is calibrated by linking locations on the created map with their actual GPS coordinates, real-time navigation of the map is possible. In addition to creating the map itself, the pedagogue can describe a route via a chain of sight points, for which multimedia presentations can be created with the editing software. Presentation of each sight point occurs automatically as the GPS receiver on the client computer moves toward the coordinates of that point. Current location on the created map is also displayed on the client software, and the route traveled by the user can be saved and displayed for future use or later analysis.

3. The environmental learning context of LAMB

The interaction between humans and the changing environment of archaeological sites can be read from the landscape by developing environmental competence. Environmental competence has perceptual, cognitive, affective, behavioural and personal components (Pedersen 1999).

Mayer and Frantz (2004, 504) defined connectedness to nature as one´s affective, experiential sense of oneness with the natural world in their research for measuring a connectedness to nature scale. Based on this definition, one´s environmental competence can be enhanced by exploring authentic natural and cultural landscapes with environmental education methods, which are designed to awake sensitivity towards, raise awareness of, and encourage action affecting the environment.

These three components can also be found in Joy A. Palmer´s (1998) widely acknowledged model for environmental education. Palmer emphasizes the development of the sense of ownership towards environmental issues in people´s communities. Due to their landscape literacy skills, people can interpret the cultural landscape and the changes in it, and evaluate the consequences of their actions.

Connectedness to nature can be compared to connectedness to the cultural landscape, in which the archaeological sites are included. In the field of environmental education research and in environmental psychology, the connectedness to nature has been studied recently (see Perrin & Benassi 2009; Ernst & Theimer 2011; Gosling & Williams 2010).

Beery (2012) argues that by enabling people to spend time in natural settings, or to spend *friluftsliv*, in the Nordic context, modern society is able to maintain their environmental connectedness, or connectedness to nature, even in urban environments, and to promote sustainable development. He also argues that an environmentally literate citizen can demonstrate the knowledge, skills, attitudes, motivation, and commitment to work individually and collectively toward sustaining a healthy natural and social environment. This conclusion can be applied into cultural landscapes, and it supports Palmer´s theory as well.

Liefländer et al. (2012) studied connectedness with nature, and found that there are various research findings which indicate that spending time in a natural environment increases empathy towards the environment and inclusion with nature. Childhood experiences in nature are also found to be positively associated with commitment to pro-environmental behaviour and attitudes in later life.

In archaeological sites, the objective for introducing new technologies into the school curriculum is to create a bond between the pupils and the cultural landscape. Clayton (2003) emphasizes the importance of the cultural component of one's environmental identity and frames an environmental identity as a part of social identity. The key objective for environmental education in cultural landscapes is to facilitate people of all ages to engage with their cultural landscape, to create a sense ownership towards it, and to provide skills to act for sustaining it for future generations.

LAMB is designed to afford learning opportunities in actual cultural landscapes in order to promote these key objectives mentioned above, although it has been used so far primarily in comprehensive school.

4. Meaningful learning and pedagogical evaluation

Meaningful learning means that the learner is provided with a suitable environment without mental or physical restrictions. Studying should be meaningful and relevant compared to the learning goals and also linked to the real world. It would be important to support children's activity in learning in groups for the socio-constructivist view of learning to be fulfilled. This could be achieved by giving up individual school subjects and focusing on wider topics that combine several subjects. The LAMB learning environment and methods are a model for inter-subject integration.

Combining religious education and history or geography and biology could serve as examples.

Meaningful learning with technology is based originally on six independent key areas (Jonassen 1995; Jonassen, Peck & Wilson 1999). Ruokamo and Pohjolainen (1999) reshaped the criteria and added transfer as a seventh. Thus, the key areas according to Jonassen (1995) and Ruokamo and Pohjolainen(1999) are: 1. activity, 2. constructivity, 3. intentionality, 4. contextuality, 5. collaboration, 6. reflectivity and 7. transfer.

Activity in learning includes interacting with the (learning) environment, observing and interpreting the outcomes of interaction and making predictions. Activity within a community helps an individual gain knowledge, skills and understanding that they can later share with the community and create and practice something new again (Jonassen, Peck & Wilson 1999). The learner controls and monitors their actions and their effects in every learning situation. Such learning requires meaning as it includes controlling the task at hand and the environment, as well as observing the outcomes of interaction. The learners construct new information themselves and leave teachers in the role of tutors rather than distributors of information (Jonassen, Peck & Wilson 1999).

Constructivist learning theory contains many different theoretical approaches to learning (see Duffy & Cunnigham 1996). According to Jonassen (1995) and Jonassen, Peck & Wilson (1999), constructive learners integrate new experiences with prior knowledge or they establish goals for what they need to learn in order to make sense out of what they observe. For constructive learning, the learning environment should support the use of cognitive tools and favour constructible content within the learning process. The cognitive value of learning environments based on ICT is that they lighten the processing load and help the learner carry out tasks that would otherwise have been impossible to achieve.

Collaboration requires supportive dialogue between individuals. Mutual tasks and methods should be discussed between individual learners. Humans naturally act in learning communities, learning from each other's skills and knowledge. In the real world, humans naturally seek out others to help them solve problems and perform tasks. Given a problem or assignment, people seek out opinions and ideas from others. When learners become part of knowledge-building communities they learn that there are different ways of viewing the world and different solutions to most of life's problems (Jonassen, Peck & Wilson 1999). Dillenbourg (1999) sees that collaborative learning occurs only if learners carry out collaborative activities that launch usage of learning mechanisms. In collaboration, learners have the opportunity to be committed to activities (i.e. explaining, arguing) that can start specific learning mechanisms (i.e. articulating, sharing cognitive load).

Reflectivity can be briefly described as the considerations and analysis that follow experiences. It also includes linking new information with what has been previously learned by accommodation or assimilation. Von Wright (1992) sees that reflection contains four components: 1) a person does and experiences things, 2) the person reflects upon his/her experiences, 3) the person conceptualizes the new insights and uses them to shape a more adequate conception of the subject matter in question and 4) finally, the person tries out the revised theory and looks for new feedback (see also Kolb 1984). Reflectivity can be increased with teamwork which combines a wide range of learned information. Through LAMB learning (as well as any learning), goals can remain undiscovered unless pointed out, for example, by a teacher. Schools are bound by curricula leaving little room for personal goals.

Human behaviour is goal driven (Schank 1994; Jonassen, Peck & Wilson 1999). When learners try actively to achieve a cognitive goal, they think and learn more because they are fulfilling intention. Articulating intention is salient for meaningful learning. When learners articulate what they have learned and reflect on the processes and decisions that were entailed by the process, they understand more and are better able to use their constructed knowledge in new situations (Jonassen, Peck & Wilson 1999). Ruokamo & Pohjolainen (1999) divide intentionality into two views; cognitive and behavioural. In this view, intention primarily describes an individual's own actions in relation to the goals and aims. Environmental and other control factors are secondary. When learning and learning tasks are connected to known and meaningful context, motivation is easier to gain and maintain.

In learning new knowledge or constructing new schemata, the ideas to be taught should be in their natural context. This means that knowledge should not be divorced from reality and simplified too much. The learning situation is related to context and external influences. The context of learning should be natural and the materials versatile (Jonassen, Peck & Wilson 1999).

Research has revealed that meaningful real-

world tasks or simulations in a case-based or problem-based learning environment are better understood and more consistently transferred to new situations (Jonassen, Peck & Wilson 1999). Transfer means that students can use or apply prior knowledge or skills in different contexts. These key areas were used as the base of the expert analysis and the teacher interviews.

5. Producing learning material

For the evaluation research, the craft process model was used as the frame of reference for self evaluation of producing learning material. Kojonkoski-Rännäli (1999) compared craft process models. All these models described the craft process as a production process in which ideas, planning and work result in a product using authentic materials and craft tools. Characteristics of crafts include: 1. manufacture by hand, 2. natural materials, 3. craft techniques and 4. a holistic process even though it may consist of different phases and procedures.

The craft process consists of four phases: 1. creative innovating, 2. planning, 3. manufacture and 4. evaluation. Creative innovating includes taking into consideration any needs and demands for the product. Personal experiences guide the innovating process. Planning consists of gathering information, solving production problems, assessing, and finally making decisions. The planning phase involves creativity, aesthetics, technical skills and product knowledge. The plan is put into practice and possibly altered during manufacture. Evaluation includes assessing the production process and the finished product. (Virta 2006).

Evaluation of designing and producing learning material includes guided self-evaluation. This was carried out as pairs of students comparing their processes to specified frames of reference that included different phases of the craft process: innovating, planning, manufacturing and evaluation. The manufacturing phase was a special focus of interest as it represented what kind of a process making LAMB learning material was. Using the LAMB learning environment in teaching was also evaluated. Every stage of the LAMB project was documented in a learning diary using text and pictures.

The task presented to student teachers included producing one of five different LAMB materials: material for motivating and orientating fifth and sixth graders (ages 11-12) or seventh (13) to ninth (15) graders, material for educating fifth and sixth graders or seventh to ninth graders in cultural heritage, and material for tourist use. Each LAMB material produced should contain five different learning exercises or tasks.

6. Pedagogical research questions, methods and data

The pedagogical goal was to evaluate how ICT applications of the LAMB learning environment are used in functional and collaborative learning. The first stage of evaluation process in 2009 was carried out in co-operation with the developers of the LAMB learning environment and analyzed the meaningful learning aspect. The research question was: does the LAMB learning environment correspond with the key aspects of meaningful learning, giving it pedagogical value?

The second stage of evaluation was carried out in autumn 2010. Teachers (one secondary school history teacher and two primary school teachers) who had used the LAMB learning environment in class were interviewed to give a teacher's perspective on meaningful learning in the LAMB environment. The research questions were: 1. does the LAMB learning environment support teachers and 2. does the LAMB learning environment support meaningful learning? The second research question was divided into sub-questions according to the seven key areas of meaningful learning: does the LAMB learning environment support: 1. activity, 2. constructivism, 3. intentionality, 4. contextuality, 5. collaboration, 6. reflectivity or 7. transfer.

The third stage contained a study module for student teachers of crafts. During the module, the student teachers familiarized themselves with the LAMB learning environment and designed learning materials related to Old Rauma that was inscribed onto the UNESCO World Heritage list in 1991 for being an outstanding example of a living and well-preserved historical Nordic wooden town (Old Rauma website). The student teachers kept learning diaries of different parts of the module. The main goal of this research was to find out what kind of a challenge it would be for beginners to produce LAMB learning materials. The research questions were: 1. how did student teachers experience the possibilities of LAMB?, 2. how well did the student teachers do in designing and producing learning materials? and 3. what kind of a process was producing finished materials?

The evaluation project, consisting of different stages, involved different ways of sampling, gathering research material and analyzing the material, but there were still some common features. The overall aim of the project was to develop education and learning.

The first two stages of evaluation focused on the user's perspective and aimed to find out whether the LAMB learning environment supports meaningful learning and whether it works technically. The main focus was on analyzing the environment with meaningful learning as a frame of reference. Another important factor was to gather user experiences from teachers.

The first stage of evaluation compared features of the learning environment with the key features of meaningful learning. The frame of reference was modified for the second stage of evaluation and the example questionnaire (Ruokamo & Pohjolainen 1999). The content analysis method used is described in more detail further on in this chapter.

The evaluation of designing and producing learning materials included guided self-evaluation. This was carried out as pairs of students comparing their processes to specified frames of reference that included different phases of the craft process: innovating, planning, manufacturing and evaluation. The manufacturing phase was a special focus of interest as it represented what kind of a process producing LAMB learning material was. Using the LAMB learning environment in teaching was also evaluated. Twelve pairs of student teachers documented every stage of the LAMB project in learning diaries using text and pictures. The learning diaries included at least: 1. goals/innovating and planning (setting of criteria), 2. manufacturing (how was the project carried out, what materials were used, what changed from the plans, what was successful and what was challenging?) and 3. evaluation (how well did you do, how long did it take?).

Content analysis was used in the first stage of evaluation to find concrete features and functions of the learning environment that corresponded with the key areas of meaningful learning. Constructing information can be used as an example: experts analyzed what different forms of information construction the environment offered.

Content analysis can be used to categorize and describe phenomena. The method can be applied for systematic and objective analysis of documents. Directed qualitative content analysis is a research method for subjectively interpreting text-based data by systematically identifying, classifying, and coding themes and patterns within the text (Hsieh & Shannon 2005; see also Pisarik, Rowell & Currie 2012). It diverges from conventional qualitative approaches by being a more structured and limited approach. The researcher is guided by existing theory, or prior research, employing a deductive process initially, in an effort to describe a phenomenon, develop a concept, or build a model (Hsieh & Shannon 2005 see also Pisarik, Rowell & Currie 2012). Rationale for our using a directed approach was based on our research questions, which were generated from pre-existing educational theories.

7. Pedagogical results

Judging on the first stage of evaluation, LAMB as a learning environment has features that support activity, constructivism and collaboration by making it possible for the learner to participate in the learning process in a new way both mentally and physically. The environment makes it possible to individualize education and gives the learners the chance to progress at their own pace. The importance of collaboration and the learner's own activity are highlighted, as the teacher isn't constantly leading discussion but leaves more responsibility to the learners – more specifically groups of learners. Constructing information is made easier with tasks requiring more activity, and learning topics are easier to contextualize by linking materials to local history, cultural heritage or biology. Intentionality is made possible with the clear model of learning that the learning environment provides. Goals can be clearly stated in the environment, along with a model path for learning. In addition, the new learning methods and the use of new technology may provide an extra source of motivation for learners.

The LAMB learning environment doesn't provide any direct tools or features to increase reflectivity, so this area should be supported in other ways. Transfer could not be fully assessed within the evaluation project. It was speculated that individual ICT, problem solving or teamwork skills may be transferred into the LAMB environment, or skills learned within the environment may be transferred to other contexts. Over all, the evaluation concluded that the LAMB learning environment provides good opportunities for meaningful learning.

7.1. Teachers' and pupils' experiences in a meaningful learning perspective

The main stage of evaluation focused on teachers' and pupils' experiences of the LAMB learning environment. Pupils' experiences were assessed indirectly through the teacher interviews.

According to teachers, the pupils were able to learn actively in the LAMB learning environment in both primary and secondary school. Taking learning outside of the classroom made pupils more active towards learning. At the same time, the teachers were left in a more tutoring role. One of the teachers said that activity was clearly visible in pupils benefiting most from LAMB learning. Pupils were enthusiastic and were happy to share their LAMB learning experiences. The teacher's role was highlighted when forming groups for teamwork and the teachers made it clear to pupils that it was the teacher's responsibility to secure working group dynamics.

Two teachers out of the three interviewed said that LAMB methods suited their teaching style from a constructivist point of view, but the third had to alter their more traditional style to match the new requirements. Two teachers said that they tried to tutor pupils towards independence and that the LAMB learning environment supported this. One added that the LAMB style changed their role into something more chairman-like. This was confirmed by the other teachers as well, but not so directly. This suggests that the teacher's role changes from a distributor of knowledge to a tutor within LAMB education.

All interviewed teachers agreed that LAMB methods add possibilities for individualizing education. Some pupils had told teachers that they learn easier through functionality. As an example, one teacher mentioned their pupil had said: "I'm standing in the sea right now. Hey Teacher, this was once the bottom of the sea!" The LAMB learning environment makes it possible to put previously learned knowledge, skills and understanding to use. Pupils can share previous experiences and skills they might have learned outside the classroom. Teachers mentioned local history, biology and geography as examples. Using ICT made it possible for such pupils to succeed that had not been as motivated in traditional classroom education. One teacher said that pupils who had pursued a deeper understanding before did so within the LAMB environment as well. This was made clear on a trip to see local historical attractions dated to the Bronze Age. Some groups were more observant than others and noticed a signpost pointing to one of the attractions. The teacher remembered the following comment: "Let's go and see that pile of rocks for real!" Previous assessment already stated that the LAMB environment doesn't hold any cognitive tools. One teacher mentioned they had previous experience of some LAMB methods such as teamwork (in the form of making a travel brochure).

When discussing how different starting levels could be taken into account, the teachers commented that they could make sure there was someone in every group that had strong ICT skills. One teacher pointed out that there already was suitable material for both primary and secondary school and that there were also different versions to choose from.

Collaboration was achieved most often in previously mentioned teamwork. For example, pupils with higher ICT skills helped others. Literary skills were highlighted when answering open questions. Technical difficulties were a challenge for collaboration when they occurred. Technical reliability was especially important in the first learning session as pupils had high expectations towards the new learning methods. GPS malfunctions along with gaining access to instructions to GPS related tasks were amongst the most typical problems.

The next topic in the interviews was learning goals and their visibility. Highlighting the learning goals served as an introduction for the next topic and motivation for the new methods, especially within LAMB. Sessions began with discussing learning goals with pupils and ended in assessing whether the goals had been achieved by discussion or a summarizing exercise. The local history task for example, included producing a travel brochure.

Contextuality and transfer were studied through the following features: transferring learned knowledge, skills and understanding, assessing the usefulness of what was learned, and analyzing how tasks relate to everyday life. According to teachers, pupils were able to transfer what they'd learned to everyday situations in for example biology, geography and history. In biology, pupils were able to identify birds and plants in other environments. Knowledge of local history could be used for making a brochure or sharing the knowledge with friends and relatives. One teacher reported that pupils had learned about their local area once being seabed and that there was a possibility of this happening again. One pupil had mentioned this at home

and seriously considered the possibility that they would have to find a boat for safety. This implies a practical advantage and contextuality in improved awareness of the local environment. Improved ICT skills were also seen as part of contextuality. One teacher said that it will also be easier for the pupils to engage in new learning methods and changes in environment after the trial period.

The LAMB learning environment doesn't provide any direct tools or features to increase reflectivity. The teachers have key roles in making sure that this area of meaningful learning is still included; discussion and summarizing exercises were mentioned as methods. One teacher commented that monitoring one's own learning is a difficult task for a sixth grader, even if the teacher encourages it.

The last part of the interview discussed producing LAMB learning materials. All three teachers were pleased with the LAMB learning environment and hadn't experienced any problems apart from technical difficulties. The secondary school teacher commented that normal lessons aren't long enough for the successful use of LAMB methods. The primary school teachers hadn't experienced the same restriction as they were freer to rearrange their schedules. The lack of time was the main restriction for producing learning materials, though dividing tasks between teachers could be a solution. Financing arose as a restriction as well. External financing would make it possible to produce learning materials and share the teachers' burden.

The interviews made it very clear that teachers were pleased with their experiences of the LAMB learning environment. It supported their work and diversified teaching, but also brought challenges. The indirect conclusion was that the pupils found the new methods stimulating and considered them to be a welcome change. The question of whether the LAMB learning environment supports meaningful learning is more complex and includes analyzing the teacher's role. Pupils are forced to take active roles, construct information and solve problems in collaboration making activity. Collaboration and constructivism are in-built features of the LAMB learning environment.

7.2. Designing, producing and testing learning material

The other stage of evaluation assessed the process of designing and producing learning materials for the LAMB learning environment. The first research question was: how did student teachers experience the possibilities of LAMB? Most student pairs found ways to apply the concept within different school subjects (n = 12). A quotation from a learning diary states: "I found several different ways to apply the LAMB learning environment in teaching. History, biology, geography and crafts could all be studied using it." Most pairs found ways to apply the concept within crafts (n = 11). One pair commented that it wasn't worth "wasting" the few crafts lessons on such methods. The students found that the LAMB environment was best suited for history, geography and biology but some (n = 5) still said that it could be used for motivation in crafts as well.

How well did the student teachers do in designing and producing learning materials? The learning diaries showed that the students had understood what was expected of them. All students set clear goals after deciding on a target group and learning path. One idea was described: "I started thinking about local history that has been recorded really far back. We have a lot of historical attractions such as the Tuiskula Crofter Museum, Kirkkokari, St. Henry's Way, the Church of St. Henry, King's Well, Kirkkosaari and many others related to archaeological findings." The student teachers didn't experience any problems with designing, which can be explained by previous teaching and craft experiences. The pairs used their own teaching materials including text and pictures (n = 12), as background information was easily available online or in literature. One pair wanted to use video as well, but the format of the video wasn't compatible with other material. Overall, innovating, designing and producing materials were found to be easy tasks.

Most pairs (n = 9) had difficulties in forming a desired learning path that combined the previous phases, even though the individual phases had been easy to achieve. Only three pairs didn't have difficulties in using the LAMB editor, but they too recognized the possible problems. Almost all pairs commented that overall, the experience was well worth it, despite the difficulties.

Complicated file hierarchy and a complicated saving process were the biggest problems (n = 8). The students found it difficult to modify a ready model and suggested the program was probably

designed for professional use. The process of saving files within the program was also found illogical and hard to use which led to a wish for clarifying this feature. File format support was also found problematic (n = 2). Even though the editor supports MSWord files, the files didn't always open as they were supposed to. Importing text and pictures into the editor was found easy once the saving problems had been overcome. There was a lot of variation within the times spent on the editor ranging from 10 to 40 hours with the average being around 15 hours. The time spent depended on the amount of background information and pictures used as well as editing and ICT skills of the pair and how quickly the use of the editor was learned. The problems mentioned earlier also had an effect on the time spent. Overall, most pupils were pleased with their experiences and learned new methods. Many saw learning and motivating within crafts from a completely new point of view.

8. Conclusion

The student teachers' frank feedback overcame any doubts about how seeking peer approval could affect results. As a conclusion, the LAMB learning environment was found to be useful to the end users (teachers and pupils) and it supported meaningful learning. However, designing learning paths was found problematic even with expert guidance.

This is due to inadequate development, and the product is not yet ready to be marketed as an easy 'powerpoint-like' tool for teachers. The great potential of the LAMB learning environment was visible in the results and it could gain high importance if compulsory education is developed towards context and project-based learning. The research could be taken further by analyzing how the learning paths produced by the student teachers work in practice. Another topic for further research is to study how well knowledge, skills and understanding learned within the LAMB learning environment can be transferred to other contexts.

The LAMB learning environment was designed to be used in windows-based tablets and smartphones. The vision was to give tools of a different type of professionals (teachers, museum curators, archaeologists) to produce differently devised learning material. The pedagogical evaluation process shows us very clearly that the idea of learning outside of the classroom was working well, and the need for tools to make small-scale projects is expected to grow in the future when technical systems are ready to make use of information outdoors.

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