Mobile Learning with Moles:
A Case Study for Enriching Cognitive Learning
by Collaborative Learning in Real World Contexts

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Abstract: In this paper we discuss the results of a mobile learning project a young art teacher in training conducted with fifth graders at a local higher secondary school in Germany. In contrast to stationary learning, effectively employed mobile learning technology provides students and teachers with the flexibility and the freedom to reach educational goals while interacting with meaningful content on-site. The learning value of this process is not unlocked automatically, but depends on the appropriate software, devices and didactic design to foster successful mobile learning. An in-depth analysis of the given project is beneficial to a more general understanding of the requirements to turn a mobile learning project into a success. The results are of special interest to rather inexperienced teachers in training who want their students to benefit from making mobile learning scenarios a feasible addition to their day-to-day work inside and outside the classroom.

Introduction

Mobile learning is a promising way of addressing aspects that can otherwise diminish the learning value of traditional classroom-bound learning, which often leads to a theoretical and abstract presentation and discussion of insufficiently contextualised material (Melzer et al., 2007). Csete et al. point out that raking up the benefits of mobile learning scenarios in any educational context will not be a matter of a single application (Csete, et al., 2003):

> *"Rather a portfolio of capabilities and support options will likely create a combination of usefulness and perceived value-added that will engage students, instructors and institutions."*

This is not only true with regard to the emerging mobile learning applications, but also applies to the way teachers should be supported in further adopting mobile learning scenarios as part of their day-to-day teaching. (Kukulska-Hulme; Traxler, 2005). The opportunity to integrate the use of portable computational technology into learning scenarios is a part of the two-year compulsory training program offered by the Institute for Quality Development at Schools in Schleswig-Holstein (IQSH)[1] in connection with local schools to further prepare graduates with a teacher's degree for their work. In the course of this program the future teachers document their learning processes in portfolios and write papers reflecting on their educational goals and projects. Another element that contextualized the project and influenced its outcome is the overall framework of the school system in general. Typically, after spending four years at primary school, the students change to different kinds of schools. The main indicator to justify this controversial allocation process is the development of cognitive skills. Thus most of the students involved in the project are highly capable of constructing abstract knowledge at an early age.

In general, context is a feature that becomes more flexible when portable computational technology is integrated into learning scenarios. There is no longer a fixed and well-defined space for learning, but also multiple and intertwined learning scenarios. Sharples et al. emphasize the dynamic construction of context by learners, which means that learners carve out their learning paths by interacting with all available features of their environment at a given time and location (Sharples et al., 2005).

Project

Within the project the students explored a local cathedral (Lübecker Dom) that lends its name to their school (Oberschule zum Dom). Their teachers initiated the project by providing a timeframe, the overall topic and different

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[1] http://www.schleswig-holstein.de/IQSH/EN/IQSH__node.html

sources of information about the church. After a first brainstorming in the school, the students visited the church and afterwards articulated an initial set of questions. Their next step was to familiarise themselves with the software system Moles (mobile learning exploration system) we designed to support mobile learning as an individual, constructive and creative process (Winkler et al., 2008, Melzer et al., 2006). The system is comprised of different applications that have been successfully used and evaluated within educational contexts for more than four years. Afterwards the students created a mobile interactive questionnaire to guide their second visit to the church. As illustrated in Fig. 1, we provided an application, which supported the creation of questionnaires on a PC.
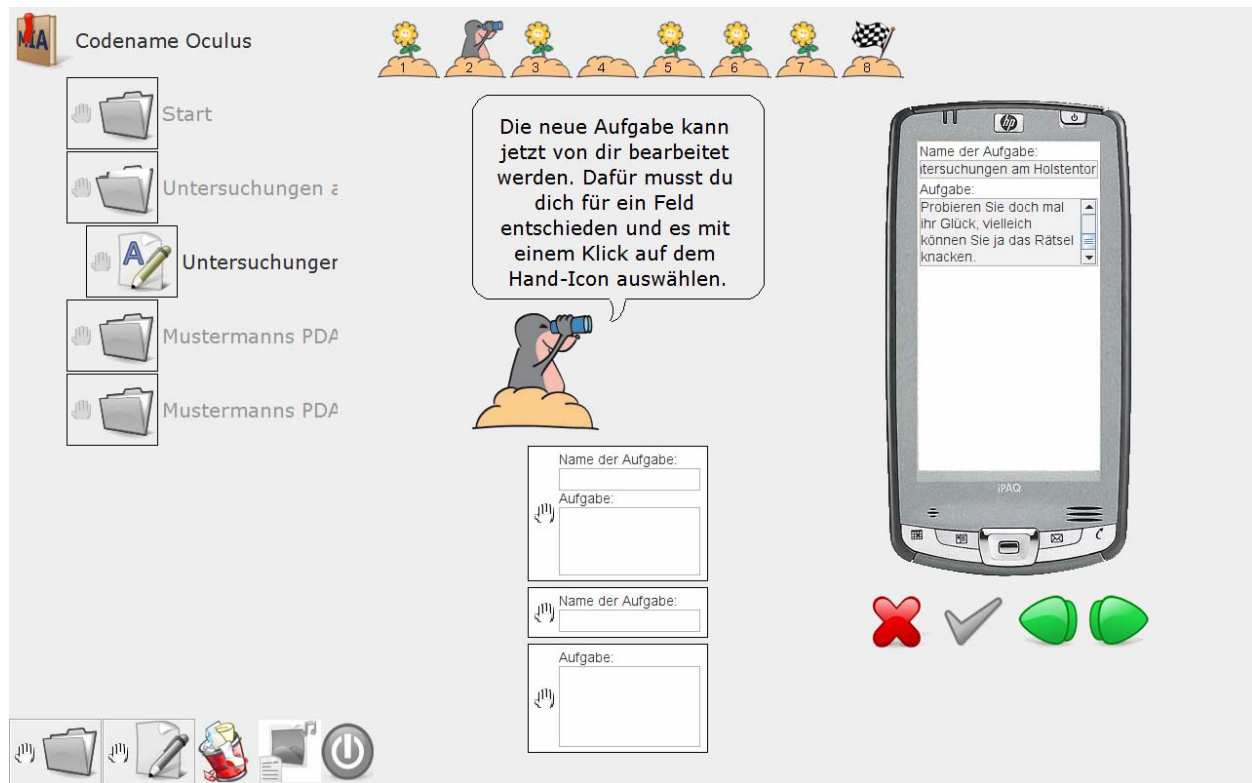

Figure 1: Screenshot of the mobile learning questionnaire creator for the mobile learning application on a PDA

Methodology

There are different sets of qualitative information that are fitted into an iterative methodological framework to reflect the interdependencies of a project like the one at hand. That allows drawing conclusions on the students' and the teacher's perceptions and reflections on the basis of integrating seemingly disparate data. With the exception of a post-research questionnaire designed for the students, this approach utilizes data routinely generated to document the mobile learning projects as a part of the overall activities at school.
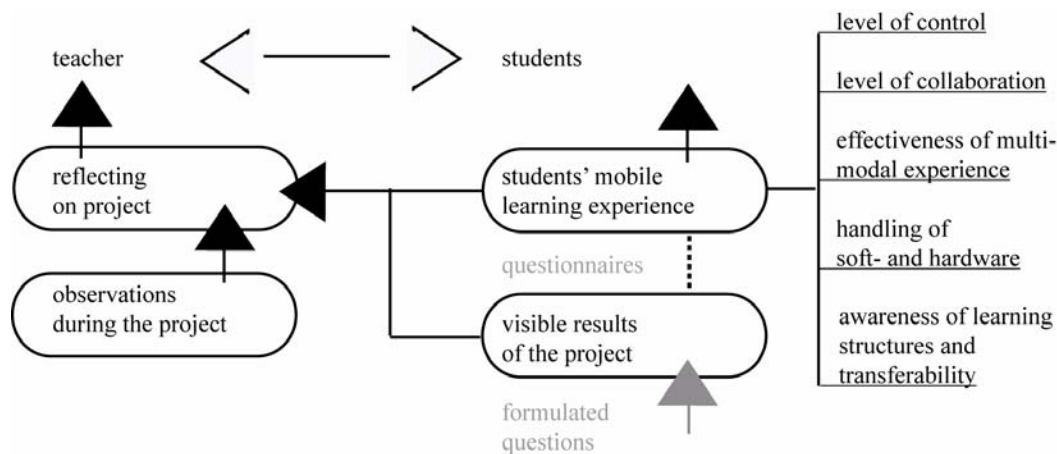

Figure 2: Integration of data

Especially when studying complex phenomena, like mobile learning scenarios, combining and relating various kinds of data contributes to a better understanding of the project at hand. The term *triangulation by method* describes the gathering of information on the same phenomenon using more than one method, which leads to an increase in the validity of the results (Meijer, P. et al., 2002). This framework for integrating the data collected at different phases of the project is based on combining the visible results of the projects, e.g. formulated questions, with the observations and subsequent reflections by the teacher and the students.

Evaluation

The associations the students came up with during the brainstorming sessions on their school and the church show that they connected their new school with the people and the places they have become familiar with during the months they have already spent there. They mentioned teachers, fellow students, subjects, special places and events related with their school. While brainstorming on their knowledge about the church, they organised their thoughts along similar categories, interlinking their school with the church, which underlines that the overall topic of the project built on their previous experiences.

The initial set of questions formulated by the students shows an almost purely cognitive way of addressing the particularities of the local church. These are some typical examples of the students' questions:

- When was the church built?
- How many chairs are there in the church?
- How much does the church weigh?
- What is the length of the church?

Answering these questions on-site is either impossible or may turn mobile learning into a nice to have add-on that can make counting the chairs more fun. Consequently, a software system is indispensable that does not rely on the delivery of pre-structured content, but enables the students to develop and modify their questions on-site. The students quickly and independently realised that they had to change their approach and came up with questions

combining cognitive reasoning with other skills, e.g. coordinated movements or the ability to concentrate on ambient sounds. These examples illustrate the qualitative changes in the questions and tasks formulated by the students while using PDAs.

- Walk through the church while carrying a book on your head.
- How many children are needed to encircle a church pillar?
- What sounds can you hear while pressing an ear to a wall of the church?
- What does it feel like to lie down on the church floor?

Results of post-project questionnaire

A standardised post-project questionnaire for the students was designed to access their assessment of four intertwined constructs indispensable in defining the educational value of mobile learning: the level of collaboration, the level of control, the effectiveness of the multimodal learning experience, and the transferability of learning structures. This choice was based on an overview of criteria commonly used to evaluate the pedagogical soundness of mobile learning projects (Syvänen & Nokelainen, 2004). Three questions were added to get information on the students' general thoughts on the suitability of the mobile devices (PDAs) and software used within the project.

The chart (Fig. 3) shows the results for the items designed to access the students' reflections on their collaboration during the project. Although all items indicate a high level of collaboration, it becomes evident that combining the results of all groups, after working on different aspects of the topic, is regarded as most important for turning the whole project into a success. Introducing mobile devices facilitated group work in spite of two key problems, which have already been addressed within the iterative design process of the mobile learning software used in the given project. First of all, there were not enough PDAs for all students so that some of them complained about having to compete for the devices. Secondly, the software did not enable the students to become aware of the other groups' current activities.
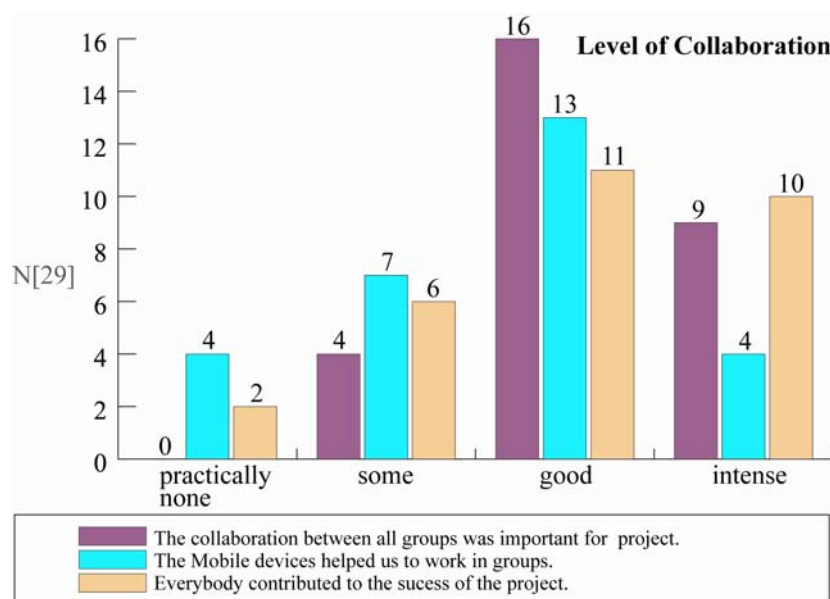

Figure 3: Level of collaboration during the mobile learning project

As far as the level of control exercised by the students is concerned (Fig. 4), most of them felt that they did not have much say in shaping the topic of the project. In his paper on the project the teacher also pinpoints this as a possible weakness, but argues that constraining factors, e.g. the age of the students, made it impossible to completely leave up the definition of the topic to them. Interestingly, formulating questions instead of answering pre-structures ones, which is a core element with regard to the didactic design of the employed software, helped the students to understand the topic better and thus put them more in charge of their learning process.
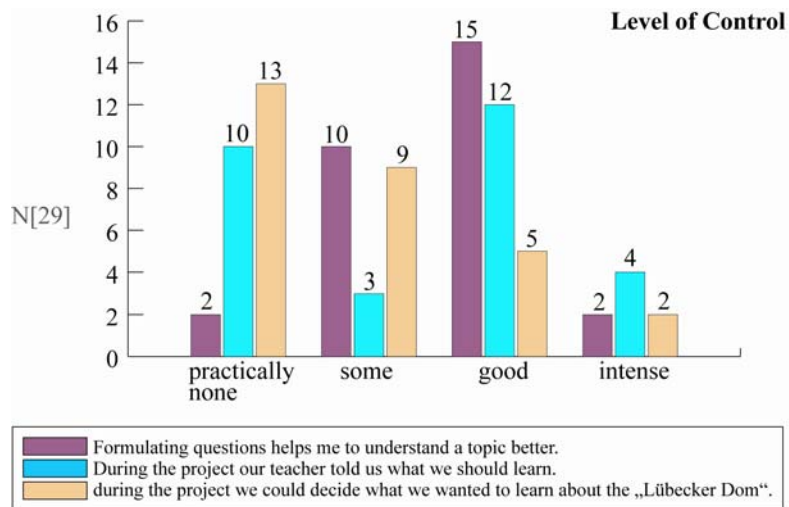
Figure 4: Level of control during the mobile learning project

The project in discussion offered lots of possibilities to connect the students' activities to previous and future work. As the Luebeck Cathedral lends its name to their school, the students could explore an immediate and relevant part of their surroundings. The items designed to elicit the students' reflections on the possibility of transferring their knowledge on the Luebeck Cathedral to related topics indicate that this aspect did not get enough attention during the project, e.g. twenty out of twenty-nine students felt that they could not use their results from the project to work on new topics. As far as related topics, such as other local churches, are concerned, the students were more or less divided with regard to the usefulness of their knowledge. Consequently, the students need to experience that an enrichment of their learning structures, such as the ability to come up with less cognitive-orientated questions, will be only beneficial to them in future learning contexts if they recognise its transferability. Especially if rather young students are involved, this aspect must be given proper consideration when designing mobile learning projects. This helps to prevent them form turning into nice to have add-ons that are not well integrated into the past and future learning experiences the students are likely to have at their school.

With regard to the effectiveness of mobile learning experiences, it is important to point out that 23 out of 29 students confirmed that different pieces of information, such as sounds, pictures and shapes, come to their minds when they think of the Luebeck Cathedral. As the students initial formulation of questions was predominately guided by a high level of abstract thinking, this underscores the potential of mobile technology to involve all senses in the learning process, which lays part of the groundwork for the acquisition of procedural knowledge. It is necessary to bear in mind that students need to experiences mobile technology as an enrichment of their capabilities in the sense of McLuhan's *"Extensions of Man"* (McLuhan, 1964), rather than a dispensable add-on, which is just fun to use. The items designed to access the students' reflections on the mobile devices underscore this aspect. As far as the handling of the mobile devices is concerned, most students report a high level of competence.

During the project the teacher provided the students with a video camera and asked them to record scenes that were of importance to them. The resulting clips cannot be analysed by video analysis software, because they are rather short, the camerawork is shaky at times and each clip primarily reflects a single student's understanding of the unfolding work on the project. Nonetheless, the clips add a valuable layer to the analysis of the project, especially to the discussion of collaboration and control as constructs that define the educational value of mobile learning scenarios. The results of the post-project questionnaire indicate that there was a high level of collaboration among the students. The clips show the students while preparing questions on posters, they do not focus on their teacher at all. All of the students who recorded the clips devoted the bulk of their attention to the (inter)actions of their classmates.

Figure 5: Students using a less cognitive-orientated approach to explore the Luebeck Cathedral

These pictures (Fig. 5) were taken in and around the Luebeck Cathedral to document the mobile learning project. Most pictures show the students interact with the mobile devices. In these pictures a group is gathered around a student who is holding a PDA. Some pictures illustrate how the students could explore the cathedral using all their senses after they had progressed to less cognitive-orientated questions. Thus it is save to conclude that the pictures underline the changes in the students' way of grasping what the Luebeck Cathedral can stand for.

Lessons Learned and Future Work

This case study illustrates the importance as well as the difficulties of integrating mobile learning into teaching scenarios on a day-to-day basis. Within the given project the teacher succeeded in utilising the flexibility and multimodality of mobile learning to support his students in developing less cognitive-orientated approaches to learning material. To make such benefits sustainable, learners need to experience the transferability of their enriched learning structures (Sharples et al., 2002). If rather inexperienced teachers are supported in having experiences with devising mobile learning scenarios, the results cannot be "picture-perfect". Understanding the merits and the difficulties of mobile learning by interlinking data generated anyway for documentation purposes is a feasible way of evaluating small-scale mobile learning projects.

To strengthen awareness and collaboration between students the possibility to chat with other groups was added during the iterative redesign process of our mobile learning applications. Furthermore different activity levels can be chosen by the learners themselves. The results have been very promising. By designing an application for mobile phones, students no longer have to compete for devices, because they can use their own ones. Since mobile phones are widely spread among German students, they are used to them and are more likely to focus on the transferability of learning structures.

Therefore an application for mobile phones and added possibilities for localisation and awareness, such as a GPS and chat, have been developed recently to make mobile devices and the corresponding software even more beneficial to projects based on collaborative work. Presently, students can develop their questionnaires more easily and hardware independently with a browser based and simple to operate software.

Conclusion

This evaluation of a well-documented small-scale local mobile learning project conducted by a teacher in training shows that the data routinely generated to document such activities can be interlinked with a post-project questionnaire to get a more cohesive picture that can support others in evaluating their work. The most successful elements of the given project are the students' turn toward the development of more holistic and less cognitive-orientated questions, which enables them to construct and access rich and meaningful knowledge, and the high level of collaboration among the students. On the other hand the results indicate that, especially when working with young students, the valuation of previous knowledge is indispensable. Pointing the students in directions that enable them to apply their knowledge to corresponding as well as completely new topics is another key factor in successful mobile learning.

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