# Application Scenarios of Mobile Learning in Vocational Training: A Case Study of Ach So! in the Construction Sector.

**Conference Paper** · June 2017

CITATIONS
0

READS
46

**4 authors**, including:

Marjo Virnes
Aalto University
**36** PUBLICATIONS **188** CITATIONS
SEE PROFILE

Markus Manhart
Apracor GmbH
**15** PUBLICATIONS **68** CITATIONS
SEE PROFILE

Stefan Thalmann
Graz University of Technology
**57** PUBLICATIONS **301** CITATIONS
SEE PROFILE

# Application Scenarios of Mobile Learning in Vocational Training: A Case Study of Ach So! in the Construction Sector

Marjo Virnes
Aalto University, School of Arts, Design and Architecture,
Department of Media, Finland
marjo.virnes@aalto.fi

Janna Thiele and Markus Manhart
University of Innsbruck, School of Management,
Information Systems, Austria
{janna.thiele, markus.manhart}@uibk.ac.at

Stefan Thalmann
Know-Center
Graz University of Technology, Institute of Interactive Systems and Data Science, Austria
sthalmann@know-center.at

**Abstract:** This study explored the application scenarios of a mobile app called Ach So! for workplace learning of construction work apprentices. The mobile application was used for piloting new technology-enhanced learning practices in vocational apprenticeship training at construction sites in Finland and in a training center in Germany. Semi-structured focus group interviews were conducted after the pilot test periods. The interview data served as the data source for the concept-driven framework analysis that employed theoretical concepts on mobile learning as well as workplace learning. Case studies showed the applicability of mobile learning to vocational training and education at construction sites and demonstrated possibility to improve information literacy.

## Introduction

Construction industry is a trade where working and learning environments are complex and changing even conservative and traditional especially when compared with an agile startup scene. Working, and thus also learning, takes place in physical environments where tasks, co-workers and work contexts change and where learning and knowing is tacit, learning happens on the job and is even infrequently spoken about (e.g. Eraut, 2007; Pink, Lingard, & Harvey, 2016).

In this kind of working and learning environment, the trade continuously looks for new solutions and practices to crucial matters, such as safety at work, well-being, workplace training, quality control and transferring innovations from one site to another. The trade is well aware of possibilities that digitalization is providing and uses for instance Building Information Models (BIM) technology, mobile technologies and augmented reality applications for gaining profit and improving competitiveness. The new technologies require new practices and changes in processes that at the end require new skills, competence and learning from workers. Improving the competence and skills of workers requires organizations to rethink about what is learning at work and to redesign how learning happens at work. As for workers, improving competence and skills requires increased awareness about learning and learning activities.

We conducted two case studies, one in Finland and one in Germany, that aimed to impact learning practices at work by using Ach So! mobile application prototype for supporting learning at the workplaces. As we aimed to evaluate the developed mobile application prototype and change practices at work as well, we approached the task via design research and action research practices (Cole, Purao, Rossi, & Sein, 2005). Exploratory case studies introduced the mobile application to construction apprentices in Finland and in Germany and thus aimed to change their daily work and study practices. Piloting interventions were evaluated and reflected by using qualitative methods that searched answers to two research questions: 1) how are mobile devices and mobile applications

adapted for workplace learning in the pilot groups? and 2) how did mobile devices and mobile applications impact current learning practices in the pilot groups?

## Theoretical Background

### Learning at Work

Informal learning is seen as the most important way of learning within the workplace (Boud & Middleton, 2003). Informal learning is hard to "standardize, systemize and assess" and thus difficult to integrate into traditional educational programs (Marsick, 2009). However, there is evidence that learning at the workplace takes place in an interaction between formal and informal learning opportunities (Eraut, 2004; Tynjälä, 2008). The latter are especially important to connect learners with their peers, to connect learning more tightly with work practices, so that informal learning enables and supports the development of innovations at the workplace (Ley, Cook, Dennerlein, Kravcik, Kunzmann, Laanpere, Pata, Purma, Sandars, Santos, & Schmidt, 2014). Social and sociocultural learning theories (e.g. Vygotsky, 1978) consider individuals as developing personal expertise through guided experience with experts or more advanced peers who help them to internalize the organizational culture and practices. Hence, mobile devices connecting peers and to facilitate learning directly in workplace settings are considered promising in this regard (Pawlowski, Bick, Peinl, Thalmann, Maier, Hetmank, Kruse, Martensen, & Pirkkalainen, 2014).

### Contextual Learning Framework in the Construction Sector

A theory-based paradigm shift from the conventional text-based methods of learning to embodied knowing and learning in construction industry can take place through digital technologies and by using a contextual model of learning (Imel, 2000; Falk & Storksdieck, 2005). Contextual learning, that includes physical, personal and socio-cultural aspects, reflects modern understanding on learning and thus provides a conceptual and theoretical platform for transforming practices at work. As a learning paradigm, it is based on socio-cultural learning theories (e.g. Vygotsky, 1978) and constructivist ontologies that emphasize knowledge construction, constructing knowledge on prior knowledge and creating knowledge in interaction with an environment and other people. At construction sites, that mean learning in situ in actual working environment, contextual learning means learning from real working processes and with co-workers. Responsibility for learning is on a learner and instructors or an environment supports the learning process.

At construction sites, the physical context is changing and dynamic in many ways including tool artifacts to work with, constructions as a target, and people to collaborate with in order to complete the construction tasks. Thus, also learning is connected with that physical environment, with tasks, work processes and people but seldom has a visible identity in the environment. The physical environment emphasizes working processes, not learning processes, which makes learning at construction sites tacit, learned on the job, infrequently spoken, and appearing as a formal written knowledge and informal ways of knowing (Pink et al., 2016). The physical environment is however authentic and makes a good use of previous professional knowledge and connects it with new knowledge that workers gain on the job. Personal context brings individual motivation, expectations, prior knowledge, interests and beliefs in working and learning environment, which have an impact on learning. Vocational education and training (VET) creates a background and learning on the job extends professional expertise but attitudes and motivation define learning as well. As learning happens also in the socio-cultural context, working culture and habits impact on learning. For instance, construction sites are perceived primarily as working environments, not learning environments, which can hide learning and thus be an obstacle to change.

### Mobile Application for Contextual Learning Framework

Mobile technologies require conceptual innovations and a theoretical basis beyond in order to keep the change meaningful – not making a change just because of new technologies available. The contextual model of learning serves as a justified standpoint for the design and development of mobile learning applications, such as Ach So! that was used as a learning tool in this case study. Ach So! mobile application is a theory-based application for carefully designed learning purposes that emphasize learning via knowledge creation, reflection and sharing of

knowledge and experiences (Leinonen, Keune, Veermans, & Toikkanen, 2014; Virnes, Purma, Bauters, & Leinonen 2015). See Fig. 1.

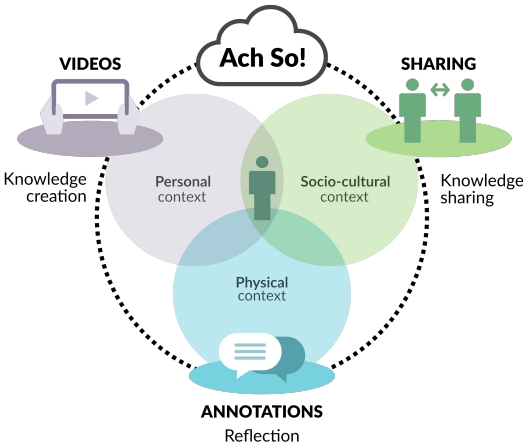


**Figure 1**. Mobile learning with Ach So! in the contextual learning framework

AchSo! (Fig. 2) is an open source high-end mobile application prototype (Android, iOS) for video recording, annotating and sharing. It was designed for workplace learning in construction and healthcare (Bauters, Purma, & Leinonen, 2014; Virnes et al., 2015), as knowledge in these fields is often highly contextual. Within informal learning processes, Ach So! particularly supports knowledge creation by videos, reflection by annotations, and knowledge sharing by delivering annotated videos to others.

With Ach So!, users record short videos, add textual annotations and share the annotated videos. Annotations are placed to points of interest on the screen and are displayed in the video timeline for quick navigation. Videos are shared in cloud with groups of co-workers and collaborators or publicly to Ach So! users. Special features that make Ach So! unique compared with other applications are 1) an easy creation of annotated videos, 2) possibility to add annotations to the videos of other authors, which increase interaction between workers, 3) a controlled sharing of annotated videos with selected groups of people, 4) a keyword-based search function that results in videos from an extensive repository of the Ach So! videos in cloud and plays only the selected points of videos according to search.

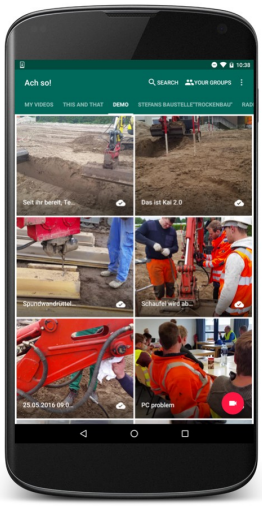


**Figure 2**. Ach So! mobile application: create, annotate, share

**Research Methodology and Settings**

We conducted qualitative field studies that aimed to investigate the high-end mobile application prototype, Ach So!, to the needs of workplace learning (Tab. 1). In addition, we aimed at identifying learning practices in vocational training and education, which the application could support. For that purpose, we conducted the field studies in two cases to have more diverse settings (Yin, 2003). In both settings, we briefly introduced the tool and supported the participants while installing and getting familiar with the tool. After this, the participants used Ach So! in their real working environment as a part of their daily tasks according to the set schedules. Finally, we conducted focus group interviews to discuss their experiences with the tool and to identify future application scenarios.

| Case | Participants | Number of participants | Context | Duration of the pilot | Location of the pilot |
|---|---|---|---|---|---|
| Finland | Apprentices, trainers, vocational teachers, company representatives | 13 | Apprenticeship training in vocational education | 2-3 months | Construction site |
| Germany | Apprentices, trainers, | 37 | Apprenticeship training in vocational education | 4 days | Training center |

**Table 1**. Case study settings

**Case 1: Vocational Apprenticeship Training in Finland**

The study involved participants from two vocational colleges and a construction company for two to three months in the spring of 2015 and 2016. Altogether eight apprentices, three supervisors, and two teachers participated in the study as a part of an ongoing apprenticeship program called 2+1, where vocational students do two-year education at vocational school and one-year apprenticeship training with employment contracts with the company. In these field studies, apprentices, their supervisors at the construction site and their vocational training teachers used Ach So! jointly. Employers provided mobile devices for Ach So! use at the construction sites and vocational colleges. Apprentices recorded one collection of videos about their work at a construction site in order to demonstrate their skills and another collection for learning and observing safety solutions at construction site and shared the videos among apprentices, supervisors and teachers. Apprentices and teachers were interviewed after the piloting study.

**Case 2: Vocational Training Center for Construction Professions in Germany**

The study involved participants from a large vocational training center for professions in the construction industry in Germany. In the three-year period of time, the apprentices of the main building occupations attend 38-week industry-wide training. Trainers and apprentices from two pilot groups of the vocational training center used Ach So!. The first group consisted of 16 apprentices from well-building and one trainer who already used technology supported learning for an apprentice group. The second group consisted of 17 apprentices of plant operators and one trainer. Furthermore, there were two trainers of other occupations who led the courses of the two given groups and therefore also used Ach So! for their courses.

To collect qualitative data on the experience with and impact of Ach So!, regular interactions with the pilot groups took place. Therefore, both groups had a kick-off and a final workshop. They used the tool within a time span of four months (05/2016 - 09/2016). Qualitative data were collected through focus groups and semi-structured interviews during each workshop. The apprentices should use Ach So! for vocational training at the center but also for their work at the construction sites. Therefore, they all installed the App on their personal devices.

**Research Data and Analysis**

Recorded and transcribed participant interviews and field observations were the main sources of the research data that were analyzed by using qualitative content analysis. The analysis focused on the design principles on learning, i.e. learning by creation of learning materials, reflection and sharing of experience, and explored how these principles were realized in the use of mobile application. The analysis followed inductive reasoning and grounded findings on the interview data at the initial stages of analysis on both cases. Design principles of the technology artifact framed the analysis on the combination of both cases by setting the focus on knowledge creation, reflection and knowledge sharing.

**Results**

The use of Ach So! showed the special requirements of building trade for mobile devices as a learning tool at workplaces. An analysis of the interview data from the field tests highlighted several expectations on Ach So! as a learning tool in the field of construction and showed some challenges of mobile devices at workplaces as well. In the following, the results of two case studies are presented.

**Case 1: Vocational Apprenticeship Training in Finland**

Mobile learning and mobile applications provided working solutions to the current challenges of vocational training. In 2+1 training period, students worked and studied as apprentices with employment contracts and completed field-specific tasks according to the school curricula requirements, personal study plans and tasks available at a given construction site. At the construction site, apprentices had personal supervisors who guided their work. In addition, a vocational teacher made occasional monitoring visits. In case of many apprentices doing their trainings at the same time in different locations, vocational teachers may have difficulty in monitoring apprentices' processes regularly enough. Mobile application made also learning and monitoring mobile by enabling the progress monitoring at distance via shared videos.

One part of vocational studies was the demonstration of skills that the apprentices typically perform during training at a vocational school or at workplace, if it is possible to do a task at that construction site and if a teacher is present there. If a teacher cannot attend, for instance because of limited time and many apprentices in different locations, apprentices give the demonstrations at vocational school, which means absence from work and costs to employer. One of the main achievements of the pilot study was conducting the demonstration of skill at workplace. By using Ach So! the apprentices did not need to take a day-off and go to the vocational school to give the skills demonstration but were able to do it at workplace by recording an Ach So! video. The video presented the work done with spoken commentary and was shared with the vocational school teacher for getting initial feedback. The teacher added feedback to the video as annotations.

Practices in conducting the demonstration of skills vary between vocational schools but always consist of a written plan and demonstration, that are compulsory in all vocational education, and often also a written report with pictures of different work stages that is a requirement from vocational schools. Before the pilot, digital technologies had not been used as learning tools in training with the exception of the use of digital cameras for documenting the different stages of work for study reports. The field study and annotated videos showed that well-planned videos could cover the whole working process or essential parts of it, which led replacing apprentice's written closing report on the demonstration of skills on video.

Watching recorded videos afterwards was seen as an activity that was experienced to deepen apprentices' learning process and to make it more effective, which reflected with the purpose of Ach So! as a tool for learning by reflection. "This [Ach So!] could be thought so that it elaborates work and topics that you [apprentice] are working with. Learning will be more effective when you get back on your work by watching the video later". (teacher, apprentice). Annotations were a communication channel between apprentices and teachers in situations where an apprentice annotated important matters in the construction process and received feedback and additional viewpoints from teachers. In such situations, Ach So! was defined as a tool for individual self-reflection. In addition, teachers suggested using annotated videos instead of photos and traditional learning portfolios for creating an extensive, but focused, the collection of skills demonstrations and showing apprentices' and student's development from the first study year to the last study year.

The apprentices recorded videos that demonstrated their performance of a given task at the construction site. “I just that I shoot a video about the starting point and then about some stage in the middle of work and then I just did it” (apprentice). These videos were watched together with a teacher later and used as a material for skills test evaluation. “I could have annotated also on how these are attached [talks about a certain stage of work] here and what are the materials…the stages of work, too” (apprentice). The apprentices recorded and annotated short videos also on safety issues at construction sites, which was experienced especially as an activity for documenting the successful stages of work that may be hidden in completed construction, faults to be further reported, and good practices to be spread. An advantage that Ach So! provided to the apprentices was thus a tool for documenting and sharing experience. [see Fig. 3 as an example]

Overall, Ach So! was experienced as an application where the main features, recording a video and making annotations, were easy and intuitive to use. Construction teachers saw documenting the whole working process important to apprentices. Even though recording required preparations, meaning extra hands to hold the device and extra time for recording, these preparations were not seen as a negative action only. The preparations required considering the whole working process in advance and taking important steps into account as well, which according to teachers indicated a capability to find critical stages in the building process. “It is possible to see from the video if an apprentice has selected most important points, that are the most essential steps in construction process…it shows professionalism when you know what you your most critical stages.” (teacher)


**Figure 3**. Example of an annotated video on safety at work observations

**Case 2: Vocational Training Center for Construction Professions in Germany**

In our data analysis, we identified three application scenarios for the usage of Ach So! at the construction sites and at the vocational training center. While the pilot groups tested the tool as a support medium for their work, some changes to learning and working practices came to light. During the workshops the pilot participants got used to working with the tool but also evolved deeper understanding for how technology supports informal learning at the workplace. Hence, participants were able to express informed information about their experiences with Ach So! Three application scenarios illustrate changes in learning and working practices, which have been experienced but also anticipated by apprentices and trainers. The scenarios are (a) creation of annotated videos, (b) requesting help and guiding towards solutions, and (c) reflection on learning situations. The next paragraphs will explain those application scenarios and provide insights on the experiences of the participants with quotes from the workshops held.

Before Ach So! was used, the creation of learning material by apprentices in the training center was limited. Apprentices are rather consumers of learning material but do not actively create material like pictures, texts, or videos. Trainers also focus on short textual descriptions of instructions but do not use multimedia material.

Further, apprentices created videos with solution to basic problems for other apprentices: “We could show to first-year plant operators basic stuff like how they get an engine started” (apprentice, plant operator), and “It would be a real zinger here when you would establish workshops where we show videos to the new apprentices. We [as apprentices] already took some videos when the new apprentices would have a look in Ach So! they could see

our videos and had the chance to directly learn something from it. They would see what we did and where our problems were" (apprentice, plant operator). The apprentices highlighted the big value such videos have for their own learning. On the one hand, they liked the video format, as it was easier for them to understand physical movements and interactions. Second, they liked to see videos from peers as they use a similar language and they better understand the explanations. "Videos made by other apprentices explain things in a similar way as I would do it – so it is easier to understand for us" (apprentice, plant operator).

However, trainers highlighted the need for appropriate quality assurance routines to avoid wrong instructions shared and applied: "if the apprentices upload everything on their own, problems could occur. It could happen for example that they upload wrong videos...someone needs to check this" (apprentice, well builder). Overall, the trainers were torn between the big advantages of the peer-to-peer interactions and the loss of control they perceived.

Before Ach So! was used, the apprentices requested help from their trainers or supervisors in their companies face to face. Trainers often only provide basic information for a project, which resulted in continual requests by apprentices. However, during preparing project tasks by apprentices, trainers or supervisors are sometimes not available. As a consequence, requesting help is accompanied by longer waiting times for the apprentices and trainers felt sometimes overstrained by the number of requests.

Apprentices can use Ach So! when they face a problem during a learning situation like performing a project task by watching annotated videos, apprentices can solve their problem situation autonomously. A second variant is recording and annotating a problem video and sending it to colleagues, supervisors or trainers, apprentices can request help even though these people are not physically available: "one colleague takes a video while the other is screwing and asks how to proceed [...] a headset or telephone is not very practical for such purposes" (apprentice, plant operators).

Apprentices can increase their autonomy and efficiency by first searching for an answer via Ach So!:"The fastest and easiest way is to look for it in the Ach So!. It is faster than asking the trainer. He is often not available, so you just look it up yourself." (apprentice, plant operator). Ach So! helps apprentices to receive better guidance towards a solution of a task or problem or better understand the problem situation. For example, instructional videos from Ach So! could help apprentices to understand how to do their tasks. "For the project tasks, Ach So! could help you to understand how to pull the string best when digging the hole" (apprentice, plant operator) and "how to put the bar with the string into the ground so that you can accomplish the project task best" (apprentice, plant operator). "You just can better imagine how the result of the project should look afterwards" (apprentice, plant operator). This enhances the autonomy to solve a task and lowers the need to contact trainers or supervisors continuously.

Moreover, apprentices can also overcome their timidity to ask a trainer for help. Especially for those who are too shy to ask the trainer too often, the tool facilitates requesting help. The barrier to request help is lowered to these apprentices: "You feel stupid if you always have to ask the trainer, and then you just do not proceed with your task. You lose time. Ach So! can reduce uncomfortable situations" (apprentice, plant operator).

Before Ach So! was used, sharing experiences of learning situations was difficult. Discussions with peers were challenging as the physical environment on the construction site is important for the reflection but difficult to describe without media. This resulted in an insufficient take-up of and limited reflection on learning situations.

With Ach So!, apprentices can reflect on self-created videos but also videos created by peers. Apprentices reported that they mainly read text-based learning material momentarily and that it is harder to understand such textbook descriptions: "Ach So! videos would be nicer to watch, instead of, just what we have, reading text [...]. You can better imagine what is meant" (apprentice, plant operator). Especially, this rich capturing of the construction site and all relevant context factors makes a video particularly valuable for the apprentices. Further, reflections can be also better captured through Ach So! annotations. The video together with the annotations enables rich contextual descriptions of a problem situation or facilitating apprentices' learning experiences. As one apprentice mentions: "I really like Ach So! in the moments where the digger overturned to annotate what triggers the overturn. You understand that situation much better" (apprentice, plant operator). The possibility to annotate a problem situation in a video enhances later reflections when apprentices review the videos. Further, reflections can be enhanced through viewing annotated videos shared by others: "you can better understand, you know what you need to solve a problem, more details are given" and "you learn faster when you use tips and tricks from others" (apprentices, well-builder). See example in Fig. 4.


**Figure 4**. Example of an annotated video on work practice

**Discussion**

Within our study, it became clear that learning with mobile devices provides many opportunities for technology-enhanced learning. We showed that mobile device and particularly the possibilities to capture and annotate videos create real value to construction employees. This is particularly due to the massively increased capability to capture contextual factors. By doing so, the contextual barriers of sharing knowledge among peers can be overcome (Waizenegger, Thalmann, Sarigianni, Eckhardt, Kolb, Maier, & Remus, 2016).

Creating learning material is a big challenge and especially in time of increasing the variants of products and more and more individualized learning needs (Thalmann & Maier, 2017). User generated content is a big opportunity in this regard to create open educational resources (Pirkkalainen, Thalmann, Pawlowski, Bick, Holtkamp, & Ha, 2010). Mobile devices and applications are promising technology in this regard as they are a constant companion and provide a wide range of multimedia capabilities (Ley et al., 2014). In our study, it became clear that videos are an important medium for creating learning experience in the field. However, just the video is not enough to transport reflections and lessons learned. The annotations are crucial in this regard and they enable workers to point out their learning experience and to create additional value for other learners.

The reflection about learning material and learned knowledge can be supported with tool usage. Reflective technologies are available for traditional office settings (e.g. Fessl, Bratic, & Pammer, 2014; Fessl, Wesiak, Rivera-Pelayo, Feyertag, & Pammer, 2015). However, for out of office situations the context of work is particular important and traditional text based tools reach their limits. Ach So! can support apprentices in facilitating their learning experiences and enhancing their understanding taking their working context into account. Experiences in context can be well captured through Ach So! and enriched by annotations. Rich contextual descriptions in form of annotated visualizations allow apprentices to understand a problem situation better and to reflect on it. Uncertainties about a task can be reduced by recording a video and reassuring the plan how to solve the problem. Particularly important was the possibility to reflect in a collaborative manner and learn as a team. Thereby supervisors or trainers can see how they approached the task and what they did to solve it.

A tool allows it to reach everyone in the network in order to share learning experience or to jointly reflect on critical situations. Connecting individual learners with a social manner enhances the learner's motivation and is a first step towards a social knowledge environment (Pawlowski et al., 2014). Sharing of learning experiences can enhance apprentices' autonomous working as they first try to find a solution or help from the content provided in the mobile app and only ask a trainer or supervisor as a second step. The app can function as a medium for giving advice for certain tasks to apprentices.

Nevertheless, a precondition for knowledge sharing is overcoming temporal, spatial, contextual and social barriers experienced at construction sites and vocational training centers. Spatial and temporal barriers are the geographical separation between individuals and the time difference between problem occurrence and asking for advice. Social barriers are described as limitations to approach certain individuals (e.g. trainers, supervisors) or

access certain networks. Contextual barriers illustrate the lack of contextual information required to fulfill a certain task (Waizenegger et al., 2016).

Those barriers can be overcome by using Ach So! for sharing knowledge and requesting help. Important changes in regulations or improvements can be demonstrated in a video and thereby shared with everyone independent of their current location and the time when they will watch the video. Apprentices can use the tool to search for help instead of asking the trainer in the first place. Videos are perceived more useful as simple textual descriptions to understand an instruction for a task. The annotations add value compared with normal videos.

**Conclusions**

The construction trade and vocational training centers have a growing interest in improving practices of learning and training and work by using mobile technologies. It is expected that technologies, such as mobile devices and applications, provide solutions to known challenges in the field, such as needs for improving the practices of work documentation, developing communication between construction sites as sharing of practices, and opening new possibilities to give skills demonstrations at work.

The case study contributed to Finnish vocational education by applying mobile apps for learning at work as a pilot in the pilot. Field trials got full support from participating organizations that saw mobile technologies as a possibility for renewing practices of learning at work. The use of Ach So! mobile app continued in vocational training at construction sites after the case study and resulted in performing the demonstrations of skills at workplace instead of school and using annotated Ach So! videos for teacher-student communication and student evaluation, which is a major achievement in changing study practices in vocational education.

The results of both cases reflect the impact of implementing mobile learning in vocational training and at construction sites. User generated content in form of annotated videos is a big opportunity to create learning material at the workplace. Annotated videos are highly usable to capture problem situations while working and possible solutions in the personal context. They also support the reflection on learning content as they make the physical context of a problem situation and solutions to problems visible. Users can watch self-created annotated videos a certain time after a problem situation to reflect on this situation. They can also watch videos from others to catch interest in other topics or to see how they handle a certain situation. Ach So! can be used for requesting help through watching annotated videos in problem situations. Thereby spatial and temporal barriers can be overcome. Guiding can be done by providing annotated videos for a community or group. Both, requesting help and guiding through Ach So! help to consider the socio-cultural context of users since group-sharing can be established.

## Acknowledgements

We acknowledge with thanks the financial support of the Learning Layers project from 7th Framework Programme of European Commission.

## References

Bauters, M., Purma, J., & Leinonen, T. (2014). In-time on-place learning. In *10th International Conference on Mobile Learning 2014*. IADIS Press. (pp. 256-260).

Boud, D., & Middleton, H. (2003). Learning from others at work: communities of practice and informal learning. *Journal of Workplace Learning*, 15(5), 194-202.

Cole, R., Purao, S., Rossi, M.& Sein, M. (2005). Being Proactive: Where Action Research Meets Design Research. Proceedings of ICIS 2005. Paper 27. http://aisel.aisnet.org/icis2005/27

Eraut, M. (2004). Informal learning in the workplace. *Studies in continuing education*, 26(2), 247-273.

Eraut, M. (2007). Learning from other people in the workplace. *Oxford review of education*, *33*(4), 403-422.

Falk, J., & Storksdieck, M. (2005). Using the contextual model of learning to understand visitor learning from a science center exhibition. *Science Education*, 89(5), 744-778.

Fessl, A., Bratic, M., & Pammer, V. (2014). Continuous learning with a quiz for stroke nurses. *International Journal of Technology Enhanced Learning*, *6*(3), 265-275.

Fessl, A., Wesiak, G., Rivera-Pelayo, V., Feyertag, S. & Pammer, V. (2015). In-app reflection guidance for workplace learning. *Design for Teaching and Learning in a Networked World* (pp. 85-99). Springer International Publishing.

Imel, S. (2000). Contextual Learning in Adult Education. *Practice Application Brief,* No. 12.

Leinonen, T., Keune, A., Veermans, M., & Toikkanen, T. (2016). Mobile apps for reflection in learning: A design research in K-12 education. *British Journal of Educational Technology*, *47*(1), 184-202.

Ley, T., Cook, J., Dennerlein, S., Kravcik, M., Kunzmann, C., Laanpere, M., Pata, K., Purma, J., Sandars, J., Santos, P. and Schmidt, A. (2014). Scaling Informal Learning at the Workplace: A Model and Four Designs from a Large-Scale Design-Based Research Effort. *British Journal of Educational Technology*, vol. 45, no. 6, 2014, 1036-1048.

Marsick, V. J. (2009). Toward a unifying framework to support informal learning theory, research and practice. *Journal of Workplace Learning*, *21*(4), 265-275.

Pawlowski, J. M., Bick, M., Peinl, R., Thalmann, S., Maier, R., Hetmank, L., Kruse, P., Martensen, M., & Pirkkalainen, H. (2014). Social knowledge environments. *Business & Information Systems Engineering*, *6*(2), 81-88.

Pink, S., Lingard, H., & Harley, J. (2016). Digital pedagogy for safety: the construction site as a collaborative learning environment. *Video Journal of Education and Pedagogy*, *1*(1), 5.

Pirkkalainen, H., Thalmann, S., Pawlowski, J., Bick, M., Holtkamp, P. & Ha, K. (2010). Internationalization Processes for Open Educational Resources. Book Internationalization Processes for Open Educational Resources, Series Internationalization Processes for Open Educational Resources 51, ed., *Springer - Lecture Notes in Business Information Processing*, pp. 57-64.

Thalmann, S., & Maier, R. (2016). Needles in the haystack: Finding content worth preparing for workplace learning with the KEP model. *IEEE Transactions on Learning Technologies*.

Tynjälä, P. (2008). Perspectives into learning at the workplace. *Educational research review*, *3*(2), 130-154.

Virnes, M., Purma, J., Bauters, M., & Leinonen, T. (2015). Creating and Sharing Knowledge Through Experiences: A Case Study with Ach so! in Healthcare Education. In *Design for Teaching and Learning in a Networked World* (pp. 642-645). Springer International Publishing.

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes* (1st ed.). Cambridge, Massachusetts, the United States of America: Harvard University Press.

Waizenegger, L., Thalmann, S., Sarigianni, C., Eckhardt, A., Kolb, D., Maier, R., & Remus, U. (2016). From Isolation to Collaboration - How the increasing Diffusion of Mobile Devices has changed Practices to Knowledge Sharing in Non-Office Settings. *Proceedings of ECIS 2016*. Association for Information Systems (AIS) / AIS Electronic Library (AISeL), Nr. 62.

Yin, R. K. (2003). *Case study research: Design and methods* (Third ed.). Thousand Oaks, California, The United States of America: Sage Publications.