



DESIGNING APPLICATIONS TO SUPPORT MOBILE WORK BASED LEARNING IN THE CONSTRUCTION INDUSTRY

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Introduction

One of the greatest potentials of technology enhanced learning is to provide access to groups with previous limited access to education. Yet there has been a tendency provision for learning through technology to be focused on those already in education, rather than extending access. Research suggests that even those enrolling on MOOCs tend to already have a degree. Despite projects targeting the development of technology enhanced learning for the unemployed, for socially excluded groups or for workplace learning, particularly in small and medium enterprises, these have seldom resulted in sustainable products, programmes or innovations.

There have been many discussions as to why this might be. Ideas put forward include lack of access to infrastructure and hardware, lack of learning materials, lack of learner motivation and lack of funding for sustainable initiatives.

This paper focuses on the use of technology for (mainly informal) learning in Small and Medium Enterprises in the construction sector. It is based on work being undertaken by the four years EU IST programme funded Learning Layers project. The project is aiming to develop large scale take up of technology for informal learning in two sectors, perceived as lagging behind, the health system and construction. The consortium includes research and development partners from European universities and SMEs including two application partners, BauABC and Agentur, from the construction industry in north Germany. Agentur is a small organisation concerned with sustainable construction; BauABC is the largest industrial training centre in Germany providing training for over 7000 apprentices as well as continuing professional development programmes.

The project includes both research and development strands, aiming to facilitate and support the development, testing and deployment of systems and tools for learning. The wider goals of the project are to develop sustainable models and tools for supporting learning in other countries and sectors. This paper describes the outcomes of empirical research undertaken in the construction sector through the project as well as the co-design process contributing to the development of Learning Toolbox, a mobile application being developed for apprentices in the construction sector. The empirical research has been undertaken with a wide range of

stakeholders in the construction industry, including surveys of apprentices whilst the co-design process has focused on trainers and apprentices from the two application partners.

Work based mobile learning

A design workshop help early in the project identified a number of design ideas for initial exploration and development.

One of these, code named Sharing Turbine, focused on the use of mobile technologies to bring together informal and formal learning by construction industry apprentices in the different contexts of the training centre, the vocational school and the workplace. Whilst working conditions inhibit the use of computers in the training centre and the workplace, mobile devices are already widely used as part of the working process in construction. Furthermore, initial suggestions suggested the potential of multimedia and particularly video in the sector, with many do it yourself videos already available on sites such as YouTube.

However it was recognised that there were different pedagogical approaches to working and learning and limited understandings of how processes of work in construction would impact on such approaches. Indeed it was suggested that it is impossible to understand how such solutions could be implemented successfully in a specific sector or area of business without understanding the field. According to Weaver-Hightower's (2008) this approach towards field understanding includes four categories:

- Actors;
- Relationships;
- Environments and structures;
- Processes.

Any use of mobile technology in and for work depends on the very specific situation and general conditions within a business sector. Hence research and development for mobile digital media includes both peoples' needs and practices as workers and learners as well as specific business challenges, directions of development and needs concerning knowledge, skills and competencies. Testing and guiding the introduction of such solutions in enterprises and organisations could be understood as one kind of action research (Gstettner, 1995).

A further concern was that in innovation research, as compared with technology development in education, it is crucial to understand the importance of business perspectives. Change is expected to result in better and/or more efficient products and services. Enterprises are more focused on work processes than on learning and the use of mobile technology or digital media within the work context influences professional action, social behaviour, required competencies, work process organisation and organisational structures (see Evans, 2011). Enterprises are concerned with the possible cost of change. Thus in researching and developing mobile learning applications and digital media for use in Small and Medium Enterprises it is important to examine the possible impacts on employees and work processes as well as just the impact or potential for learning.

Researching in the field: aims and methods

The Learning Layers project is based on a process of iterative co-design, bringing together end users in the construction field, together with researchers and developers. One of the main aims of the initial research undertaken was to collect learner stories as a prelude to developing persona as part of the co-design process. Over 50 semi-structured interviews were undertaken with different stakeholders in the construction industry in north Germany. These included large enterprises, SMEs and craft trade companies, chambers of trade, industry associations and the construction industry training centre.

The interviews were designed to address a series of research questions including:

1. How do employees in the German construction industry perceive their current professional usage of mobile devices and tools?
2. What are their views about the future potential of technology enhanced learning and information management tools?
3. What is the relation to work process organisation?
4. Can technology based tools be used for (informal) learning?

The conduction and analysis of the interviews followed the open but structured procedure described by Witzel (1982), which means that there were a number of questions prepared, but the interviewees' narrative flow had priority. The interviews were summarized individually and in a second step common contents were collected and statements compared. Additional literature was used to understand some of the background to the narratives.

Research findings

Digital media in work and learning

While most teachers and trainers in Vocational Education and Training in Germany avoid using digital media in teaching (Lübcke & Burchert, 2013), employees and managers in construction related occupations had disparate attitudes towards the use of technology and digital media for learning. Some expressed fears and doubts while others spoke about their hope that the use of technology could lead to changes in professional behaviour. Some formulated concrete ideas for tools. We differentiated four lines of argumentation with i) anxious-avoiding, ii) critical, iii) optimistic and iv) pragmatically oriented ideas around the implementation of new media.

Typical anxious-avoiding arguments are concerns that the work conditions in building sites would quickly destroy technical devices and even that workers' fingers are too chunky to deal with small keypads.

On the side of critical arguments we found two main lines. On the one hand the environmental problems caused by the production, use and disposal of smart phones and tablets were emphasised. On the other hand the organizational changes caused by digitalisation are regarded as not always useful (resulting for example in information

overload) or even as a threat to working conditions. A further concern was that technical innovation could be used as a means to increase work pressure and managerial control.

In addition, several interviewees from these two groups were sceptical that digital media work be useful for their practical – mostly manual – work.

In contrast, the optimistic and pragmatic interviewees, who often seemed more familiar with Information and Communication Technologies and mobile devices, had a clear idea of how to use technology in their work places. They pointed to the advantages such technologies could bring including the comprehensive documentation of work, the enhanced coordination of work processes and the potential both to avoid mistakes and to improve quality. While the pragmatically oriented interviewees tend to look at using technology for dealing with everyday work, the optimistic group also point to innovative, not yet implemented modes of use. A number of senior managers felt that the use of mobile devices and digital media would improve the image of the construction industry, especially to young people. This was seen as important as the industry struggles to attract sufficient well-qualified applicants.

Both perspectives point to a changing world of construction, in which work pressure and the demand to document work rise. It was noted that mobile devices are increasingly being used to produce a photographic record of construction work, as part of quality assurance procedures.

Digital media in a changing construction sector

There are different aspects to on-going change in the construction sector.

At the level of tasks, those interviewed reported increasing complexity in the construction industry with the use of innovative technical devices, materials and processes, For example heavy plant machinery used for road construction is increasingly incorporating advanced technologies including satellite connections and digital recording of operations. Apprentices and craftsmen need to understand how such technical tools are working, on what the technical calculations are based and how the things they execute are embedded into the construction process as a whole.

Project and team based work organisation is increasingly replacing more traditional hierarchical organisational structures. Rather than information and knowledge being the prerogative of a site foreman, it is now distributed through the team, often using digital processes for management, planning and evaluation. Computerised Building Information Management systems are being introduced as a tool for managing and documenting construction work.

Some in-company trainers and teachers use Facebook and WhatsApp in order to support their apprentices and deal with problems – be it school related or private problems.

At the level of the construction industry supply chain, suppliers of materials and machines have moved to digital ordering and support processes. Oral interactions are being replaced or

amended by the use of digital photographs, videos, digital blueprints etc. The interviewees mentioned many examples of learning and teaching manuals that were provided online by companies and company associations.

At the level of cultural habits and practices, perhaps most important are the changing expectations of new workers who have grown up in a digital society. For many the use of digital devices and new media is natural and obvious. This includes especially the use of smart phones for communication and sharing problems and issues through photographs. is self understanding and easy. However some employers do not officially allow the use of such technologies fearing it may be time wasting.

Being aware that digital devices are already a part of the working life, we asked our interviewees about their ideas for the further development of such tools to support work and learning.

Ideas for digital tools to enhance work and work-related learning

Although many were enthusiastic about the increased use of mobile devices and digital media there were few ideas of what applications might be developed. One suggestion was the development of mobile apps providing information about occupations in the construction sector. Although such information is already available on the internet, it was felt that more young people might access it on a mobile app.

Another common idea was the increased provision of videos for example providing information about innovative materials.

There was pronounced scepticism towards what was termed as “VET researcher fantasies” for instance in developing g knowledge exchange networks. Companies were not prepared to share knowledge which was seen as giving them a competitive advantage over others. Doubts were expressed as to the use of a digital portfolio to replace the existing paper based portfolio required of apprentices. Whilst it was recognised that many apprentices do not like the amount of wording involved, merely replacing this with typing on a small keyboard was seen as of limited value.

This lack of ideas to design learning tools may be related to the traditionally formal vocational training system in Germany. There is a common perception that professional competences/qualifications are developed through basic apprenticeship training in the initial vocational training programme and further career development is available through state-defined formal educational courses (e.g. Meister, Techniker). Also, for many workers in the construction sector, knowledge is not easily exchangeable, but something that needs to be “inscribed in flesh and blood”. Although informal learning happens continuously at work by solving problems, adjusting work organisation, making and sharing experiences etc., it is not defined or perceived as learning.

The initial interviews were followed up with a survey of apprentices was undertaken with over 700 first, second and third year apprentices completing the survey. The survey confirmed the desire for more use of mobile learning resources and a frustration with the limitations of existing commercial applications. Whilst only a limited number of companies permitted the use of mobile devices in the workplace, 53% of apprentices said they used them for learning or for obtaining work related information, explaining this was in their own times in breaks or after work.

The results of the research resulted in the development of a number of personas. The results, together with the survey findings were also the subject of a series of workshops with trainers from BauABC as part of the co-design process for Rapid Turbine and later the Learning Toolbox. This is described in the next section of this paper.

Three iterations – from Sharing Turbine to Learning Toolbox

Sharing Turbine

The design idea for “Sharing Turbine” emerged from the Learning Layers Design Conference held in Helsinki in March 2013. The idea was to digitise the White Folder – the collection of instructions and worksheets with which the apprentices at the BauABC construction industry training centre work during their training periods in the centre. Currently the tasks are delivered and documented with papers collected in a physical folder. This was seen by trainers and apprentices as inflexible and difficult to use in the context of construction sites. The development of a digital White Folder, accessed through a mobile application, was seen as linking informal and formal learning and learning taking place in different venues, in the training centre, in the vocational school and in companies. Initial development included design workshops with the Bau-ABC trainers and the development of wireframes as well as lengthy and in depth conversations with both apprentices and trainers regarding the pedagogic use of new technologies for informal learning.

Rapid Turbine

The second phase codenamed “Rapid Turbine” was launched in summer 2013, with the aim to focus on selected pilot areas (road-building, pipeline-laying) that had indicated interest in serving as pilot areas and to use multimedia and video material in their training. The work in this phase was based on workshops involving both trainers and apprentices. The results were captured by producing wireframes and a clickable prototype, based on digitalisation of one task in the White Folder. At the end of this phase, an interim evaluation was carried out in the development team and discussed in meetings with Bau-ABC management and trainers. It was concluded that:

- The work of digitising existing materials was extremely time consuming.
- There was a need for more flexibility in designing applications which can be used in different learning contexts - taking into account different working environments.
- There was a need to develop tools and workflows that would allow trainers themselves to produce learning materials.

- There was a need for closer integration between the Application frontend development and the social semantic server, acting as a back end, which was being developed for use on the Learning Layers project.

Learning Toolbox

The evaluation of Rapid Turbine led to the development of a third iteration, called Learning Toolbox. Learning Toolbox is designed as a comprehensive framework that can be used for apprentice training and continuing training as well as for other services for the building and construction sector. For craft trade companies the interest in web tools and mobile technologies does not arise primarily from the context of training. Their key concerns are related to real-time, knowledge sharing, communication and problem-solving. The experiences with earlier web tools have shown that they do not necessarily contribute to optimisation of work and business processes. However, flexible framework solutions like the Learning Toolbox can be customised to their needs. Supplier companies (e.g. vendors of machinery, equipment and material) have an interest to customise their user guidelines, maintenance manuals and instructional media for different users. They also need to develop real-time feedback mechanisms to improve their error control mechanisms. From this perspective they have also shown interest in the functionality of the Learning Toolbox.

The initial wireframes and clickable prototype for Learning Toolbox have been the subject of wide consultation with different stakeholders including:

1. Trainers from Bau-ABC.
2. Apprentices in the north Germany construction companies.
3. Materials and machinery suppliers.
4. SMEs and larger companies in the construction sector.

Learning Toolbox integrates the different tools and applications that are being developed in the Learning Layers project. It provides flexible access both to customised tiles (tiles are interfaces to tools providing different functionality, but accessed through a single mobile interface, the toolbox) and to tiles accessing other Learning Layers applications. Initially, the co-design and development work for the Learning Toolbox was launched with Bau-ABC and as a response to specific needs in the construction sector.

At a technical level the complete Learning Toolbox (LTB) will have two front-end applications: the Learning Toolbox App and the Learning Toolbox Tilestore. Both will be serviced by the same RESTful but stateful back-end Learning Toolbox API. The Learning Toolbox Tilestore is meant to create, edit and share so-called Stacks. A stack is a multi-paged predefined set of Tiles that are meant to be used together in a specific context or situation. The user can use the LTB Tilestore to find, create or repurpose the Stack they need and make it available for use in their LTB App. In the LTB Tilestore, each Stack has a unique URI to make them easily retrievable by the LTB App. The loading of specific context related Stacks in the users LTB App can be invoked through QR Codes and later possibly sensors or geo-location.

Tiles can be defined to have various tasks: access to other Learning Layers applications and third-party apps, to integrate different functionality, access useful resources, access to and interaction with learning materials, help seeking, social networking videos, navigation to other pages or other Stacks and a wide range of different functionality depending on context of use and learning needs. The first release of Learning Toolbox is planned for March 2015 and there has already been considerable interest in the application from different sectors, including health care and engineering.

Interim conclusions

The Learning Layers project plans a large scale roll out of the Learning toolbox over the next two years with an extensive evaluation programme and further consultations with stakeholders including, most importantly, end users. It is only then when we will be able to conclude whether the design ideas and design processes have succeeded. However the design process and the accompanying research allow us to present a number of interim conclusions.

First, the use of mobile technologies and digital media for work based learning can greatly expand access to Technology Enhanced Learning to new learner groups. However this requires a move away from seeing mobile learning as predominantly a push technology and instead focused more functionality for communication and sharing and creativity in the workplace. Mobile learning should not be seen as a replacement for face to face learning and work based learning activities but rather as enhancing such a learning approach. Functionality needs to reflect and enhance work based activities and as such to be integrated into work and business processes.

For such design activities co-design is not a luxury of a research experiment. The full involvement of trainers and learners is needed in order to fully understand the work and learning undertaken and integrate Technology Based Learning with pedagogic approaches within the sectors. Equally it is probably impossible for e-learning developers to themselves produce learning materials due to the knowledge required of occupational work and learning. Neither is the digitalisation of existing analogue materials a particularly useful approach. Thus mobile learning tools require functionality, approaches and work flows to allow trainers to easily produce digital media themselves, and to allow learners to share their own learning as part of a digital ecology.

Thirdly the implementation of Technology Enhanced Learning in Small and Medium Enterprises will require capacity building in organisations, networks and sectors. This includes the capacity of trainers to support pedagogically the implementation of technology for learning, the development of technical infrastructure and the capacity of organisations and managements to support the use of technologies.

Finally is the importance of context in work based learning. Mobile learning applications need to be able to adapt to different contexts. These include, but are not limited to, the context of what kind of work are being undertaken, different forms of work organisation and different locations and forms of learning. In the case of Learning Toolbox, the application is

particularly designed to bridge formal and informal learning and to take account of the different contexts of learning in the vocational schools, learning in the industry training centre and learning on the construction site.

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