

Work Process Oriented Learning via Mobile Devices – Theoretical Basics and Examples for a (New) Didactical Approach

Georg SPÖTTL

Institute Technology and Education (ITB), University of Bremen, Am Fallturm 1
28359 Bremen, Germany

and

Sven SCHULTE

Institute Technology and Education (ITB), University of Bremen, Am Fallturm 1
28359 Bremen, Germany

ABSTRACT

Two problems can be identified which counteract the need for further training: On the one hand the clientele of skilled workers is not necessarily keen on further training. On the other hand the time and cost pressure within the sector does not offer any room for time-consuming further training measures far away from the workplace. This is why the project “Virtual Learning on the building site – (Vila-b)” was realized in cooperation with the project partners of the University of Bremen (Working group »Digital Media« of the Centre for Information Technology) as well as from the economy (Arbeitskreis ökologischer Holzbau e. V. and Claus Holm, pm|c). The project team has tested a concept which facilitated learning adapted to the occupational reality and supported by the advantages of digital media. The central didactical elements for the development of this further training course are the contextual and methodological orientation to real work processes as well as the use of digital mobile media which facilitate learning directly at the workplace. The present article starts with a description of the theoretical basics for learning within the work process and discusses the didactical elements which are necessary for work process oriented learning with digital and mobile media.

Keywords: Work process orientated learning, Blended Learning, competency development

1. INTRODUCTION

In European scientific circles, discussion of curricula is currently playing an increasingly important role [1] [2]. This discussion is taking place in an interdisciplinary way and is gradually increasing links to the world of work and to the employment system. The merging economic systems of the European Union provide the background and impetus for this discussion.

Education systems are thus challenged to safeguard the acquisition of competencies and to work according to standards known and acknowledged in all European countries. The further development of these systems is at the same time the political position of the European Commission, which has formulated five objectives:

1. The improvement of educational standards in Europe.
2. An easier access to learning in all phases of life.

3. The actualization of the definition of basic skills for the knowledge society.
4. The opening of general and vocational training to the local environment, to Europe and to the world.
5. The best possible use of resources [1].

In order to implement these objectives - above all, no. 4 - the quality of vocational education systems has to be improved so that they train students for widely accepted competency levels in the labour market. While the idea of a European educational policy has long been established, education and training in individual countries are carried out according to highly varied curricula structures with transfers only taking place with difficulty. There is a close interrelationship between employees' competencies and curricula. Curricula determine the framework conditions and the prerequisites for competency development. They determine the extent to which the competencies to be developed will be broad, flexible and adequate for the labour market [3].

2. LEARNING DURING THE WORK PROCESS – BASICS AND TECHNOLOGICAL DEVELOPMENTS

The paradigm change in the world of work during the 1990ies entailed a new orientation in terms of the then strongly traditional and Tayloristic shaping of the conditions of production and work [4]. This was replaced by an enrichment of the occupational tasks particularly known as the concepts of “job enlargement” and “job enrichment” [5]. This new orientation and enlargement and enrichment of work was supported by further accompanying measures resulting in the implementation of self-organized team or group work, the reduction of corporate hierarchy levels and in the continuous further development of the necessary specialist and individual competences of the staff. At the same time the companies were prepared to establish a new learning culture calling for a life-long and self-organized learning of the employees in order to successfully face the swiftly changing and ever more complex world of work.

These changes in the world of work are reflected by the structural change towards a more knowledge-intensive and complex society which is marked by a continuous and even increasing need for highly qualified skilled workers. With regard to the problems of a (at least in terms of sectors) shortage of skilled workers [6] and the long-term changes in the demographical structure, consequences

become visible for both the companies and their employees. In order to safeguard a company location in a highly industrialized country and on the conditions of the swiftly progressing globalization, strategies are necessary which help to ensure and improve the ability for innovations and the quality of the produced goods and offered services. Therefore production, manufacturing and business processes of the companies must be continuously and dynamically adapted to the work-scientific or economical developments. These developments and also further changes, such as the dominance of data processing of the skilled work or the demographic change, have an impact on the qualifications and competences of the employees and thus also on initial and further training.

So far further training models mostly work with a sequential process: There are phases without any further training for the employees due to a lack of time, the current status of orders or because further training is not deemed necessary. And there are phases when further training courses are carried through as urgent "fire fighting measures". This contradicts the basic rules of how further training measures should be organized within the framework of "lean management" which assigns a central importance to the philosophy of human resource development [7]. It calls for the establishment of a corporate culture with competence development and knowledge transfer as central and continuous elements.

With regard to this changed importance of continuing further training of the employees, the systematic linkage of learning to the work and business processes represent one option. The orientation to work and to concrete work tasks promotes the development of increasingly relevant process oriented competences. At the same time the ability of self-relied learning is in high demand. Active learning and self-reflection in the context of concrete work processes enable the workers to acquire implicit and explicit learning experiences during and/or with the aid of an action. The core idea of the approach of learning during the work process is that learning processes start where they have the highest relevance and urgency for skilled workers and companies. Current mobile information and communication technologies support the shifting of learning into the work process. This development happened in the above mentioned research project and was optimized for concrete work processes. Therefore an approach to learning with a close link to work processes during the restoration of old buildings was developed. Due to the constantly changing places of work it was obvious to focus on mobile learning as a central support for a successful coping with the work processes.

3. WORK PROCESS ORIENTATED LEARNING WITH DIGITAL AND MOBILE MEDIA – THE APPROACH

Principles of curriculum development

Learning in and during vocational work processes and/or work-oriented change in vocational training is being discussed everywhere triggering the question of sources for the structuring and shaping of the respective curricula. The task is to find out which contents should find their way into vocational education and training and how they should be structured. Contents with a special relevance for curricula are groundbreaking work interrelationships that have to be identified with the help of qualifications research. Such contents are the basis for conceiving complex learning and work arrangements for the qualification of employees for occupational fields. Numerous curriculum approaches - above all, when developed by work

scientists - reveal a work orientation. This is, however, not the only performance index for a good curriculum.

"A curriculum must not only perform better than simply answering to the needs of the labour market and to ensure that the imparted qualifications can be made use of. It must also react to the changes in the labour market and take into consideration the multi-dimensional requirements of employees/apprentices and the learning process. These are all normative determinations for the quality of a curriculum which are subject to different criteria depending on their purpose." [8]

In order to ensure a work orientation for curricula, vocational education scientific work-process analyses concentrate on the identification of work interrelationships and the dimensions of skilled workers. Scientifically oriented work-process analyses for vocational education pursue the following three aims:

1. To identify the *competencies* for coping with and shaping occupational work tasks;
2. To access the most important coherences for *competency development*;
3. To determine the *work-process knowledge* for the shaping of business and work processes.

With their three categories of objectives, i.e. *competency*, *competency development* and *work process knowledge*, these objectives hint at competing principles for the determination of the contents of curricula. Reetz and Seyd presume three different curriculum structures and approaches (science principle, personality principle and situation principle) and predicted well in advance of the introduction of learning fields that there would be an increasing importance of the principle of personality in vocational education practice and a continuous dominance of the principle of science at the macro-level with its specialized scientific structures [9]. Work-process analyses take into consideration all three principles as conceived by vocational education science [10].

The following sections will outline the example of application of work process analyses for curriculum construction. The embedding of work-process analyses into a scientifically oriented set of research instruments for vocational educational and the basic methodological concept of work-process analyses are outlined.

Didactical principles and framework conditions for learning during the work process

Since the 1990-ies the work process as a new didactical reference point has increasingly moved to the center of interest in research [11]. Within the framework of a work process oriented turning point for the areas of vocational and corporate education and training it is increasingly "demanded to make better use of the potential of the workplace as a place of self-relied and guided learning for learning processes and competence development respectively." [12] [cf. 13] [cf. 14]. The development can be traced back to different framework conditions and targets as well as to some of the latest research questions and conceptual approaches.

Technological progress and organization development

The parallelly proceeding technological and organizational developments in many companies led to the emergence of decentrally organized initial and further training concepts. Related measures such as knowledge organization, continuing improvement processes, quality assurance etc. contain learning potentials immanent in work which are a direct part of skilled work [15]. The novelty of these concepts is the use of new

learning opportunities and potentials which are present due to the development of digital media but also due to an interlinking of learning and working. The technical progress in the field of information and communication technologies also supports this development.

Knowledge as a competitive factor

The development towards more decentralized learning also has economical reasons as the resource of knowledge is of increasing importance in a knowledge and service society: For a lot of experts of different disciplines, learning during the work process and the thus acquired knowledge has currently become an important productive force in an increasingly customer oriented and globalised economy [cf. *ibid*]. By shifting learning into the work process the companies can – contrary to classical learning situations – increase the effectiveness and efficiency of corporate further training. The employees as well can take advantages from this situation: learning processes are linked to work actions and thus have a positive motivational impact. Therefore learning during the work process is likely to gain further importance also in the future.

Interlinking learning and work processes

The term "learning during the work process" has rarely been used in this context. It is assumed that adequate (work)processes with learning contents can be identified and that learning can be encouraged by coping with tasks. The authors pursue the approach that learning can be consequently shifted into work processes. The work process as such represents a complete, multi-dimensional work process in order to cope with a corporate work order, corporate problem-solving or unknown tasks. The latter must always be seen with all their implications and imponderabilities and must always aim at a work result [16]. A complete and multi-dimensional approach also reveals previous and successive processes, objects and tools, as well as work methods as elements and takes into account that this complex process is important for the individual.

From qualification to competence

The rediscovery of learning during the work process includes a changed understanding of learning objectives. Thus the focus of the learning process is no longer just on analytical qualifications and behavior imparted in educational institutions, qualifications and behavior necessary for the coping with concrete occupational work situations with the help of abilities, skills and knowledge. Moreover competence development is the primary target. The term "competence" also encompasses a person's knowledge, abilities and skills. However, these properties represent "dispositions of self-organized acting" [17]. Another definition describes competence as "availability and adequate use of (motor, cognitive and emotional) behavior for an effective performance in concrete (occupational) situations" [18].

In this sense the understanding of competence includes subjective components in the form of self-organization. On the other hand it is clearly shown that emphasis is placed on behavior required in the occupational context. Against this background the occupational scientific research aims at identifying and analyzing the typical tasks including the respective requirements with regard to their didactical importance for competence development [19]. With regard to the present case, this context implies that the complex work tasks to be found in real work processes should serve as the basis for learning situations. Learning takes place by confronting the learner with these tasks. The development of

competences can then take place during the coping with core work tasks.

Blended Learning – the integration of digital media in the learning process

The pedagogical legitimation for the use of new media in the learning process reveals a number of advantages: Technology permits more flexibility in terms of time and place and supports an active and individual learning process. These benefits on the level of the individual learner also result in cost saving effects for the companies, as well as the option to better keep learning contents up-to-date and to make knowledge available where it is needed.

In spite of these advantages which altogether underpin the objective of an increase of efficiency and quality of learning processes, a critical reflection also reveals possible "dangers" or problems: given the various requirements, the use of new media is linked to a certain technical quality. The requirements for the individuals as well as the necessary acceptance within a company in terms of medially supported and/or self-organized learning process may hamper the desired learning success.

All in all the value-added of digital media does not result from their implementation but from the didactical concept, i.e. their targeted media-pedagogical use [21]. One possible approach is the integration of different learning environments and methods into a learning concept by making use of the respective benefits. Such a mixed setting is known as the concept of "Blended Learning". It combines virtual learning phases with attendance phases in an effort to unite the potentials of e-learning with the potentials of traditional courses [22]. This is supported by a didactically adapted combination of media, medial learning offers and methods [cf. *ibid*]. As for the learning opportunities at the workplace, digitalized media play an important role and are being used as a support for learning.

The use of technology brings along a (qualitative and quantitative) extension of the interaction during a learning process: The teachers' task is the pedagogical shaping of knowledge transfer to be reached by adequate didactical-methodological framework conditions. The learners' learning strategy depends on the technical prerequisites, but also on the individual abilities of coping with technology. This perception had already been applied during the development of a didactical approach. A direct connection of learning to the work processes by mobile devices was the adequate choice.

Nevertheless the support of interactions during the learning process via the use of attendance and technological methods represents the basic idea of „Blended Learning“. The interlinking of individual learning strategies for the different learning environments results in new teaching-learning-settings whose interactive structure helps the learners to mutually benefit from their experience knowledge.

The learning concept for further training developed within the framework of the research project Vila-b basically consists of such a "Blended Learning" approach. The following learning environments are interlinked:

- Seminar (attendance phase),
- Workplace: Learning during work processes on the building site, supported by a mobile device and
- PC-workplace, to be used in the company and also at home (cf. Figure 1).

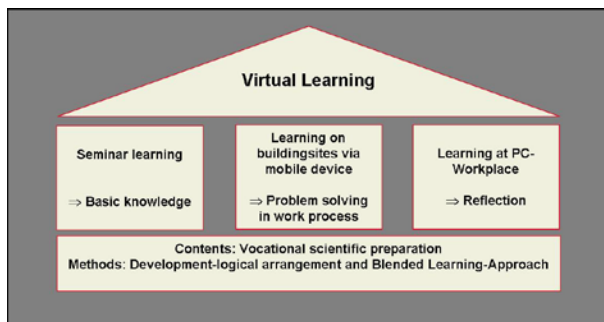


Figure 1: The learning approach

The target oriented and joint application of the three learning environments within a further training measures makes use of the respective advantages: Apart from specialized and methodological basics, in-class or attendance learning offers a direct interaction among the students and/or between students and teachers. Thus informal contacts between the students of the further training course will be established. Above all for learning processes shaped by the use of digital media it has been shown that in-class learning phases are of great importance for the later exchange of information and for the communication via the media [23]. The use of technology for learning on the building site offers new cooperative forms of learning and at the same time allows for learning processes oriented to problem solving [cf. *ibid*]. Learning at the PC-workplace calls for an active reflection of the just experienced learning processes and offers the opportunity to act in the sense of self-organized learning. Nevertheless a minimum of learning contents and learning times have to be achieved in order to meet the requirements for a successful completion of the further training measure.

The central didactical element is problem-solving oriented learning within the work process with the help of mobile terminals/ devices. Learning then takes place as soon as the skilled worker encounters a problem situation during the work process and during the execution of work tasks. At that moment, the skilled workers can access context-related information with the help of the mobile device, e.g. product data sheets, information of processing, expert knowledge of other skilled staff and other hints relevant for problem-solving. The existing detailed knowledge on the level of engineers and experts is then transferred to the skilled-worker level and is available at the required time and within the correct context. At the same time the relevance of these learning contents is increased.

4. IMPLEMENTATION: IDENTIFICATION AND PROCESSING OF LEARNING CONTENTS FOR MOBILE LEARNING DURING THE WORK PROCESS

The central question for the development of contents for a further training measure is, how competence development processes are designed and what they are based on in order to generate a domain-specific (expert)knowledge. Answers to this question can be accessed by the use of vocational scientific research methods. Four research levels and the use of adequate instruments are envisioned:

Sector analysis

A sector analysis is planned as the first step of a measure which serves as a contentual preparation for the occupational context

[20]. With the aid of a document analysis, specialist literature, occupational statistics, sector reports, market analyses, or descriptions of technological developments are taken into consideration. This measure is normally a long-term and comprehensive task and will be tackled in cooperation with experts.

Case studies - Organizational structures of occupational work processes

Case studies are suitable to determine the basic interrelationship between work organization and the relevant work tasks at company level. The result of the case studies reveals a multi-dimensional image of the company and shows work task structures, overall structure and personnel management, acting routines and change processes as well as organizational and in-firm processes.

Work process analyses

The next step is marked by work process analyses. Based on the results of the sector description, adequate companies will be selected. These companies and their employees will be accompanied during their work on building sites. The monitoring will take place during the work process and in the form of a participating observation and interviews. Special observation and interview forms have been developed. The vocational scientists are especially interested in the corporate processes, the work tasks and their organizational structures as well as how the skilled workers are coping with core work tasks. This requires knowledge of the work structures in the companies and the involvement of the skilled workers. The objective is to document the corporate work processes, the applied and relevant tools and methods as well as the competences to be developed on the level of subjects in order to enable them to holistically tackle these work processes.

Expert-skilled worker-workshops

The documentation of the performed work process analyses are evaluated and summarized. At first core work processes will be identified which have emerged from a number of work process analyses and represent the central task for an occupational group. The observations will be evaluated with the aid of clustering.

These methods help to establish an approach for the identification of central core work tasks and the necessary appropriate core competences. However, also the next step, i.e. the didactical processing of the learning contents, must be performed.

The didactical basics for the design of the identified learning contents represent a development-logical didactical approach which concentrates on competence development by working on concrete work tasks and on problem-solving in challenging real work situations.

In terms of learning theory, development logical didactics constitutes a further development which - in contrast to behaviorism - applies some elements of the constructivist approach [24]. The orientation to concrete work tasks thus clearly differs from the stimulus-reaction scheme of learning on the one hand but also from learning processes based on the mainly experience-based construction of knowledge. The orientation on real (work) tasks makes greater demands on the ability of self-learning in the context of work situations and contains active learning and self-reflection processes in the context of real work situations. In addition the perspective of holistic learning processes is in the focus of development logical didactics: Knowledge and acting form a unit and allow the gaining of both implicit and explicit learning experiences. This means that competence development is not only perceived

as a behavioral change oriented to consequences or as a mere context-specific generation of knowledge and skills. With regard to an innovative use of the mobile terminals, the application of new media cannot only be regarded as a programmed instruction or as an acting oriented simulation. Moreover it promotes real problem solving during the work processes.

Based on these reflections the question must be raised how the learning contents may be didactically arranged in a development logical order which reveals a learning development. Considerations of a respective competence model lead to a multi-dimensional implementation which differs in terms of depth and/or levels of learning contents, with regard to the specter of the learning contents and in terms of the phases of a holistic action. Therefore the context orientation of the learning contents as a result of the different work tasks is relevant.

The competence acquisition model created by Dreyfus and Dreyfus illustrates the five-level development path from a "novice" to an "expert" [25]. A slightly modified version of this approach has been discussed for some time in the German speaking countries. The contents of learning processes can be formulated as competence requirements on different levels. Nevertheless the holistic approach is being pursued and the learning contents are always focused on concrete work processes.

Comprehensive studies carried through in the health sector [26] and in the automotive sector (car mechatronic) [27] confirm the model in its basic form, above all in terms of its horizontal arrangement of competence levels. In addition these studies show the relevance of the incorporation of competences into the domain specific work interrelationships: Occupational competences are typified by a close link to the respective occupational sector and to vocational education and training.

5. FINDINGS OF THE RESEARCH PROJECT

The implementation of the approach of work process oriented learning with the aid of digital media and a further training measure based on this approach has been tested for craftspersons.

In practice a learning process was e.g. triggered by a problem resulting from a work situation of a skilled worker on the building site. The worker scanned the barcode assigned to the problematic component with the aid of a mobile terminal. The user surface then indicated all proposals or information available for the respective component. Due to the shaping of the surface, the explorative and development-logical structure of the learning contents and the intuitive operation, deeper and more detailed solutions could be found for the problems. The learning experience acquired during the execution of the work processes could later be retrieved, deepened and reflected at the PC workplace.

The mobile learning system to be developed offers additional social components to the user. The option for the generation and incorporation of User Generated Content (UGC) allows for the addition of comments on the indicated contents element. Apart from this, the skilled worker can highlight the information in order to facilitate a quick access to experience knowledge according to the current situation.

By linking of learning and working within the work processes, knowledge is generated where it originates. At the same time, active and acting oriented learning takes place on an individual level. This contains phases of holistic acting (planning,

realization and evaluation) and thus facilitates the required holistic competence development process.

However, the organisational framework conditions have to be adequately adapted. Initial and further training concepts are needed which help to develop and to support the required competences. Above all in today's digitalized world, digital media are deeply integrated into the work processes due to an increased application of personal computers and the Internet. Thus it is crucial to extend the initial and further training measures in the companies by the use of E-Learning concepts.

6. PROJECT EVALUATION AND OUTLOOK

The central question is how successful the learners are by adhering to this approach with respect to learning progress and increase in competences. But also the applicability (the present case concentrates on the learning environment "building site"), the satisfaction of the participants and companies as well as the contribution of the different learning environments and teaching-learning methods for the learning success are subjects to scientific evaluation questions. These are necessary to verify the options of a target-group adequate implementation of the learning concepts as well as the shaping of the further training contents according to a work process oriented didactical approach of learning with mobile end devices. The following topics show the most important results of the project and the main focus for further research activities:

The influence of work process oriented learning with digital media on competence development

Surveys have to be conducted in the context of work process oriented learning in order to identify the impact of Web2.0 technology on the one hand and of the individual media competences of the trainees/skilled workers in terms of competence development. The questionnaires recorded a "work process oriented competence" resulting from an interaction between know-how and the coping of work processes. Within the framework of self-assessment sheets the participants were questioned at the beginning and at the end of the further training measure. Guided interviews were carried through as an amendment. The self-assessment encompassed descriptions of the realization of individual work steps along a work process and was at the same time formulated for different competence levels from the novice to the expert (cf. 25). The results showed differentiated itemized "competency developments" which can be seen as a consequence of the specific features of the Vila-be approach, of the good cooperation of the project team during the development and realization of the further training as well as of the previous knowledge and commitment of the participants. The strong orientation along the work processes was above all a sustainable factor of success: The learners were immediately aware of the applicability of their further training measure for their daily practical work. As for the employers, a swift integration of the learning contents into the existing processes within the companies was realistic.

Options for the use and shaping of learning with digital media

The use of digital media brings along options for a qualitative and quantitative extension of the interaction during the learning process: Teachers (e.g. in the form of a tutor) must shape the pedagogical learning processes in an innovative and individually coordinated way. In addition the shaping depends on the technical prerequisites, but also on the individual prerequisites of the learners. The Web2.0 technology

emphasizes the aspect of self-organized learning [cf. 28] and enables the opportunity to establish “communities of practice” (and the use their advantages) inside of companies [29]. At the same time the potential difficulties resulting from the requirements and the acceptances by the individuals must also be taken into consideration.

Altogether the project successfully developed a further training measure within difficult framework conditions (media at the building site? Target group hesitant with respect to further training? Economic pressure?). At the same time the project yielded good starting points and results with respect to didactical issues and competence research which could be further investigated in future projects. Focus is on didactical impulses for the development of work process oriented (and media supported) initial and further training measures as well as a “legitimization” of these measures by a more output oriented competence research.

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Authors:

Prof. Dr. Georg Spöttl is Director of the Institute Technology and Education (ITB) at the University of Bremen, Am Fallturm 1, 28359 Bremen, Germany.
(e-mail: spoettl@uni-bremen.de.)

Sven Schulte is scientific assistant of the Institute Technology and Education (ITB) at the University of Bremen, Am Fallturm 1, 28359 Bremen, Germany.
(e-mail: sven.schulte@uni-bremen.de.)