

Precise and Succinct Yet Interlinked Requirements for E-learning in the Workplace

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Abstract: The goal of the study 'Learning for Production' is to develop a concept for an E-learning system in collaboration with the workers. The workers are interested in small learning units; these units should also show the connections within the working process. They would like to learn theoretical knowledge and they asked how experience could be a part of the E-learning system. The paper focuses on the relation between these expectations and the necessary consequences for computer-aided learning systems with regard to the possibilities of micro learning.

0. Introduction

"Precise and succinct yet interlinked." This statement neatly summarizes the repeated demands made by skilled workers at a paper mill when interviewed about the design of E-learning modules during our study on "Learning for Production" (LfP).¹ This demand fits in very well with the idea of microlearning. Picking up on it, one could immediately start to develop small learning units, but that would be tantamount to taking the second step before the first.

In my opinion, too much emphasis has usually been placed on aspects of technology when developing E-learning systems, and not enough attention has been paid to what knowledge is required in specific learning and working situations and how this knowledge has been traditionally acquired. This information should affect the way knowledge is presented in E-learning programmes. The probable consequences of ignoring these factors are learning systems which do not correspond adequately to the requirements of the specific learning situation.

In this paper I would like to deal with this deficit by firstly looking at fundamental aspects of the constitution of knowledge in the workplace. I will then discuss the requirements for E-learning against this background. My remarks are mainly based on the study I mentioned at the beginning, the aim of which was to develop computer-aided learning software for initial and further in-house training programmes. In addition to an analysis of production processes in the paper industry, thematically structured interviews were carried out with the skilled workers in which they described what knowledge they require to carry out their work routines and to master critical situations. Finally, the skilled workers attended a workshop at which the various

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findings were discussed, clarified and evaluated. The situation-oriented participative research approach which was chosen starts from the assumption that precise knowledge of the circumstances in which the systems are to be used is required to design computer-aided learning software and that this knowledge can only be acquired by working together with potential users of the learning system.

1. What and how?

Generally speaking, it is the task of employees in production industries to ensure that production is trouble free (cf. Böhle 2004, 17), that any problems that arise are solved as quickly as possible and that quality is maintained. What knowledge do they need to achieve this? The reason why I asked that question is that the answer has to create the foundations for computer-aided learning software.

1.1 Theoretical knowledge and experience

All of the skilled workers interviewed in the paper factory agreed that the theoretical knowledge acquired during their apprenticeship was very important. They characterized it as background knowledge about the fundamental connections between various aspects of paper production. Theoretical knowledge includes information about work routines and general trouble-shooting. It is explicit, systematized, standard knowledge and thanks to these properties it can be integrated in a text-based learning system relatively easily. However, as the workers pointed out, theory alone is not enough to ensure qualified work on the shop floor. While theory tells you about the “road signs“ or the general rules, additional knowledge is required to know how to react in concrete situations, and this knowledge is called experience. It is not only in this study that interviewees insisted that experience is indispensable. Similar results have also been obtained in other studies in the paper industry (cf. Krenn/Flecker 2000), in the metal producing industries (cf. Böhle 2004), in connection with project management (cf. Porschen/Böhle 2005) and with doctors (cf. Schachtner 1999) and nursing staff (cf. Benner 1994).

What does experience involve? Amongst other things, experience includes a good feel for materials and machines, a good ear for the noises made by machines, lightning reactions to what is going on, knowledge of the “bugs“ in systems and machines, foreseeing faults and the right instinct for sources of technical trouble (cf. Böhle 2004, 18). Knowledge of this nature is essential in order to recognize looming problems in production processes at an early stage and to intervene to deal with them; experience helps to interpret situations in all their complexity. As one skilled worker explained: “You always have to take account of so many factors, and just how easy that is for you largely depends on how much experience you have“ (stock preparation worker, LfP). According to Fritz Böhle's findings in the metal producing industries, skilled workers are able to diagnose and predict processes without stopping to analyse them (cf. Böhle 2004, 20). What is going on at any one point is interpreted by experienced workers in the light

of what has happened previously. That hones their prediction skills: “You just have a feeling that something is going to happen“ (quoted in Böhle, *ibid.*). An important facet of experience is knowledge of how things interact in situ, as illustrated by a skilled worker's comment analysing a crack in the paper: “You look at the web. Are there any indications of where the crack might have started? Is there any sedimentation? I'll be able to see it in the paper. Is there anything else I can see? Is there a clump somewhere on the edge? Then it'll crack at the edge“ (foreman, LfP).

Knowledge based on experience is founded on a close relation between worker and machine. “He (the worker) has to slowly build up a relationship with the machine“ (LfP), a foreman explained. The intimacy required here demands a differentiated, emotional and sensorial relationship to the machine. It is not enough to follow standardized parameters in order to operate the paper-making machine successfully: “I have to be able to use my eyes. It doesn't make sense to tell you what speed I set the machine at. I have to take a look at it or sense it. That's what makes a machine operator with experience stand out“ (foreman, LfP). Alongside looking, listening to the noises made by the machine is also important, as is the sense of smell, e.g. when the bearings overheat, and the sense of touch, e.g. when assessing the quality of the paper. Building up a relationship with the machine, as the foreman put it, means becoming sensitized to the peculiarities of the technology, being able to identify changes and setting the machine code to cope with changes in the raw materials. Experts operating the machine see a situation and know what has to be done; they act intuitively, backed up by their experience.

1.2 How has experience-based expertise been acquired to date?

When I know something about how expertise is acquired, I can draw conclusions relating to the didactic design of an E-learning system. Generally, the paper workers recommend learning on the job, in front of the equipment, either by observing or by being trained by experienced workers: “To start with the apprentices get to know the general surroundings, where things are and what things are happening (...) and then you have to tell them how you can influence certain things“ (1st assistant, LfP). On the basis of this knowledge, which can be defined as basic knowledge, the apprentices have to make their own experiences with what is going on. Learning by doing is stressed as the most important way of appropriating knowledge: “I have to do it myself and then I know, aha, that's how it works“ (1st assistant, LfP). Seen from the point of view of learning, when a mistake is made, it forces learning to take place, as was repeatedly emphasized. “Pushing the wrong button is the best way of learning“ (1st assistant, LfP). Mistakes initiate learning processes with lasting effect because people are emotionally involved in what they have done wrong; they are annoyed, embarrassed or frustrated.

The high status accorded to experience by workers in the paper and metal industries as a way of acquiring knowledge is confirmed in the educational approach formulated by John Dewey: “The analysis and rearrangement of facts which is indispensable to the growth of knowledge and power of explanation and right classification cannot be attained purely mentally – just inside the

head. Men have to do something to the thing when they wish to find out something; they have to alter conditions“ (Dewey 1949, 359).

2. Gearwheels which mesh: How to integrate theory and experience

Just to pose the question again: What is the relationship between theory and knowledge when performing tasks at work? The answer to this question provides clues on how to combine both forms of knowledge in computer-aided learning software.

Knowledge from experience is object oriented and work related knowledge; in contrast to theoretical knowledge, it is geared towards particularities. It is implicit knowledge in the form of feelings, premonitions and hunches; it is holistic knowledge imbued with sensorial perceptions, emotional impressions and thought processes.

Just because I am giving more space in my paper to experience as a form of knowledge and a skill than to theoretical knowledge, does not imply that theoretical knowledge is less important. It is rather more a question of combining both pools of knowledge when dealing with work routines, or as a worker in the paper industry put it: “It's like when one gear meshes with another, you need both of them”. The expertise of a skilled worker consists in putting general theoretical knowledge into practice and in making flexible use of this knowledge, as one worker explained: “I can't say which switch has to be operated when a red light goes on as it's not always the same switch. Once it's this switch and once it's that switch, and that's why I need experience so that I can be flexible“ (1st assistant, LfP). It is experience which allows skilled workers to be flexible.

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Illustration 1: Gearwheels which mesh

Thus knowledge born of experience has just an important function as theoretical knowledge when acting and reacting appropriately in the working process. Irrespective of this function, experience tends not to have been appreciated very much so far in industrial science and in practice. The extent to which a task or job is considered qualified depends on the extent to which theoretical knowledge and abstract thinking are required. Occupational qualifications are based on a model of scheduled-rational actions while feelings and impressions, the senses and the body are classified as contributing less to knowledge (cf. Böhle, 2004, 18). This failure to recognize the importance of unfolding “subjektivierendes Arbeitshandeln” (one's subjectivity in the working process), as Fritz Böhle defines it, is the same as reducing the workers' opportunity to build up an sensorial relationship to a machine, as production processes become increasingly encapsulated.

E-learning systems also follow this trend, particularly when they reproduce the dominance of theoretical knowledge over experience with the help of computer software. This is to be expected as it is extremely difficult to develop software which takes vague, implicit, physically and sensorially related experience into account as software developing is dependent on knowledge being explicit, nameable and unambiguous. Nevertheless, it is imperative that the knowledge from experience is not ignored, unless E-learning is “pre-programmed” to fail.

3. E-learning as integrated learning

I would now like to discuss two possibilities of taking experience into account when designing computer-aided learning software: on the one hand, experience can be integrated in the learning units and on the other hand learning situations can be created which combine online and offline learning. I would like to fall back on suggestions which were developed during the “Learning for Production” project, without restricting myself just to these suggestions, and finally I will look into the possibilities of micro learning.

3.1 The integration of experience in learning systems

One way of integrating experience into learning systems is to transfer the logic of learning from experience into the system. This can happen in the form of learning paths which can branch off time and again. This gives the learner the possibility both to gain deeper understanding of specific aspects of a production process and to gain insights into how this operation relates to other operations. The learner has to make decisions as to which learning path is chosen.

Learners have the opportunity to acquire closely connected knowledge because the work process is reproduced more realistically than with a linear structure. Having the potential to branch off at any point, the learning paths follow the typical networked logic which constitutes the acquisition of experience on the job based on the interaction between the individual and the machine. A second opportunity to include connective logic in an interactive way is in the form of experimental action based on simulations, something which Gabriele Frankl will deal with in her paper in more detail.

3.2 Blended learning

The second possibility to allow enough space for acquiring experience in the context of computer-aided learning is so-called blended learning. A concrete example of this is writing experience journals in the form of weblogs, which particularly give apprentices and workers the opportunity to record observations on the job during training phases, e.g. when inspecting the machinery, in critical situations (cracks in the paper) or during repair and modification work. Recording their observations helps trainees to hone their skills of perception offline, to become

more aware of what they have seen or heard by having to express it in writing and to profit from the observations of others. The experience journal has a communicative component which is typical for the acquisition of experience on the job. Discussion forums offer another possibility to exploit communication for the acquisition of knowledge in that experienced workers can provide the answers to questions posed by the apprentices. This online dialogue between the generations can even help preserve knowledge for both individual workers and the company as a whole which would otherwise be easily lost when older employees leave the company.

Research in industrial science has shown that story telling, or simply talking about work and machines, is an informal yet central component in experience-governed cooperation (cf. Porschen/Böhle 2005). It takes place during breaks and often even begins at the breakfast table, once again illustrating that the acquisition of knowledge is closely associated with communicative settings. Story telling in the company is a further starting point for blended learning, for example by retaining niches offline and extending them into virtual space, in the form of regular chats under the title of "Talking about Machines" (Orr 1996) in which everybody can take part who has the time and desire to do so.

3.3 Microlearning

Microlearning using small handheld computers extends the possibilities of learning on the job and communicative learning in the production process. Trainees could use portable computers to display explanations about how the machine works, while they are standing by the machine. The computers could also be used as digital advisors to help repair faults. When the small computers have communicative applications, they could be used to consult experienced colleagues who are not available on the spot but who have expert knowledge. It is not, however, clear whether the use of portable computers while working on a machine contravenes safety regulations. In any case they could be used for training purposes. Apprentices could be given the task of inspecting the machinery and finding out more about the machine and its functions online while being able to look at the actual machine. It is also conceivable that trainees could follow a recommended learning path or select what they want to learn themselves, thus encouraging individual learning.

Something mentioned by the interviewees that I referred to right at the start was small, precise units. This wish reflects the intentions of micro learning in an ideal way although I do see a contradiction in the demand for short learning units with the demand for emphasizing interrelated themes. Maybe this dilemma can be avoided by not even attempting to precisely describe a process or alternative ways of acting on the screen but by deliberately choosing concepts which require interpretation, i.e. which appeal to experience.

In conclusion, I would like to emphasize that E-learning and microlearning can provide new impulses for learning on the job. They only gain this innovative strength, however, when the starting point is the complex knowledge required in the work process and the specific forms of acquiring knowledge and not the technical possibilities.

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