

Context-Aware Workplace Learning Support: Concept, Experiences, and Remaining Challenges

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Abstract. Workplace learning offers the unique possibility of the immediacy of purpose and real-world context. In order to leverage on this, we have developed a context-aware method to support workplace learning. In this paper, we want to describe the concept of context-steered learning, both from a content-driven and communication-driven perspective, and present corresponding system functionality primitives.

1 Introduction

In the wake of constructivism dominating pedagogy research during the last years, the situatedness of learning has come to the center of attention, also a result of the insight that traditional learning methods in the form of large decontextualized courses lead to inert knowledge; i.e., knowledge that can be reproduced, but not applied to real-world problem solving [1]. In order to avoid the inertness, pedagogy tries to set up authentic learning settings, an approach increasingly shared in e-learning domain. If we consider professional training, it is the immediacy of purpose and context that makes it largely different to learning in schools or academic education. This immediacy has the benefit that we actually have an authentic context that we need to preserve. The majority of current e-learning approaches, however, ignores this context and provides decontextualized forms of learning as a multimedia copy of traditional presence seminars.

Technology-enhanced workplace learning tries to leverage on the work context by providing solutions to smoothly integrate learning processes into work processes and—in a more advanced stage—to consciously reflect the work situation e.g. in learning objects. In this paper, we want to present the conceptual foundation for technically realizing context-aware learning support systems in which *awareness* has the aspects both of *knowing about* and *taking into account*.

First, we introduce the notion of *context-steered learning* (section 2) before operationalizing it in a conceptual model and methodology for workplace learning support together with the associated system primitives (section 3 and 4). We conclude with a comparison to the state of the art (section 5) and a summary and outlook (section 6).

2 Redefining Guidance: The Notion of Context-Steered Learning

With formal training support, the system role seems to be quite clear: (a) provide functionality to find or to assign and to access learning resources, (b) to assess and track learning progress and (c) to provide tutoring support. The system is mainly reactive in the sense that employees need to consciously access the system in order to learn. With an increased level of informality and the associated higher degree of integration into everyday work processes, this system paradigm does no longer fit. This has already been realized both in research and practice, but the answer to that challenge mostly is the salvation of self-steered or self-directed learning. If we translate this, it actually means that we completely give up the concept of pedagogical guidance; learners search on their own for suitable learning resources as soon as they know what they don't know. They pace their learning progress and look for additional support as soon as they get stuck. This view is definitely a bit too naïve. Even research on information seeking and information behavior has shown in empirical studies that already initiating a search process is a cognitively challenging barrier (cp. [2]).

Furthermore, guidance is not only important for the individual learner, but also for the company and the alignment of individual learning with corporate strategies, e.g., in the context of competence management and other human resource development approaches. So the question is not whether guidance is important, but rather how and which form of guidance. To redefine guidance, we have analyzed two extremes of guidance (course-steered vs. self-steered) and developed a new form of guidance (context-steered learning) [3], which shall be briefly introduced in the following:

- **Course-steered learning** currently is in the focus of corporate learning strategies. Learning activity is controlled by the pre-defined course structure, where courses typically are relatively large learning units, which can be subscribed to or assigned to. It is important to note that this encompasses both e-learning courses and presence seminars (and, of course, “blended learning” arrangements).
- **Self-steered learning** implies that the learner initiates and controls the learning process herself. Typically, she actively searches for learning resources, which help to satisfy the current knowledge need. This includes purposefully contacting colleagues for help on a particular problem.

The main drawback of course-steered learning is that it only allows for a limited integration of working and learning activities due to the coarse-grained nature. Self-steered learning on the other hand allows for interweaving these processes, but it requires non-trivial cognitive abilities (e.g. becoming aware of knowledge gaps and formulating a corresponding query in whatever form). In order to overcome these problems, we have elaborated a third type of learning process: **context-steered learning**. Here, the system observes the (potential) learner's work activities, while she interacts with her everyday applications. The system deduces from its domain knowledge and the learner's knowledge potential knowledge gaps. For these gaps, the system can compile small learning programs from available learning resources and recommend them to the learner, who can decide whether to learn now, to postpone it, or to discard the recommendation completely. In the following two sections, we want to present a conceptual

model for context-steered learning and primitives in the system functionality to realize context-aware learning functionality. We divide context-steered learning basically into two cases: learning through content and learning through communicating with other humans.

3 Content-Based Context-Steered Learning

Context-steered learning seems to be a natural transition from e-learning and knowledge management approaches. It is based on the assumption that there are small learning units that can be used on demand. Context-steered learning can be visualized as a process cycle, which appears as an on-demand 'detour' of the working processes and can be broken down into the following system primitives (see fig. 1):

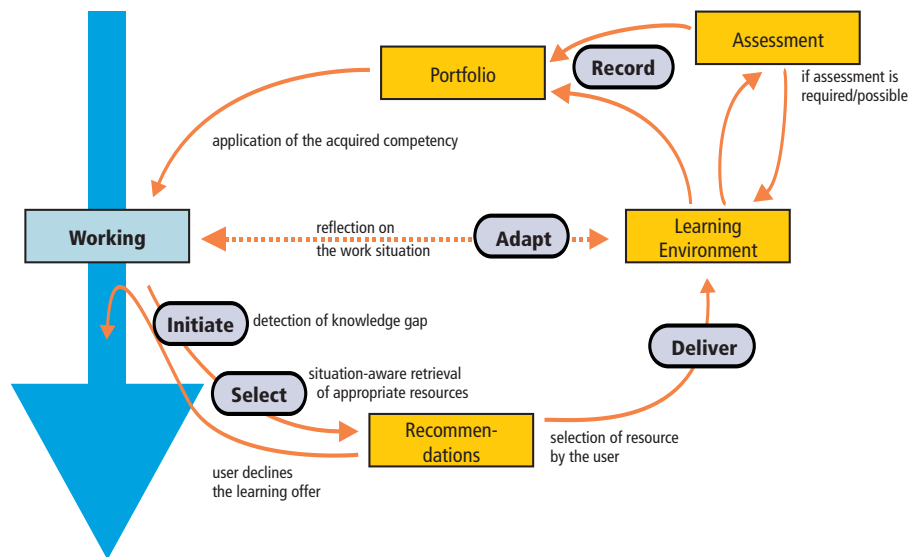


Fig. 1. Content-based context-steered learning

- **Initiate.** In the first phase, the system detects based on observations of the work context and background knowledge if there is a learning opportunity. This functionality refers to the timing (*when*) and modality (*how*) of interventions. These interventions can be interpreted as a sort of automated scaffolding activity of the system that tries to overcome learning barriers resulting from cognitive and affective factors typically associated with a knowledge gap. Timing and modality have to be carefully crafted (e.g., in the form of peripheral attention interfaces like balloon tooltips or tray icon animations) in order to avoid distracting and annoying the potential learner.

- **Select.** Appropriate learning resources that help to satisfy the learner’s knowledge need and that fit to the learner requirements are selected. Relevance criteria can range from current competencies or the current task or role via information about the technical equipment up to personal learning style and preferences. Some of these criteria are hard criteria (mandatory for inclusion in the result set, e.g. objectives), others soft criteria (affecting ranking like interactivity level).
- **Deliver.** In contrast to traditional information retrieval & filtering (the paradigm of which is also prevalent in the domain of knowledge management), it is important to acknowledge that even for self-contained learning resources it might be not appropriate to deliver just a single learning object because the learner cannot understand it without learning other topics first. So the *what*-aspect of delivery cannot be restricted to simple filtering, but must also consider the aggregation of smaller parts into a delivery unit. Here, the context provides the constraints of this aggregation problem by specifying the prerequisites. This consideration of semantic constraints represent a form of pedagogical guidance [3], which avoids overstraining the individual with the unknown and thus helps to reduce (or at least not increase) the feeling of uncertainty typically associated with an information/knowledge need [4].
- **Adapt.** This is the domain of classical micro adaptivity in e-learning. This incorporates adaptive navigation support (to suggested further readings), the adaptation of presentation (e.g., in terms of verbosity or for mobile devices) and behavior of (active) learning content (*context-aware learning objects*) that directly responds to aspects of the situation (e.g., in simulations).
- **Record.** Moving from traditional formal training towards flexible on-demand learning implies that we can no longer rely on training certificates or impartial assessments. However, although often neglected, these certificates still play an important role in an employee’s career. The most promising concept to overcome this problem are electronic portfolios [5]—in analogy to traditional portfolios documenting achievements in the area of creative arts. One often neglected aspect in the business context of classical formal training are certificates that can be obtained after successfully attending training activities. In the case of context-steered learning, electronic portfolios can form the basis for documenting the learning activity and its context in which it took place.

After completion of this micro learning process, the learner returns to his working process and has the possibility to apply the newly acquired competencies—and to return to the learning process if transfer to practice was not successful.

4 Communication-Based Context-Steered Learning

Although there is far more research on formal learning, learning objects and other explicit resources, the majority of learning activities informally takes place and within inter-human communication. Therefore, our research does not only comprise delivery of explicit learning resources, but also investigate how context can improve these informal processes. Apart from collaboration within teams or communities of practice, a very typical situation is what has recently been labeled as *informal teaching*: an employee asks her colleague about something, and the other side explains to her (cp. [6]).

This situation is a generalization of the expert finder problem of knowledge management where the system knows about experts in certain subject areas and provides yellow pages to search for them.

In many practical cases, these expert finder applications are considered problematic because they lead to communication overload on the teacher's side. Also for learners, especially new and unexperienced employees who are almost always on the learner side, do not want to contact experts. They would feel more comfortable with *peers* with whom they can discuss their problem on a similar level. Obviously, establishing contact between an informal learner and an informal teacher cannot be reduced to the problem of identifying an expert for a subject area the learner wants to know about. Rather, this informal teaching must be supported in a context-aware way, which means negotiating between the teacher and the learner context. This can be broken down into the following functionality primitives (see fig. 2):

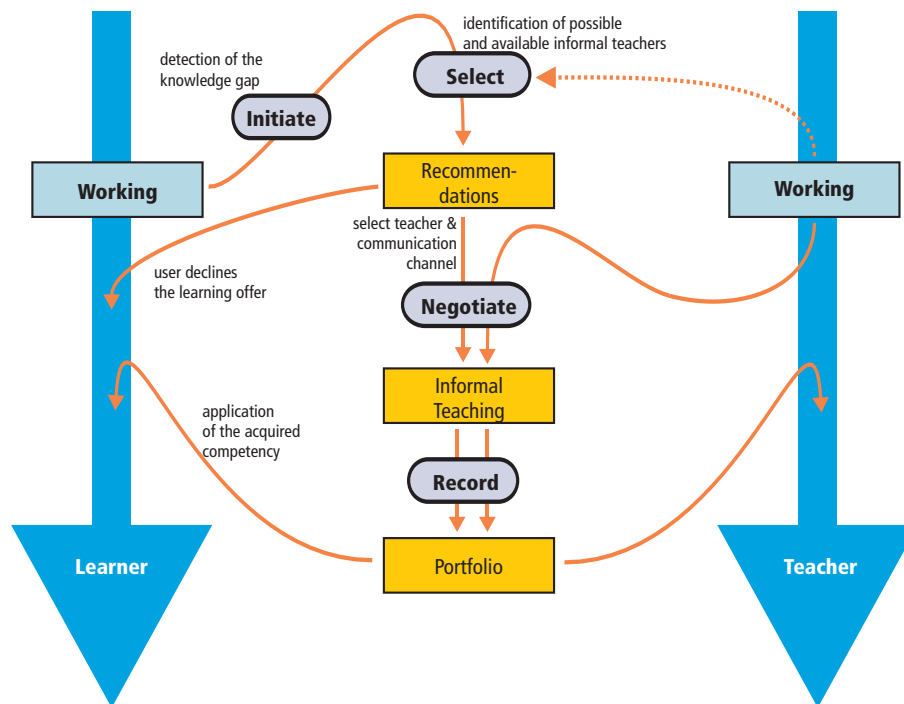


Fig. 2. Communication-based context-steered learning

- **Initiate.** This step is identical to the content-based approach.
- **Select.** In contrast to content (which is always available), informal learning through communication requires an informal teacher on the other side. Informal teaching is more complex than classical expert finding: learners often favour a person being on

a par and at the same competence level; for instance, a person who has recently had the same problems and difficulties. Furthermore, before presenting recommended teachers, the system has to check their availability in a broader sense than pure presence. Availability signifies a person's receptiveness for communication and for the resulting interruption besides her physical presence and her reachability in terms of access to communication devices.

- **Negotiate.** To support the informal way of context-steered learning, it is insufficient only to recommend potential contact persons. Rather the system has to mediate the subsequent approach between the learner and the selected informal teacher. This reflects the problem that not only learning processes have to be integrated into the surrounding work processes, but also teaching processes. In this step, the system tries to find a compromise between the learner's need and the teacher's interest, taking into account contextual factors on both sides like current task, subject of the inquiry, urgency, and communication partner relationship. So the system has to balance the learner's need and the teacher's interest e.g. by delaying message delivery on the teacher's side, if the message is not urgent and the teacher is occupied, or by an explicit notification in the reverse case.
- **Record.** In addition to learning activities, also teaching activities are to be recorded.

5 Existing Approaches

Although context-aware learning support as a separate research field does not exist, there is prior work in many different fields:

Business-process-oriented knowledge management (BPOKM, e.g. [7]) has realized the importance of the process context for context-aware delivery and storage of knowledge assets. While it is true that business processes are an important element of the work context, they definitely are too narrow. Furthermore, BPOKM has so far completely ignored the concept of pedagogical guidance, viewing the problem mainly as a retrieval problem of the right content.

Macroadaptive e-learning approaches like [8] or [9] mainly adapt to the learner in terms of delivery. They filter the learning content based on the learner's competencies and the knowledge requirements of the current position or business process context. While this is an important step into the direction of context-aware learning support, they only consider rather static elements of the context, which does not allow for deeper integration of working and learning processes. **Microadaptive e-learning approaches** and adaptive hypermedia approaches are probably the area of research with the longest history and highest activity [10]. They focus primarily on the learning object behavior itself and how to adapt it to the learner and her characteristics. The main problem of current adaptive e-learning approaches is that they do not consider learning in a work context, but rather set up artificial contexts in learning labs.

6 Conclusions and Outlook

We presented a conceptual model that responds to the challenges of context-aware learning support: what is context, how to get it and how to make use of it. Context-steered learning provides a framework for on-demand learning support, both in the case

of formal and informal learning. With an appropriate context infrastructure consisting of a sufficient amount of sensors and a management system that hides the complexity of dealing with contradictory, uncertain and aging information, this is also technically feasible. For the content-oriented part, this has been shown in the EU-funded project *Learning in Process* [3] and subsequent industry projects. The communication-based methods have been successfully demonstrated outside the learning domain [11] and are now developed further within the project *Im Wissensnetz*.

Currently, we are working on broadening the scope of awareness to making learning support *socially aware*, i.e. aware of the individual's perspective on social relationships, and on incorporating knowledge maturing processes [12] (with the learner as content generator) into the concept.

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References

1. Bereiter, C., Scardamalia, M.: Cognitive Coping Strategies and the Problem of 'Inert Knowledge'. In Chipman, S., Seagal, J., Glaser, R., eds.: *Thinking and Learning Skills*. Volume 2. LEA, Hillsdale, NJ, USA (1985)
2. Niedzwiedzka, B.: A proposed general model of information behaviour. *Information Research* **9** (2003)
3. Schmidt, A.: Bridging the Gap Between Knowledge Management and E-Learning with Context-Aware Corporate Learning Solutions. In: 3rd Conference on Professional Knowledge Management (WM 2005). Volume 3782 of LNAI., Springer (2005) 203–213
4. Kuhlthau, C.C.: *Seeking Meaning: A Process Approach to Library and Information Services*. 2nd edition edn. Libraries Unlimited, Westport, CT (2004)
5. Tosh, D., Werdmuller, B.: The Learning Landscape: a conceptual framework for ePortfolios. *interact* **2004** (2004) 14–15
6. Grebow, D.: At the Water Cooler of Learning. *Transforming Culture: An Executive Briefing on the Power of Learning* (2002) 55–57
7. Abecker, A.: *Business process oriented knowledge management: concepts, methods, and tools*. PhD thesis, Fakultät für Wirtschaftswissenschaften, Universität Karlsruhe (2004)
8. Woelk, D., Agarwal, S.: Integration of e-Learning and Knowledge Management. In: *World Conference on E-Learning in Corporate, Government, Health Institutions, and Higher Education*. Volume 1. (2002) 1035–1042
9. Davis, J., Kay, J., Kummerfeld, B., Poon, J., Quigley, A., Saunders, G., Yacef, K.: Using Workflow, User Modeling and Tutoring Strategies for Just-in-time Document Delivery. *Journal of Interactive Learning* **4** (2005) 131–148
10. Park, O.C., Lee, J.: Adaptive Instructional Systems. In Jonassen, D.H., ed.: *Handbook of research for educational communications and technology*. 2nd edition edn. Lawrence Erlbaum, Mahwah, N.J. (2004) 651–684
11. Gross, T., Braun, S., Krause, S.: Matchbase: A development suite for efficient context-aware communication. In: *Proceedings of PDP 2006*, Los Alamitos, CA, IEEE Computer Society Press (2006) 308–315
12. Schmidt, A.: Knowledge Maturing and the Continuity of Context as a Unifying Concept for Knowledge Management and E-Learning. In: *Proceedings of I-KNOW 05*, Graz, Austria. (2005)