# Supporting the Learning Dimension of Knowledge Work

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**Abstract.** We argue that in order to increase knowledge work productivity we have to put more emphasis on supporting this learning dimension of knowledge work. The key distinctions compared to other TEL approaches are (1) taking the tight integration of working and learning seriously, (2) enabling seamless transitions on the continuum of learning practices, and (3) tapping into the resources (material as well as human) of the organization. Within this contribution we develop the concept of *work-integrated learning (WIL)* and show how it can be implemented. The APOSDLE environment serves as a reference architecture which proves how a variety of tightly integrated support services implement the three key distinctions discussed above.

**Keywords:** workplace learning, professional learning, self-directed learning, collaboration scripts, user profiles, recommendation systems.

## 1 The Learning Dimension of Knowledge Work

We conceptualize learning as a dimension of knowledge work which varies in focus (from focus on work performance to focus on learn performance) and time available for learning. This learning dimension of knowledge work describes a continuum of learning practices. It starts at one side with brief questions and task related informal learning (work processes with learning as a by-product), and extends at the other side to more formalized learning processes (learning processes at or near the workplace). This continuum covers the whole learning practices typology of Eraut and Hirsh [9] and emphasizes that support for learning must enable a knowledge worker to seamlessly switch from one learning practice to another as time and other context factors permit or demand. Research on supporting workplace learning and life long learning so far has focused predominantly on the formal side of this spectrum, specifically on course design applicable for the workplace and blended-learning.

U. Cress, V. Dimitrova, and M. Specht (Eds.): EC-TEL 2009, LNCS 5794, pp. 639–644, 2009.

In contrast, the focus of our work is on the informal side of the spectrum, specifically covering work processes with learning as a by-product and learning activities located within work processes. In order to refer to this type of learning practices we coined the term *work-integrated learning (WIL)* [11]. By using this term we emphasize that learning at the workplace needs to be truly integrated in current work processes and practices and makes use of existing resources within an organization – knowledge artifacts (e.g. reports, project results) as well as humans (e.g. peers, communities). WIL is relatively brief and unstructured (in terms of learning objectives, learning time, or learning support). The main aim of WIL activities is to enhance task performance. From the learner's perspective, WIL is spontaneous and/or unintentional. Learning in this case is a by-product of the activities at the workplace. This conceptualization enables a shift from the training perspective of the organization to the learning perspective of the individual.

We have shown in [2] that the learning continuum exists for all commonly agreed upon knowledge work types (create, transfer, apply, package). For example, on the one hand knowledge can be informally created within work practices when people learn from each other based on observations. On the other hand more formalized settings at the workplace such as dedicated brainstorming sessions can be employed to create knowledge. That is, in order to support knowledge work we have to provide learning support for all four knowledge work types on a continuum of formality. Therefore we have chosen to present our proposed WIL support functionalities structured along the four knowledge work types.

## 2 Supporting WIL with APOSDLE

This section provides a brief overview of how the APOSDLE1 environment supports the learning dimension of knowledge work. We already have evaluated much of the presented WIL support in previous prototypes within workplace situations of our application partners as well as within controlled lab studies, for example [12]. Future work in the APOSDLE project will mainly focus on a summative evaluation of the entire APOSDLE environment. This summative evaluation will be carried out at the site of four organizations participating in the project and will span a period of three months.

### 2.1 Supporting Creation and Transfer of Knowledge

**Sharing Knowledge Artifacts**

In APOSDLE knowledge resides in knowledge artifacts: documents, parts of documents (referred to as snippets), notes, collaboration reflections, collections, etc. Such artifacts are containers for more or less structured information which relate to individual or collaborative tasks and activities. Knowledge artifacts are created from resources within the organizational memory by (automatically) attaching metadata which define the relationship and semantic meaning of artifacts in relationship to the work domain. They are shared throughout the organization.

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[1] Developed in the EU funded Integrated Project APOSDLE (www.aposdle.org).

A variety of different knowledge artifact types can be created and edited by knowledge workers. For example, knowledge workers can create notes in relation to other knowledge artifacts. They can create collections containing other knowledge artifacts which stay in relationship to each other. As an important outcome of collaborative learning or work, reflections contain not only transcripts of collaborative activities but also individual reflections of knowledge applied for a certain learning context or situation. Knowledge workers are made aware of knowledge artifacts through automatic suggestions (see below).

**Scripted, Contextualized Collaboration**

Collaboration is a social interaction in which knowledge workers transfer and construct knowledge while working or learning together. In APOSDLE, the collaboration process is structured into a pre-collaboration, collaboration and post-collaboration phase to allow a clear allocation of preparatory, executive and closing work or learning functions [13]. This structure is made explicit with the Collaboration Wizard, a visual component which guides all collaborating knowledge workers through the collaboration process. It provides collaboration scripts on macro and micro level [7] for each process phase in order to support collaboration as a structured process. These scripts help knowledge workers to use each process phase as efficiently as possible. In the pre-collaboration, a combination of problem formulating, social and fading script is used to collect all required information for coupling knowledge workers in collaborative interactions.

In addition, the Collaboration Wizard contextualizes the work environment of collaborating knowledge workers with information required for a common anticipation of collaborative activities in which knowledge needs to be transferred. This contextual information is taken from previous and current activities of knowledge workers: information they searched for, knowledge artifacts which relate to their activities and tasks, snapshots of individual work environments, etc.

## 2.2 Supporting Application of Knowledge

**Providing an Overview of Past Experiences**

Meta-cognitive skills have been identified as an important ingredient of self-directed learning [3] [13]. In particular studies suggest that mirroring the learner's actions and their results have positive effects on learning. The goal of these interventions is to provide the learner with a (more objective) external perspective on her actions. APOSDLE provides the user with an overview of tasks performed and topics engaged with in the past. The activities are grouped into three categories: seeking knowledge, applying knowledge, and providing knowledge and are displayed within a tree map:

- *Seeking knowledge:* The user seeks information or help about the topic (for example by accessing hints and contacting colleagues about the topic).
- *Applying knowledge:* The user applies knowledge about a certain topic (for example, performing a task which requires knowledge about that topic).
- *Providing knowledge:* The user provides knowledge about a topic to other people or to the APOSDLE system (for example, sharing a resource, storing a note, creating an annotation).

Within the tree map the size of a square is related to the frequency with which the user has been engaged with the topic. The larger the square, the more frequent the engagement has been. This overview of activities allows the user to reflect on her past actions, to immediately asses her activity patterns, and to become aware of topics which she might want to advance further in.

**Suggesting Knowledge Artifacts**

In order to apply knowledge to a specific work situation, a knowledge worker has to assess the situation and transform the knowledge to fit the situation. Reducing the effort for this *learning transfer* is believed to improving the likelihood of application of learned knowledge. APOSDLE takes the following approach: an intelligent recommendation algorithm suggests knowledge artifacts to the learner which are similar to the task or topic at hand and which have been retrieved from the organizational memory – thus improving the likelihood of offering highly relevant information which can be directly applied to the work situation with little or no learning transfer required. In doing so, APOSDLE also utilizes the automatically maintained user profile of the learner in order to compute a learning gap. The learning gap expresses the difference between knowledge about topics needed when executing a work task and the knowledge the user possesses about these topics. Based on this learning gap APOSDLE suggests relevant learning goals which the learner could pursue within her current work situations.

**Suggesting Knowledgeable People**

Besides suggesting knowledge artifacts to the user, APOSDLE also suggests people in the organization which are knowledgeable in this specific task or topic. The goal is not, to always suggest the most knowledgeable person (e.g. the official topic matter expert). Instead, our algorithm seeks to identify peers which have (recently) executed the task before and which are believed to possess more or equal knowledge to the user in question. The identification of knowledgeable persons is based on the user profile.

## 2.3 Supporting Acquisition of Knowledge

**Learning Paths**

Sometimes, learners wish to learn a substantive part of a relatively unfamiliar learning domain, but this will frequently take more than several hours to complete. In order to successfully realize such learning, learners should carefully plan and manage the entire learning process. For self-directed learners, planning a learning path is often difficult, as most learners can not rely on instructional knowledge and have limited prior knowledge about the learning domain.

In APOSDLE, planning is supported with learning paths. A learning path describes how a learning domain can be traversed in an ordered way when learning about the domain. There are many possible paths through a learning domain. Learning paths can be created by the system or by learners.

The learning path wizard helps learners to construct and optimize learning paths. The wizard takes existing knowledge of the learner in the user profile into account and checks whether learners lack the prerequisite knowledge for their learning goals. The wizard suggests prerequisite topics and topics that might be relevant for a learning trajectory.

Topics in a learning path are automatically ordered in such a way, that the learning paths can be traversed easily. Basic knowledge is addressed first and more advanced knowledge that builds on the basic knowledge is addressed afterwards.

**Hints**

Though in general it is expected that workers are motivated to acquire new knowledge in the context of their work, the knowledge acquisition process can be enhanced by providing hints how one could process the information retrieved. In APOSDLE hints are based on two features of learning: learning goals and the possible instructional meaning of retrieved information. According to Gery [10] and Choo [5], people often have specific questions or requests that come to mind when faced with performing new or complex tasks. For instance, questions like: “What must I do? How do I do it? Am I doing it right?”, or requests like: “Show me…”. The information type associated with such a question or request can reasonably be defined. One way of supporting learners is be to identify a set of relevant questions and requests and a set of related information types. This is similar to the approach followed by Anderson and Krathwohl [1] who developed a taxonomy of learning goals which are subsequently used for assessment purposes.

In APOSDLE, we opt for a generic categorisation of information types/materials that could be used to specify and limit the type of content that should be presented to learners (with a specific question). There are some categorisations available (based on projects like LOM, Ariadne, and SCORM), but these are rather low in meaning from a learning perspective. A classification schema is used based on the one developed in the IMAT project [8], which classifies fragments extracted from maintenance manuals into categories like: definition, overview, example, assignment, guideline, how-to, summary, etc. For instance, a learner with the question “How do I do it?” will be referred to fragments from retrieved documents that are labeled with categories like “guideline” or “how-to”.

Learning hints can be contemplative in nature (without observable output), but can also be aiming at explicit outcomes that can be observed and assessed by others. In the latter case, the hints will contain an activity giving the opportunity to the user to enter information in specific input fields. Every hint consists of two elements:

- An activity that states *what* a learner could do to process the information.
- A rationale that states *why* it is considered useful to engage in this activity.

The content of the hints is adjusted to the specific material resource type associated with a learning goal (need). This means that hints that accompany an example are (slightly) different from hints related to a guideline or a constraint.

## Acknowledgements

APOSDLE (**www.aposdle.org**) is partially funded under grant 027023 in the IST work programme of the European Community. The Know-Center is funded within the Austrian COMET Program - Competence Centers for Excellent Technologies - under the auspices of the Austrian Federal Ministry of Transport, Innovation and Technology, the Austrian Federal Ministry of Economy, Family and Youth and by the State of Styria. COMET is managed by the Austrian Research Promotion Agency FFG.

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