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Video-based Competence Development in Chemistry Vocational Training

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Abstract: Digitization in vocational education and training (VET) offers new opportunities for integrating work processes and background knowledge through interactive media. This involves the design, testing and evaluation of innovative means of didactic and technical support. In the project "Digitized support for competence development in the workplace", this task is approached from a combined psychological and computer science perspective. This paper reports on one usage scenario from the first year of the project examining how to embed learning videos in VET. The results include new findings on video-based learning, and inform the design and implementation of a prototypical online learning platform.

Keywords: VET, video-based learning, scientific discovery learning, group awareness support

1. Introduction

Competence development in the workplace requires that trainees not only acquire knowledge at a theoretical level, but are also capable of applying it self-organized in practice. Digitization offers a multitude of possibilities for supporting these processes, but at the same time increases the need to design, test and evaluate the didactic and technical support. The interdisciplinary project "Digitized support for competence development in the workplace" addresses these needs by transferring instructional design principles to VET and applying them with new technologies at Evonik Industries, a globally operating specialty chemicals company with more than 600 apprentices in Germany every year. VET in Germany is "dual" in the sense that it is distributed between two types of training venues, workplaces and vocational schools. This dual system requires trainees to independently integrate learning content across learning locations. For trainers, this means to support the trainees in self-regulated learning (Schwendimann, Kappeler, Mauroux, & Gurtner, 2018). To this purpose, the educational psychology and the computer science team involved in the project, examine support measures from different perspectives.

2. Video-based learning in VET from an educational psychology perspective

From the psychology and instructional design perspective, the aim is to develop and investigate measures for competence development that are linked to the interaction with learning contents or peers. In the first year of the project, this task involved designing and testing the didactic support of video-based learning including the following goals: (1) Embedding learning videos accurately into the VET curriculum, (2) evaluating didactic measures designed for the interaction with learning videos, and (3) evaluating the measures designed for video-based collaborative learning. Regarding (1), it was essential to consider the trainees' motivation of using learning videos in different VET scenarios. To this purpose, a guide was created on how learning videos should be designed, extended by didactic measures and embedded in different scenarios (demonstration by instructors, use by trainees in laboratory activities or in self-learning scenarios). This guide was presented to trainers and trainees to discuss the situational and didactic options in focus groups (study 1). Considering (2), the principles of scientific discovery learning (SDL) were transferred from computer simulations to learning videos. SDL is characterized by learners actively using strategies such as generating hypotheses, testing them via experiments or observations, and interpreting the results, with a particular challenge in generating hypotheses (De Jong & Van Joolingen, 1998). Thus, the transfer consisted of integrating knowledge-activating questions into videos, stimulating the formation of hypotheses that can be tested in the course of the video. The effect of such *video-based discovery learning* on motivation, learning processes and learning outcomes (study 2) was tested in the field with a comparison of the experimental groups: (2a) static learning material vs. learning videos, (2b) learning videos without vs. with knowledge-activating questions. Regarding (3), the guidance principles of group awareness support were applied. Group awareness support means to inform learners about their learning partners' characteristics and therewith suggest specific modes of thinking and behaving during the collaboration (Bodemer, 2011). The effect of this *video-based collaborative learning* with group awareness support on motivation, learning processes, self-assessed competence, and learning outcomes (study 3) was also tested in the field with three different groups: (3a) individual vs. collaborative video-based learning (and group awareness support), (3b) video-based collaborative learning without vs. with trainer (see Fig. 1 for an overview).

Figure 1. Overview of empirical studies conducted in the first phase of the project.

Study 1 showed that trainers and trainees are open to video-based learning and its didactic extension, with trainees making the use of learning videos dependent on an increase in performance and having a special interest in self-learning scenarios. Study 2 illustrated that trainees achieved better learning outcomes with learning videos than with static learning material ($p < .01$), but knowledge-activating questions do not add value to learning outcomes. Furthermore, motivation and learning strategies do not mediate the effect of the treatment on learning outcomes. However, the descriptive results illustrated with regard to motivation that the questions lead to the highest "interest/enjoyment". The explorative analysis of log data further indicated that knowledge-activating questions make the trainees deal more intensively with the learning content. Finally, study 3 showed that collaborative outperformed individual video-based learning in terms of learning outcomes ($p < .01$) and "interest/enjoyment" ($p < .05$) as a dimension of motivation, but no difference was given between collaborating groups with and without trainer support. Taking into account the time points, competence has improved over time in all experimental groups, with the improvement being greater in video-based collaborative learning with trainer support than without this support ($p < .05$).

3. Video-based learning in VET from a computer science perspective

In the computer science perspective, the point is to provide well-adapted technologies to support digitization in VET (a) by enabling video-based technologies, and (b) through intelligent contextualized information access for learning. The implementation of these approaches is done in a participatory design approach with trainees and trainers who are using prototypes and creating content for the system. Supporting digitization processes requires both hardware and software solutions. Mobile devices have the potential to enhance learning by providing anytime and anywhere access to information, learning resources and learning activities. The trainees have been equipped with tablet PCs (i.e., IPads) in order to follow a mobile-first digitization process. In addition to the requirements of the psychological perspective to embed didactical components, the design of the software targets active learning using interactive web content in augmentation of learning videos, in particular by embedding in-video quizzes or other interactive tasks. This led to a design of a software prototype for video-based learning with interactive web content using open and standard technologies such as Moodle, H5P, Learning Locker as a learning record store (LRS) and xAPI (see Harbarth et al., 2018). Figure 2 shows an architecture that consists of the aforementioned sub-components of the software system. It contains mechanisms to capture traces of learners (xAPI and LRS) and to provide intelligent information access.

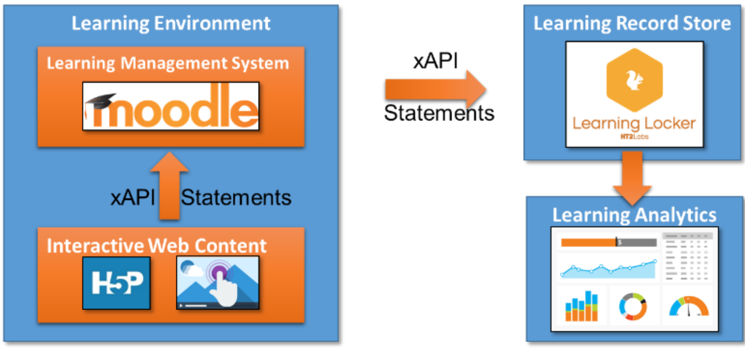

Figure 2. Architecture of the video-based learning prototype with learning analytics enabled.

Integrating new systems into already existing infrastructures is a special challenge since it potentially increases the level of fragmentation by adding new systems. Therefore, we provide access to the already existing infrastructure by linking and connecting data and sub-systems in this context. Particularly in the context of learning, this includes the recommendation and dynamic linking of learning resources based on contextualized information, such as the learning context, content, and metadata. Semantic technologies such as DBPedia Spotlight are beneficial to automatically capture characteristics of the content without a major loss of information on educational data (Manske & Hoppe, 2016).

4. Conclusion and Outlook

The resulting concept for competence development envisages using learning videos for self-learning scenarios, but also for collaborative learning in the training workplace and the classroom with strong involvement of the trainers and group awareness support. Due to a better engagement with content, also knowledge-activating questions are integrated what has to be considered in the production of videos so that hypotheses can be tested. Enabling these concepts of video-based discovery and collaborative learning on a prototypical online learning platform can be achieved using open and standard technologies that are ready for learning analytics. In the next phase of the project, the focus will be on the development of a didactic and technical concept for the use of learning journals to further support learning strategies with regard to the reflection of learning contents.

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References

Bodemer, D. (2011). Tacit guidance for collaborative multimedia learning. *Computers in Human Behavior*, *27*(3), 1079–1086. https://doi.org/10.1016/j.chb.2010.05.016

De Jong, T., & Van Joolingen, W. R. (1998). Scientific discovery learning with computer simulations of conceptual domains. *Review of Educational Research*, *68*(2), 179–201. https://doi.org/10.3102/0034654 3068002179

Schwendimann, B. A., Kappeler, G., Mauroux, L., & Gurtner, J.-L. (2018). What makes an online learning journal powerful for VET? Distinguishing productive usage patterns and effective learning strategies. *Empirical Research in Vocational Education and Training*, *10*(1), 1–20. https://doi.org/10.1186/s40461-018-0070-y

Harbarth, L., Delsing, S., Richtscheid, F., Yücepur, V., Feldmann, F., Akhavanfarm, M., ... & Hoppe, H. U. (2018). Learning by tagging–supporting constructive learning in video-based environment. In D. Krömker, & U. Schroeder (Eds.), *Lecture Notes in Informatics. DeLFI 2018 – Die 16. E-Learning Fachtagung Informatik* (pp. 105-116). Bonn, Germany: Gesellschaft für Informatik.

Manske, S., & Hoppe, H. U. (2016). The "Concept Cloud": Supporting collaborative knowledge construction based on semantic extraction from learner-generated artefacts. In L. O'Connor (Ed.), *2016 IEEE 16th International Conference on Advanced Learning Technologies (ICALT)* (pp. 302–306). Austin, TX: IEEE.