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Understanding video tools for teaching: Mental models of technology affordances as inhibitors and facilitators of lesson planning in history and language arts

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ABSTRACT

The aim of this study was to investigate how pre-service teachers' mental models of the functions of a newly encountered video technology (WebDIVER^{TM}) influence their lesson planning employing this technology. Participants designed a lesson plan and evaluated a practice-proven lesson plan for a sample topic. Results revealed that few participants cognitively represented specific functions of the tool. However, in their designed lesson plans, specific tool functions were only scarcely reflected and participants relied upon tool-unspecific uses. Of greater interest, representing cognitive or socio-cognitive functions of a technology differentially predicted the evaluation and design of lesson plans. We conclude that it is insufficient to provide pre-service teachers with separate technological and pedagogical knowledge to develop TPCK to leverage the potential of video tools.

Introduction

Recently, the role of video technology as a tool for teacher education has been studied with regard to supporting teachers' reflection on their classroom practices (Borko, Jacobs, Eiteljorg, & Pittman, 2008; Brophy, 2004). Respective research has shown that pre-service teachers can profit from this use of digital video technology (Seidel, Stürmer, Blomberg, Kobarg, & Schwindt, 2011; Zottmann et al., 2011). However, in addition to the potential for supporting *teacher* learning directly, such video tools also harbor the potential to support individual and collaborative *student* learning in the classroom (Merkt, Weigand, Heier, & Schwan, 2011; Zahn, Krauskopf, Hesse, & Pea, 2012; Zahn, Pea, Hesse, & Rosen, 2010). This creates a new challenge for teachers, to don their professional glasses to consider the affordances of video technology in light of how students learn. This challenge arises now for pre-service teachers studying at university, because during their teacher preparation they need to step out of the learner role and into the role of the teacher when they are using technology (Kramarski & Michalsky, 2010). This is, because relying only on their private experience with technology is not a sufficient basis for the professional use of video technologies with students in the classroom (Krauskopf, Zahn, & Hesse, 2012; cf. also, Russell, Bebell, O'Dwyer, & O'Connor, 2003). Accordingly, it remains a challenge for many teachers to use video in class effectively for learning (Hobbs, 2006). This confluence of considerations leads to examination of how pre-service teachers understand digital video technologies as tools for teaching and learning to best leverage their potential. In the study presented here, we provided an approach to complement a more common approach in TPCK research—to design and evaluate rather complex teacher education programs that often focus on teachers *skills in* implementing a specific technology (e.g., Blonder et al., 2013). While we do believe that such intervention studies on the meso-level are important, it is also necessary to complement them with research to help us understand the learning of pre-service teachers on a cognitive micro-level—to understand what facilitates and what inhibits their pedagogical reasoning regarding the use of technology for teaching. Only when we know which conceptions about the learning-relevant affordances of emerging technologies such as video tools will we be able to design teacher training programs in

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the long term that support the development of teachers' professional knowledge that enables them to integrate different kinds of technology from a pedagogical point of view (TPCK).

Affordances of digital video technology as a learning tool

Two different education research strands examine either individual or collaborative learning processes using digital video technology. Research focusing on individual learning has investigated digital video mainly as an information vehicle for students' knowledge acquisition. The empirical studies have focused on aspects of technology design, such as complexity (e.g., Furnham, De Siena, & Gunter, 2002) or multimedia effects (Mayer, 2001). Additionally, the level of interactivity has been investigated, for example, using hyper-video tools for suggesting non-linear paths through networked video-based information (Chambel, Zahn, & Finke, 2005) or presenting the learner with possibilities to regulate the flow of information by tables of content or indices (Merkt et al., 2011). Studies based on this approach found that differences in the use of these navigation functions influence individual learning; however, patterns of use which benefit learning do not occur spontaneously (Merkt et al., 2011; Zahn, Barquero, & Schwan, 2004; Zahn & Finke, 2003). Taken together with findings that show a positive relationship between schooling and students' use of search strategies in texts (Kobasigawa, Lacasse, & MacDonald, 1988; Rouet & Coutelet, 2008), this suggests that students tend to misunderstand the functions of a tool when not guided by pedagogy (Merkt et al., 2011).

Research that focuses on collaborative learning views digital video technologies in their function as mediating tools that influence the structure of activity in which learners use video collaboratively (Zahn, Pea, et al., 2010). Based on the idea of differential affordances of representational tools (cf. Suthers & Hundhausen, 2003), specific video tools are expected to facilitate specific ways in which groups of students negotiate meaning and collaboratively construct knowledge from a video source. Here as well, research has shown that these tools need to be embedded in an appropriate pedagogical context (Zahn, Krauskopf, Hesse, & Pea, 2010; Zahn, Pea, et al., 2010).

In conclusion, both lines of research provide evidence that the affordances of new (video) technologies provide potentials for student classroom learning with either a focus on individual learning (*cognitive functions*) or collaborative learning (*socio-cognitive functions*). Teachers need to leverage these potentials by creating a pedagogical setting and selecting appropriate content. In our work, we consider the cognitive prerequisites that determine how pre- and in-service teachers plan their professional use of video tools as a complementary approach to focusing on teachers' technology implementation skills (e.g., Blonder et al., 2013). Currently, teachers' professional knowledge is discussed as one of the most relevant factors.

Teacher knowledge for teaching with technology—TPCK

Teachers' professional knowledge is conceptually understood as a means to the end of fulfilling their professional roles within the school system and the classroom (Ben-Peretz, 2011). With regard to how teachers develop this knowledge, research suggests that teachers construct different types of knowledge. However, the assumed processes have not been specified in the articles reviewed by Ben-Peretz (2011). This is reflected in research employing the currently most prominent framework of teacher knowledge in the context of technology use: the Technological Pedagogical Content Knowledge framework (TPCK). The TPCK framework has been developed with a strong focus on experience from teacher education (e.g., Mishra & Koehler, 2006) and the design of teacher preparation programs (Niess, 2005). Based on Shulman's (1986) definition of Pedagogical Content Knowledge (PCK), TPCK is conceptualized as an integrated, unique body of knowledge that intertwines aspects of technology, pedagogy, and content. This unique body of knowledge is considered prerequisite for teachers if they are to adequately evaluate and design lessons that create added-value for student technology-enhanced learning (Angeli & Valanides, 2009; Harris, Mishra, & Koehler, 2009; Koehler & Mishra, 2009). Thus, TPCK is contrasted with mere unconnected knowledge of technology, pedagogy, and content.

Although this framework has provided a fruitful period of common ground for discussing what teachers need to know in order to exploit the potential of emerging technologies, a lack of specificity remains for the TPCK construct, the basic sub-domains (Technology, Pedagogy, and Content) of the framework, and the boundaries between them (Cox & Graham, 2009; Graham, 2011). It remains unclear whether knowledge in the basic sub-domains is a prerequisite for constructing more complex professional knowledge (=TPCK). As a result, the interplay between the different knowledge domains and how they are represented remains an unresolved theoretical and empirical issue. With regard to this question, Angeli and Valanides (2009) have contrasted a *transformative* view on TPCK as a unique body of knowledge that also requires specific instruction with an *integrative* view that assumes spontaneous construction of TPCK when knowledge in the sub-domains exists. The latter suggests that it is sufficient to train the separate sub-domains and then assume TPCK development will follow. The authors argue that spontaneous construction of TPCK when sub-domain knowledge is given is unlikely and postulate the *transformative* view. According to Graham (2011), this postulation is in line with how Mishra and Koehler conceptualize TPCK. But the operationalization in Mishra and Koehler's empirical research does not adhere to this assumption (Koehler & Mishra, 2005; Koehler, Mishra, & Yahya, 2007) and furthermore, studies by Angeli and Valanides (2005, 2009) do not systematically compare the two assumptions.

To summarize, considering the current definitions of TPCK as knowledge of "how to coordinate" different knowledge domains (Abbitt, 2011; Cox & Graham, 2009; Harris et al., 2009; Koehler, Mishra, Kereluik, Shin, & Graham, 2014) we agree with the transformative view on TPCK and build upon it by suggesting a theoretical approach which conceptualizes this knowledge in terms of cognitive representations. We suggest the notion of mental models as a helpful theoretical extension to tackle these issue of how TPCK has to differ from list-like mental representations of examples of how technology can be used in teaching. Moreover, we explain why we expect that such theoretical clarity will also lead to more specific hypotheses about learning outcomes with technology and a wider base of empirical research for testing them (Graham, 2011; Voogt, Fisser, Pareja Roblin, Tondeur, & van Braak, 2012).

Mental models of video tool affordances

Krauskopf et al. (2012) proposed that *mental models* of technology affordances of teachers are an important factor in their thinking and reasoning as they plan how to use technology in class. In an initial study, the authors investigated teachers' mental models using the example of the video tool YouTube.

What we consider most important about the concept of mental models is that it refers to assumptions about the representational form of a teacher's professional knowledge about technology. In contrast to list-like knowledge about a number of possible uses of a video technology in class, the construction of a mental model assumes a transformation of prior professional knowledge into an integrative cognitive representation of relevant elements *and* their interrelations. Because such a representation can then be

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