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Review

Supporting reflection in technology-enhanced learning

Külli Kori *, Margus Pedaste, Äli Leijen, Mario Mäeots

University of Tartu, Salme 1a, Tartu 50103, Estonia

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ABSTRACT

Reflection has been regarded as a process that leads to deeper learning and a more complex and integrated knowledge structure. Various studies argue that reflection is more effective when given specific support. Technology-enhanced learning environments are recognised as effective facilitators that support students' learning. This study reviews the reflection support that research papers from the past six years (2007–2012) have introduced in the context of technology-enhanced learning. Three support types are distinguished: technical tools, technical tools with predefined guidance, and technical tools with human interaction guidance. Most of the analysed articles relied on empirical evidence about the effectiveness of reflection support. Some articles gave only argumentative discussion to justify how reflection should be supported. It was showed that all these types of support could have a positive effect on reflection; however, not all the studies found positive effect.

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1. Introduction

Reflection can generally be defined as a cognitive process carried out in order to learn from experience (Moon, 2004) through individual inquiry and collaboration with others (Dewey, 1933). Despite consensus on the importance of reflection for learning, there are different interpretations of reflection in education. In brief, there are three different perspectives on

* Corresponding author. Tel.: +372 56237966.
E-mail address: kulli.kori@ut.ee (K. Kori).

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reflection in education, embedded in the philosophical traditions of pragmatism, critical social theory, and Kantian approach. Accordingly, the focus, purpose, and process of reflection vary in each tradition.

Procee (2006) elaborates on the differences between the approaches to reflection by exploring the roots of reflection in education in Western philosophy. In his view, the most influential approaches are the pragmatist school of Dewey and the so-called Frankfurt school of critical social theory, e.g., the notions of Habermas. The followers of these schools interpret reflection differently. In Dewey's view, reflection allows one to become conscious of and thoughtful about one's actions, as opposed to using trial and error to deal with confusing and problematic situations.

The critical social theory perspective on reflection emphasises the critical position of individuals and groups in relation to the actual situation. Reflection involves questioning existing assumptions, values, and perspectives that underlie people's actions, decisions, and judgments. The purpose of questioning is to liberate people from their habitual ways of thinking and acting (Procee, 2006). Inspired by Habermas, Mezirow (1991) introduced the term *perspective transformation*, which entitles the process of becoming critically aware of how and why our assumptions about the world have come to constrain the way we see ourselves and relate to others. According to him, transformation in perspectives is only possible through the critical reconsideration of one's own perspectives and orientations to perceiving, knowing, feeling, and acting. Bolhuis and Simons (1999) characterise this kind of learning as breaking down and building up; what has been learned before – the frame of reference – has to be unlearned to make room for new knowledge, skills, and attitudes. Gur-Ze'ev, Masschelein, and Blake (2001) stated that this practice of reflection is more related to counter education and is not possible in the formal education owing to 'the hegemonic realm of self-evidence and the productive violence of social and cultural order' (p. 93).

In addition to these two well-known approaches to reflection in education, a third approach was developed by Procee (2006). His systematic approach to reflection is based on Kant's distinction between *understanding* and *judgment*. The latter is associated with reflection. 'Understanding is related to the ability to grasp logical, theoretical, and conceptual rules; judgment is related to ability to connect experiences with rules' (p. 247). As Procee argues: 'Both are important in the field of education – students have to learn existing concepts and theories in their specialty (understanding), but they also have to learn to make connections between their state-of-art knowledge and the domains of reality in which they are operating (judgment)' (pp. 247–248).

These connections can occur in two ways, driven by pre-given concepts (*determinative judgment*) and driven by experiences (*reflective judgment*). Determinative judgement implies that a person stipulates and applies a set of rules or concepts in a particular practice. Reflective judgement is carried out when existing concepts or principles are limited and need to be developed based on a particular practice (Procee, 2006). In accordance with the above, to reflect means both to compare and hold together one's conceptions and experiences in order to act with more self-confidence (see Leijen, Lam, Wildschut, & Simons, 2008b). Although three interpretations of reflection in education are distinguished, the pragmatism perspective, which focuses on the improvement of practice, is most frequently used.

Reflection is particularly important in science and technology education because students' specific initial understanding of natural phenomena might be not in accordance with scientific explanations. In the context of science and technology education, reflection can be tied to a variety of learning methods, including inquiry learning. Baird and White (1996) and Davis (2003) found that reflection skills can be developed through inquiry learning. White and Frederiksen (2005) identified three metacognitive skills used in inquiry learning: planning, monitoring, and reflection. These skills are similar to those of regulative inquiry introduced by de Jong and Njoo (1992): planning, monitoring, evaluating. Several studies (de Jong & Njoo, 1992; Manlove, Lazonder, & de Jong, 2006; Mäeots, Pedaste, & Sarapuu, 2009) have shown that inquiry learning can improve regulative skills. Therefore, reflection is one inquiry skill that can be developed through inquiry learning.

Despite reflection's relevance in educational practices, it is a challenging activity for students in different fields. Students need further support for reflection (Abou Baker El-Dib, 2007; Lee, 2005; Wade, 1994). For example, students' perceptions of their own experience are often influenced by implicit and explicit knowledge and by the feelings associated with a concrete experience. Argyris and Schön (1974) showed that what students think and feel about an experience can differ from the actual event. In addition, students tend to wait for the teacher to present evaluations, instead of evaluating their experiences themselves (Leijen, Lam, Wildschut, Simons, & Admiraal, 2009; Mountford & Rogers, 1996). To support self-assessment, students need to understand evaluation standards and the criteria for these standards. Also, reflection requires creative thinking about experience and seeing alternatives, which are challenging tasks for students. In this situation, interaction with others could be useful (Dewey, 1933; Leijen, Valtna, Leijen, & Pedaste, 2012; Moon, 1999, 2004).

Since technology has developed quickly in recent years, it has been used more widely in education, and some technology-enhanced learning environments support learners by enhancing their regulative skills and reflection (see de Jong et al., 2012; Pedaste & Sarapuu, 2006, 2012). Technology-enhanced learning environments have been widely used to apply inquiry learning in science education and are seen as instructional systems through which students acquire skills or knowledge with the help of teachers or facilitators, learning support tools, and technological resources (Aleven, Stahl, Schworm, Fischer, & Wallace, 2003; Shapiro, Roskos, & Philip, 1995; Wang & Hannafin, 2005). In the online learning context, learners can learn at anytime from anywhere, but instructors cannot always be online to guide learners engaging in reflective practice. For such situations, some kind of mechanism could be designed to guide learners in focusing on critical points and engaging in reflective practice (Chen, Wei, Wu, & Uden, 2009). In addition to teachers, computers facilitate inquiry learning because they enable the presentation of models and simulations (van Joolingen, de Jong, Lazonder, Savelsbergh, & Manlove, 2005). Therefore, technology could be used to support reflection (e.g., Chen, Kinshuk, Wei, & Liu, 2011; Chen et al., 2009; Hsieh, Jang, Hwang, & Chen, 2011; Leijen et al., 2012). However, to increase students' self-awareness of the regulation of the