



## Full length article

## Associations between technological scaffolding and micro-level processes of self-regulated learning: A workplace study

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## ABSTRACT

This paper reports the results of a study of the association of a set of technological scaffolding interventions – implemented in a learning software called Learn-B – with micro-level processes of self-regulated learning in the workplace. The study was conducted in the context of two European organizations, in which the study participants ( $N = 53$ ) used the learning software Learn-B for two months in their regular activities. Data about perceived usefulness of the technological scaffolding interventions and traces about the events of the actual use of the technological interventions and micro-level processes of self-regulated learning were collected and analyzed. The analysis of the data showed that when directly asked about their own perspectives, the participants tended to rely on their organizational context in their planning phase. The results also indicate that the participants did consider the social context of their organization when planning their learning goals, but it was not found as the most influential factor. The analysis of the trace data revealed a moderate balance between reliance on both social and organizational contexts. The analysis of the theorized contingencies via trace data showed that the participants' usefulness perceptions of the proposed interventions for their self-regulated processes, poorly matched with their actual learning actions.

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## 1. Introduction

For individuals working in today's rapidly growing knowledge-driven society where organizations dynamically change their work practices in order to improve their productivity, continual learning and agile adaptation to these societal and technological transformations is not only expected, but an essential part of the work processes (Cairns & Malloch, 2011; Littlejohn, Milligan, & Margaryan, 2012). Frequently emphasized in the existing literature, learning in workplace is regarded to be informal and autonomous (Ellinger, 2005; Eraut, 2004; Hart, 2010; Kyndt, Dochy, & Nijs, 2009; Lee et al., 2004; Tynjälä, 2008). This implies that most often it is the individual worker who needs to address some knowledge or competence gap (i.e., initiating the learning process is autonomous) based on the requirements of a task at hand (learning happens in an informal mode). This ideal image of informal pro-active learning, however, rarely happens in everyday work environments; unless provided with structured learning scenarios in

formal settings, most people are not proactive enough to initiate a learning process on their own, or they simply do not know how to learn (Margaryan, Milligan, Littlejohn, Hendrix, & Graeb-Koenneker, 2009a). Coupled with the new demands brought forth by socio-economic demands, the informal nature of workplace learning requires contemporary knowledge workers to be capable of deploying self-regulatory learning processes in order to identify and address their learning needs (Siadaty, Jovanović et al., 2012; Margaryan et al., 2009a).

Although the concept of self-regulated learning (SRL) in the workplace has recently gained some attention (Carneiro, Lefrere, & Steffens, 2007; Fontana, Milligan, Littlejohn, & Margaryan, 2015; Littlejohn et al., 2012; Margaryan, Littlejohn, & Milligan, 2013), still, the majority of the existing body of research on the application of and support for SRL processes in learning environments has taken place in formal, educational settings, e.g., (Azevedo, Moos, Johnson, & Chauncey, 2010; Chen, 2002; Dabbagh & Kitsantas, 2005; Kumar et al., 2005; Winne, 2010a; Winne et al., 2006). There are at least two important challenges that call for investigating SRL processes, in particular, in workplace environments (Littlejohn et al., 2012). Firstly, the nature and objective of learning is noticeably different between educational and workplace environments. In formal,

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academic settings learning is a goal in itself (Margaryan, Milligan, & Littlejohn, 2009), and learning requirements and processes are typically well-structured and formally defined. Learning in workplaces, however, is usually a “by-product of work” (Margaryan et al., 2009, p.2), where the actual goal of a knowledge worker is task performance and learning is mainly a means to achieve this goal (Illeris, 2011; Ley, Kump, & Albert, 2010; Margaryan et al., 2009a). Secondly, the majority of conventional interpretations of and existing studies on supporting SRL processes have placed their focus rather on factors that relate to individuals. This is, of course, not intended to disregard the social-cognitive theories of SRL, e.g. (Zimmerman & Schunk, 1989), or the recent interest in studying co- or socially-shared regulation (Hadwin, Järvelä, & Miller, 2011; Hadwin, Oshige, Gress, & Winne, 2010; Inoue, 2007); it is to point out that the existing literature on SRL follows an individualized perspective in that the social context and collective knowledge of a learning environment are considered to play a secondary role compared to individual-based factors (Jackson, MacKenzie, & Hobfoll, 2000). Such a perspective contradicts the nature of the workplace, where individuals’ work and learning activities are highly social and community centered (Hart, 2010; Margaryan et al., 2009; Marsick, Watkins, & O’Connor, 2011).

These challenges highlight a need for systematic research on self-regulated learning as well as how it is best facilitated through learning scaffolds in informal workplace settings. Modern technological enhancements can lend support to address these challenges. The existing literature acknowledges and has already shown that innovative tools and software can in general deliver great benefits for studying and bootstrapping SRL processes, specifically, in formal educational settings; see for instance (Azevedo, 2010; Dabbagh & Kitsantas, 2005; Winne et al., 2006; Winters, Greene, & Costich, 2008).

The main contribution of this paper is the findings of a study that investigated to what extent a set of technological scaffolds, designed in accordance to the social and organizational dimensions of a workplace, can be utilized to support individuals’ self-regulatory learning processes in the workplace. In particular, the study investigated the association of the use of different technological scaffolds on the three phases of self-regulated, including, planning (of the learning goals), engagement (in learning activities and strategies), and evaluation and reflection (over the learning process). To conduct this research, we developed a learning environment, Learn-B, that implemented the technological scaffolds, and employed a trace-based methodology (Siadaty, Gašević, & Hatala, 2015b), to collect the traces of users’ learning actions in their very context, as they navigated through the learning environment and made use of the scaffolding interventions in various learning situations. Specifically, Learn-B is implemented as an environment that allowed workplace learners to define goals, get recommendations which competences to study next, get recommendations how to study competences by receiving recommendation about learning plans and resources, and share experience with and received updates about the progression of colleagues in the workplace (see Appendix A of the electronic supplement for details). In the study, reported in this paper, we investigated the perceived usefulness of the technological scaffolding interventions, the association between the technological scaffolding interventions and self-regulated learning processes, and the extent to which the technological scaffolding interventions led to engagement in SRL processes.

## 2. Supporting self-regulated learning processes in the workplace

In this section, we discuss the SRL model underpinning the theoretical framework of our research and briefly review the tech-

nological scaffolding interventions that we proposed within this framework in order to support users’ self-regulatory processes in the workplace and everyday work practices. The framework and the interventions were designed by following a design-based research approach (Anderson & Shattuck, 2012) through which we tried to answer research questions and address practical needs of contemporary knowledge workers for scaffolding their learning in the workplace. Details about the iterative process of the development of the framework and interventions are beyond the scope of this paper and are reported elsewhere (Siadaty, 2013; Siadaty, Gašević et al., 2012; Siadaty, Jovanović, Gašević, & Jeremić, 2010).

### 2.1. Self-regulated workplace learning

A vast majority of the existing research in self-regulated learning is decided to formal educational contexts (Winne, 2013; Zimmerman & Schunk, 2011). However, much less research has been dedicated to the study of self-regulated learning in workplace settings (Littlejohn et al., 2012; Milligan, Fontana, Littlejohn, & Margaryan, 2015). Although some general principles may apply between the two types of learning contexts (workplace vs. formal education), the natures of these two contexts and opportunities for provision and support of learning are different (Littlejohn et al., 2012; Margaryan, Milligan, Littlejohn, Hendrix, & Graeb-Koenneker, 2009b). This is of special importance when it comes to understanding what types of scaffolds are necessary to be integrated into learning technologies that aim to support self-regulated learning. More importantly, it is essential to understand the extent to which the use of certain technological scaffolds is associated with different processes of self-regulated learning. Although many of these different technologies have been proposed to support self-regulated learning (Winne, 2006), there is the dearth of empirical research that investigates the association between the use of technological scaffolds and the engagement into self-regulated learning processes. Technological scaffolds of special interest are recommender systems and social media due to their growing availability in learning and workplace collaborative technologies (Dabbagh & Kitsantas, 2012; Lytras & de Pablos, 2011; Manouselis, Drachler, Riina, Hummel, & Koper, 2011; McAfee, 2009; Vargas-Vera, Nagy, & De Pablos, 2013; Verbert et al., 2012a). Specifically, this study aims to fill this gap in research by studying the association of the use of technological scaffolds with micro-level processes of self-regulated learning.

Methodologically, existing research studies in self-regulated learning in workplace settings have primarily relied on the use of interviews and self-reports. While self-reports and interviews offer much merit to understand motivation and affective dimensions of learning (Winne, 2010b), existing research in self-regulated learning showed that learners are inaccurate in calibrating self-reports about the use of learning tool with the actual tool use (Winne & Jamieson-Noel, 2002). This primarily is caused by the biased memories of learning experience rather than actual learning experience that is recalled and reflected on in self-reported instruments and interviews. On the other hand, think aloud protocols – commonly used for the study of micro-level processes of self-regulated learning (Azevedo, Moos, Greene, Winters, & Cromley, 2008; Azevedo et al., 2010) – are considered intrusive and their validity for understanding of self-regulated learning is questioned (Winne, 2013). Previous research have shown that some cognitive and metacognitive processes are triggered by think aloud protocols that would be activated otherwise in ecologically valid settings. Therefore, the use of trace data about learning activities performed by learners and recorded in real-time by learning technologies is suggested as a promising approach to overcoming limitations of existing data collection approaches (Hadwin, Nesbit, Jamieson-Noel, Code, & Winne, 2007). With the emergence of the field of

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