

The Social Semantic Web and Workplace Learning

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Abstract. Recent technological advancements offer new affordances for supporting learning in contemporary workplaces. Social Semantic Web technologies is one of the most recent streams of technology used for workplace learning. Semantic Web technologies bring semantics to existing knowledge, enabling knowledge to be used and advanced across a variety of contexts. By contrast, social software supports the production and sharing of user-generated content. In this chapter, we firstly outline the main challenges in supporting workplace learning. Then we introduce basic principles underpinning Social Semantic Web technologies. We then outline the state-of-the-art in research on professional learning with respect to these technologies. The chapter concludes with a discussion on lessons learned, open research questions, and directions for future research.

1 Introduction

Continuous workplace learning is critical for today's society that is rapidly-changing and knowledge-driven (Kyndt, Dochy, & Nijs, 2009; Littlejohn, Milligan, & Margaryan, 2012). Workplace learning is often informal and social (Hart, 2010; Tynjälä, 2008). The informal nature of workplace learning means that knowledge workers must be capable of, and supported in, deploying self-regulatory learning processes to identify and address their learning needs (Carneiro, Lefrere, & Steffens, 2007; Littlejohn et al., 2012). The social nature of informal, workplace learning draws attention to the role of collective in learning processes. These challenges are discussed in Section 2 of this chapter. Further challenges arise from the contextual nature of workplace learning (Illeris, 2011; Margaryan, Littlejohn, & Milligan, in press) and the fact that learning and work contexts are inextricably interwoven. Therefore, to address users' information needs in the workplace, both work and learning processes should be considered and supported. These challenges are discussed in Section 3 of this chapter.

Information technologies offer considerable opportunities for supporting learning in work environments (Tochtermann & Granitzer, 2008). Notably, the Social Web provides a platform for the creation and sharing of user-generated knowledge, thereby supporting the realisation of social learning (Bingham & Conner, 2010; Vassileva, 2008). Typically, knowledge workers use a variety of social software tools for work and learning purposes. As a result the collective knowledge tends to be distributed across different, often heterogeneous, social technologies. Semantic Web technologies could potentially provide critical advantage in structuring and integrating online traces of workers' activities dispersed across various tools. These traces can be turned into relevant, contextualised information within the workplace (Jeremić, Jovanović, & Gašević, 2013). Built on top of these two streams of technology - the Semantic and the Social Web- Social Semantic Web (SSW) merges the 'best of both worlds', combining common formats for defining and structuring information with the social mechanisms for creating and sharing knowledge (Jovanović, Gašević, Torniai, Bateman, & Hatala, 2009; Mikroyannidis, 2007). These technologies are briefly out-

lined in Section 4 of this chapter. We provide a discussion of the current attempts to address the challenges of workplace learning using SSW technologies in Section 4, and conclude by discussing the lessons learned from current research and avenues for future directions (Section 6).

2 An overarching pedagogical strategy

Workplace learning is mainly informal (Hart, 2010; Kyndt et al., 2009; Tynjälä, 2008). This implies that usually it is the individual worker who has to initiate a learning process to address his or her own knowledge or competence gap. Ideally, individual knowledge workers are aware of their learning needs based on the requirements of a task, project, duty or their other work-related responsibilities (Siadaty, Gašević, Jovanović, Pata, Milikić, Holocher-Ertl et al., 2012); are able to define relevant learning goals and undertake appropriate learning processes to attain them; and have the capability to reflect upon and share their learning experience, so that others in need of the same knowledge can learn more effectively. This ideal image of informal, proactive learning, however, rarely happens in everyday workplaces. Unless provided with structured learning scenarios in formal settings, most people are not sufficiently proactive to initiate a learning process on their own, or they simply do not know how to self-regulate their learning (Margaryan et al., in press).

Self-regulated learning (SRL) has the potential to address this challenge (Margaryan et al., in press; Siadaty et al., 2012). The application of and support for SRL processes have previously been studied in formal, educational settings (for example Winne, 2010), however little is known about the applicability of SRL to workplace environments. To gain a better understanding of self-regulated learning in the workplace, specific issues must be considered (Littlejohn et al., 2012). First, the nature and objective of learning are noticeably different between educational and workplace environments. In formal, academic settings learning is a goal in itself (Margaryan et al., in press), and learning requirements and processes are typically well-structured and formally defined. Learning in the workplace, however, is usually a ‘by-product of work’ (Illeris, 2011; Margaryan et al., in press). This foregrounds the imperative role of the organisational context on how users recognise their learning needs; define their learning goals; conduct learning strategies to attain those goals; and reflect on their overall learning process to address their following or upcoming learning needs (Ashton, 2004).

Second, although the social-cognitive theories of SRL (for example, Zimmerman & Schunk, 1989) posit that the regulation of learning is social, there is little evidence of co- or socially-shared regulation (Hadwin, Järvelä, & Miller, 2011). For a long period of time, the role of the collective in SRL, particularly in workplace settings, has been under-researched (Jackson, MacKenzie, & Hobfoll, 2000), even though in the work-

place, individuals' work and learning activities are highly social and community-centred (Hart, 2010; Margaryan et al., in press).

Therefore, we suggest that an overarching learning strategy aimed at workplace learning is critical to supporting knowledge workers in self-regulating their learning, capitalising on the social and organisational contexts of the workplace. The social context can be represented, for instance, as awareness of group goal(s), such that individuals can improve their use of knowledge and contribute back to collective knowledge within their workplace. The organisational context can be manifest through the learning objectives of the organisation, so individuals can monitor their learning progress and ensure to keep on task.

3 Workplace learning context and users' information needs

Workplace learning is highly contextualised: the learning objectives and information needs of users are greatly dependent on the organisational context (Hager, 2011). However, there is currently no commonly-agreed definition of 'workplace learning context', with very few studies investigating how it affects workplace learning (Ashton, 2004). Researchers studying formal learning environments seem to agree that a learning context is comprised of learners, learning resources and a set of learning activities that are performed as part of a specific pedagogical approach (Siadat et al., 2008). In the workplace, however, the notion of learning context needs to be expanded to take into consideration additional, workplace-specific variables, such as work performance and organisational attributes. Therefore, research aimed at analysing the contextual nature of workplace learning is faced with major questions, including (i) how the concept of 'context' is defined and operationalised; (ii) what elements of the workplace environment are included in the definition of context; (iii) what processes might be applied in order to recognise and capture the context, and (iv) what factors affect workplace learning within an organisation.

Another important issue is how organisations deal with their workers' information needs in the very context of the workplace – how do organisations provide the right information resource to the right user at the right moment. Employees typically search for information available in reports, emails, or through other employees. This approach, however, leads to information overload (Spira, 2011), as each individual has limited information processing capacity to select the most relevant information (Klingberg, 2008).

Adaptive learning systems - systems which can adapt to behaviours of individual learners based on the information they collect about learners- have been applied to deliver 'the right *information* to the right learner at the right time' (Shute & Towle, 2003). However, it is the context – in this case the workplace learning context - which triggers the adaptation process in adaptive systems (Bomsdorf, 2005). Some studies (Ghidini, Pammer, Scheir, Serafini, & Lindstaedt, 2007; Siadat, Jovanović, Gašević,

& Jeremić, 2010) focused on delivering the right *information* - for example, learning content or details of relevant others such as expert peers - based on relevant elements of an individual's workplace context (such as their job description or competence gaps). Organisational factors, such as the higher importance of the tasks related to a project which is due in a short time frame, play a significant role in the definition of the workplace learning context. Consequently, this impacts on the adaptive delivery of information resources, such as those that could assist in acquiring the required but missing competences.

Technological enhancements to work environments can deliver great benefits for addressing users' information needs. Also, technology can support users in self-regulating their learning processes, with regard to the social and organisational contexts of their workplace. In the following section, we examine how the Social Semantic Web paradigm can be utilised to support workplace learning.

4 The Social Semantic Web

'Semantic Web' refers to the evolution of the World Wide Web into a Web of Data, where data are presented with well-defined semantics and thus available for automated discovery and integration across distributed applications (Berners-Lee et al., 2001). A set of technologies, tools and standards such as RDF (Resource Description Framework), SPARQL (SPARQL Protocol and RDF Query Language) and OWL (Web Ontology Language) form the building blocks of this enhanced vision of the Web (Breslin, Passant & Decker, 2009). Ontologies are one of the fundamental building blocks of the Semantic Web. They bring explicitly defined semantics to existing data, thus making the data machine-processable and ready for automated inferencing (Breslin et al., 2009). By building on top of an ontological infrastructure, various collective intelligent systems can be developed and utilised in different domains (Gruber, 2008). Such systems typically aim at: (i) collecting and aggregating user contributions (by adding well-defined structure and meaning to them); and (ii) enabling reasoning over the aggregated data, leading to answers, feedback, discoveries, or other beneficial results that are not available in contributions of individual users.

'Social Web' refers to the so-called *social* applications that have increasingly been present on the Web over the last decade. These applications introduced a novel form of users' interaction with and via the Web, thus transforming the Web from a read-only medium to a widely available, collaborative read-write Web. While the social aspect of the Web has always been one of its intrinsic properties (Berners-Lee & Fischetti, 1999), it gained momentum with services and technologies such as blogs, wikis, social networks, RSS-feeds, sharing services, bookmarking/tagging tools and the like (Breslin, Passant & Vrandeć, 2011). Social Web applications are already widely adopted in different contexts, and provide technical affordances, especially in learning environments, for a transition from conventional pedagogical approaches to

more participative and social-based forms of learning (Vassileva, 2008). However, most of them have one significant disadvantage: isolation from the rest of the Web (Breslin et al., 2011; Jovanović et al., 2009). Although huge amounts of user contributions exist within each individual social application, those contributions are often available only within the *walls* of that very application, thus preventing the seamless integration of the contributed data and knowledge. To realise the goal of cross-application data interoperability and allow for the realisation of collective knowledge systems, the Social Web can benefit from the Semantic Web stack of standards and technologies for explicitly defining the structure and meaning of data and knowledge. This could, in turn, make it easier for collective knowledge to be shared and integrated across various social applications (Breslin et al., 2009; Gruber, 2008; Jovanović et al., 2007).

These potentials have excited many researchers and resulted in a new paradigm known as Social Semantic Web (SSW). SSW enables creation, management and sharing of information, by combining the technologies and approaches from the Semantic Web and the Social Web (Breslin et al., 2009). SSW can be seen as a huge graph of collective knowledge systems, where social interactions within each system lead to the creation of explicit and semantically-rich knowledge representations. These systems are capable of providing useful information, based on users' contributions: they get more productive as more users contribute to the collective knowledge stored in them.

This novel paradigm has already started making its way into online education, and has proved beneficial for: (i) on-demand assembly of online courses from existing learning content (for instance, Westerski, Kruk, Samp, Woroniecki, Czaja & O'Nuallain, 2006); (ii) learning and knowledge sharing and co-construction in collaborative online learning environments (for instance, Auer, Dietzold, & Riechert, 2006); and (iii) provision of feedback for online educators (Jovanović et al., 2007). In addition, in our previous research (Jovanović et al., 2009), we explored and demonstrated the potential of the SSW paradigm for: (i) introducing new and improving existing forms of interaction in online learning environments; (ii) supporting interactivity across different systems and tools; and (iii) integrating interaction data to allow for advanced forms of adaptation and personalization in online learning.

5 Addressing the workplace learning challenges

In this section, we present a summary of existing research that relies on the affordances offered by the SSW in order to address the workplace learning challenges outlined earlier.

Using Social Semantic Web to Address Users' Information Needs

By leveraging Semantic Web technologies for storing data about group-related, content and knowledge management activities, the GroupMe! System, a system which offers personalised content management in a collaborative learning/working context, allows for the integration, sharing and better (re-)use of resources relevant for a group of users (Abel Henze, Krause & Kriesell, , 2009). The usefulness of GroupMe! in learning settings has been explored and evaluated in the context of LearnWeb2.0, a learning environment for Content and Language Integrated Learning (Marenzi, Kupetz, Nejd, & Zerr, 2010). LearnWeb2.0 supports collaborative search and aggregation of learning resources from various Social Web applications and services, including YouTube, SlideShare, and Blogger.

MetaMorphosis¹ is an online environment for sharing learning resources in medical education (Kaldoudi, Dovrolis, Giordano, & Dietze, 2011). It is a social network of content authors, learners, and learning resources, where the latter 'interact' with one another and with users. Learning resource profiles consist of a variety of data that capture their basic characteristics. Through the use of Semantic Web technologies, these data are augmented with formal semantics, readying them for automated processing and inferencing. More than 260 domain-specific (biomedical) ontologies are used to describe learning resources, facilitating the search and discovery of those resources. The Social Semantic Desktop, developed within the EU-funded project NEPOMUK is an open source environment supporting personal knowledge management (Bernardi, Grimnes, Groza, & Scerri, 2011) and the exchange of knowledge across social networks. It makes use of Semantic Web technologies to enable linking of data and information dispersed across various applications within a knowledge worker's personal computer. The Social Semantic Desktop is available as a standard component of KDE, a popular graphical interface for the Linux operating system². At present the technology is being further developed within the Open Semantic Collaboration Architecture Foundation³.

SSW-supported Overarching Learning Strategy

We explored the potential of the SSW to facilitate the creation and maintenance of Personal Learning Environments (PLEs) (Jeremić et al., 2013). The idea of a PLE fits well with the concept of self-regulated learning: it assumes that learners have the ability to control their learning. Our analysis of the state-of-the-art in PLEs and the application of social software and SSW tools in online learning identified a set of high-level principles for the development of SSW-supported PLEs (Jeremić et al., 2013). These principles have been instantiated through the design, implementation, analysis, and evaluation of DEPTHS (DEsign Patterns Teaching Help System) – a SSW-based PLE for the domain of software design patterns (Jeremić, Jovanović, & Gašević,

¹ <http://metamorphosis.med.duth.gr/>

² <http://nepomuk.kde.org>

³ <http://www.oscaf.org/>

2011). While DEPTHS was originally developed for, and evaluated in, higher education settings, it could be used to support workplace learning of software engineers. In another example, the MATURE project⁴ examined how informal knowledge matures in organisations, networks and communities of practice, through collaborative activities. The Knowledge Maturing Model is used to analyse real-world knowledge maturing practices (Maier & Schmidt, 2007). The process of knowledge maturing is supported through semantically-enhanced Social Web applications, such as semantic wikis, semantic tagging and common vocabulary building tools. Even though this project did not directly explore SRL and social-embeddedness of workplace learning, it indirectly contributed to these research areas. This work provides insights into knowledge maturing as an organisationally-guided learning process, that emerges at an individual and/or community level and moves towards the organisational level. In our own research on socially- and organisationally-embedded self-regulated workplace learning, we proposed a novel pedagogical framework, SRL@Work, that enhances a conventional model of SRL, by incorporating variables relating to the social and organisational contexts of workplace learning (Siadat et al., 2012). Based on a knowledge-building model (Pata & Laanpere, 2008), SRL@Work argues for the alignment of knowledge workers' SRL practices with their own learning goals, learning goals and activities of their colleagues, and learning goals of the organisation. However, this alignment is a challenging task for a knowledge worker, since it requires them to be well-informed about their present learning context. Workers also need to be aware of the availability and relevance of information resources that could help them advanced their learning objectives.

To assist workers in this challenging task and support their (organisationally-embedded) SRL process, our approach makes use of ontologies for the integration/linking of traces about individuals' activities across diverse tools/services they use in their daily working/learning practices, as well as the integration of individuals' knowledge into shared, organisational knowledge. Specifically, we developed a network of ontologies that enables formal representation and seamless integration of data about individuals' learning experiences (learning activities and their context), information being shared, and different kinds of annotations, such as tags, comments, and ratings, that capture either personal or community reflections on the shared content/knowledge (Siadat et al., 2011). To semantically link data and knowledge items used in/resulting from learning activities, we proposed the application of open formal knowledge bases, such as DBpedia⁵ or Freebase⁶.

To assess the validity and effectiveness of the SRL@Work framework and the technology that supports it, we have developed and evaluated Learn-B prototype. Learn-B

⁴ <http://mature-ip.eu>

⁵ <http://dbpedia.org>

⁶ <http://www.freebase.com/>

gives knowledge workers recommendations helping them identify their competence gaps; find the most fitting learning strategies to reach the missing competences; monitor their learning progress, sharing and documenting their learning experiences and comparing their self-observed performances against organisational benchmarks and/or the performance of their colleagues (Siadaty et al., 2012). Evaluation results suggest that both social and organisational elements of a workplace should be integrated into the design and development of interventions aimed at supporting users' SRL processes in the workplace. Users' perceived usefulness of the various learning interventions provided via Learn-B showed that they do consider the social context of their organisation when planning their learning goals. Yet, they primarily seek their organisational context and prefer to know clearly what options their organisation offers them and what competences they are expected to achieve. Analysis of users' trace data, on the other hand, indicated a relative balance between users' reliance on both social and organisational contexts. Additionally, the results revealed that the learning intervention that provided users with updates from their social context was the most important component in their overall set of learning actions. Also, the usage of this learning intervention was found to be the strongest determinant of users' engagement in SRL processes. The next most central intervention included the one that informed users about how various learning resources were used by their colleagues, along with the two interventions providing users with the organisational context of their workplace (Siadaty, 2013).

6 Conclusions

We identified the key challenges in supporting workplace learning and examined the potential of the SSW and related paradigms in addressing these challenges. Solutions based on the SSW paradigm, such as the GroupMe! System (Abel et al., 2009) or the Learn-B environment (Siadaty et al., 2012), are becoming increasingly available. Yet there is still a serious lack of empirical research of the benefits of the SSW paradigm. Most research is focused on addressing only one or a limited range of the challenges. Since these challenges are closely related, any attempt to address and solve one challenge should take into consideration the effects on other challenges.

Our research around the Learn-B environment provides some promising insights on solving these challenges. In these studies, we captured and analysed workers' actions 'on-the-fly' as they used various features of Learn-B. Thus, we grounded our analysis in accurate and authentic data, which represented workers' actual learning activities in the context of their workplace. In addition, we analysed workers' perceptions of the usefulness of the support provided through the Learn-B environment. These two streams of data (workers' actions and self-reports) gave insight into the factors that encourage knowledge workers' use of self-regulatory processes.

Different software/technological enhancements deliver different cognitive affordances. Such affordances allow for the expression and capturing of different traces of users' (self-regulatory) learning processes. These user traces can be used to evaluate the support that different types of tools offer for various macro and micro-level SRL processes (Cleary, Callan & Zimmerman, 2012). Future research should investigate the use of such traces and other kinds of objective data to assess the effectiveness of technology support of self-regulatory learning processes in the workplace.

7 References

- Abel, F., Henze, N., Krause, D., & Kriesell, M. (2009). Semantic enhancement of social tagging systems. *Web 2.0 & Semantic Web*, 6(1), 25-54.
- Anderson, P., Hepworth, M., Kelly, B., & Metcalfe, R. (2007). What is Web 2.0? Ideas, technologies and implications for education. Bristol, UK: JISC.
- Ashton, D. (2004). The impact of organisational structure and practices on learning in the workplace. *International Journal of Training and Development*, 8(1), 43-53.
- Auer, S., Dietzold, S., & Riechert, T. (2006). OntoWiki: A tool for social, semantic collaboration. In Y. Gil, E. Motta, R. V. Benjamins, & M. Musen (Eds.), *Proceedings of the 5th International Semantic Web Conference (ISWC'06)* (pp. 736 - 749). Athens, GA: Springer.
- Bernardi, A., Grimnes, G., Groza, T., & Scerri, S. (2011). The NEPOMUK Semantic Desktop. In P. Warren, J. Davies, & E. Simperl (Eds.), *Context and semantics for knowledge management: Technologies for personal productivity* (pp. 255 - 273). Heidelberg, Germany: Springer.
- Berners-Lee, T., & Fischetti, M. (1999). *Weaving the Web: The original design and ultimate destiny of the World Wide Web by its inventor*. San Francisco: Harper.
- Berners-Lee, T., Hendler, J., & Lassila, O. (2001). The Semantic Web. *Scientific American*, 284(5), 28 - 37.
- Bingham, T., & Conner, M. (2010). *The new social learning: A guide to transforming organizations through social media*. San Francisco, CA: Berrett-Koehler Publishers.
- Bomsdorf, B. (2005). *Adaptation of learning spaces: supporting ubiquitous learning in higher distance education*. In N. Davies, T. Kirste, & H. Schumann (Eds.), *Mobile computing and ambient intelligence: The challenge of multimedia*. (pp. 1-13). Dagstuhl, Germany: Internationales Begegnungs und Forschungszentrum für Informatik (IBFI).
- Breslin, J. G., Passant, A., & Decker, S. (2009). *Social Semantic Web*. Retrieved from <http://books.google.com/books>
- Breslin, J. G., Passant, A., & Vrandeć, D. (2011). *Handbook of Semantic Web Technologies*. (J. Domingue, D. Fensel, & J. A. Hendler, Eds.). Berlin, Heidelberg: Springer.
- Carneiro, R., Lefrere, P., & Steffens, K. (2007). *Self-regulated Learning in Technology Enhanced Learning Environments: A European Review*. UK: Kaleidoscope Network of Excellence. Retrieved from <http://telearn.noe-kaleidoscope.org/>
- Cleary, T. J., Callan, G. L., & Zimmerman, B. J. (2012). Assessing self-regulation as a cyclical, context-specific phenomenon: Overview and analysis of SRL microanalytic protocols. *Education Research International*. Retrieved from <http://downloads.hindawi.com/journals/edu/2012/428639.pdf>
- Ellinger, A. D. (2005). Contextual Factors Influencing Informal Learning in a Workplace Setting : The Case of " Reinventing Itself Company ." *Human Resource Development Quarterly*, 16(3), 389-415.
- Eraut, M. (2004). Informal learning in the workplace. *Studies in continuing education*, 26(2), 247-273.
- Ghidini, C., Pammer, V., Scheir, P., Serafini, L., & Lindstaedt, S. (2007). APOSDLE: learn@ work with semantic web technology. *I-SEMANTICS 2007* (pp. 262-269). Gratz, Austria. Retrieved from http://i-know.tugraz.at/wp-content/uploads/2008/11/8_aposdle.pdf

- Gruber, T. (2008). Collective knowledge systems: Where the Social Web meets the Semantic Web. *Web Semantics: Science, Services and Agents on the World Wide Web*, 6(1), 4-13.
- Hadwin, A. F., Järvelä, S., & Miller, M. (2011). Self-regulated, co-regulated, and socially-shared regulation of learning. In B. J. Zimmerman & D. Schunk (Eds.), *Handbook of Self-Regulation of Learning and Performance* (pp. 65 - 84). New York: Routledge.
- Hager, P. (2011). Theories of Workplace Learning. In M. Malloch, L. Cairns, K. Evans, & B. N. O'Connor (Eds.), *The SAGE Handbook of Workplace Learning* (pp. 17-32). London: SAGE Publications Ltd.
- Hart, J. (2010). The State of Learning in the Workplace Today. *Center for Learning and Performance Technologies website*. Retrieved March 15, 2010 from <http://c4lpt.co.uk/social-learning-handbook/>
- Illeris, K. (2011). Workplaces and learning. In M. Malloch, L. Cairns, K. Evans, & B. N. O'Connor (Eds.), *The SAGE Handbook of Workplace Learning* (pp. 32 - 45). London: SAGE Publications Ltd.
- Jackson, T., MacKenzie, J., & Hobfoll, S. E. (2000). Communal aspects of self-regulation. In M. Boekaerts, P. R. Pintrich, & M. Zeidner (Eds.), *Handbook of self-regulation* (pp. 275-299). San Diego, CA: Academic Press.
- Jeremić, Z., Jovanović, J., & Gašević, D. (2011). An environment for project-based collaborative learning of software design patterns. *International Journal of Engineering Education*, 27(1), 41 - 51.
- Jeremić, Z., Jovanović, J., & Gašević, D. (2013). Personal learning environments on the Social Semantic Web. *Semantic Web*, 4(1), 23-51.
- Jovanović, J., Gašević, D., Knight, C., & Richards, G. (2007). Ontologies for effective use of context in e-learning settings. *Educational Technology & Society*, 10(3), 47 - 59.
- Jovanović, J., Gašević, D., Torniai, C., Bateman, S., & Hatala, M. (2009). The Social Semantic Web in Intelligent Learning Environments: state of the art and future challenges. *Interactive Learning Environments*, 17(4), 273-309.
- Kaldoudi, E., Dovrolis, N., Giordano, D., & Dietze, S. (2011). *Educational Resources as Social Objects in Semantic Social Networks*. Paper presented at the 1st International Workshop on eLearning Approaches for the Linked Data Age, Heraklion, Greece.
- Klingberg, T. (2008). *The overflowing brain: Information overload and the limits of working memory*. New York: Oxford University Press.
- Kyndt, E., Dochy, F., & Nijs, H. (2009). Learning conditions for non-formal and informal workplace learning. *Journal of Workplace Learning*, 21(5), 369-383.
- Lee, T., Fuller, A., Ashton, D., Butler, P., Felstead, A., Unwin, L., & Walters, S. (2004). *Workplace Learning: Main Themes & Perspectives. Learning as Work Research Paper*. Leicester: Centre for Labour Market Studies, University of Leicester.
- Ley, T., Kump, B., & Albert, D. (2010). A methodology for eliciting, modelling, and evaluating expert knowledge for an adaptive work-integrated learning system. *International Journal of Human-Computer Studies*, 68(4), 185-208.
- Littlejohn, A., Milligan, C., & Margaryan, A. (2012). Charting collective knowledge: supporting self-regulated learning in the workplace. *Journal of Workplace Learning*, 24(3), 226-238.
- Maier, R., & Schmidt, A. (2007). *Characterizing Knowledge Maturing – Conceptual Process Model for Integrating E-Learning and Knowledge Management*. Paper presented at 4th Conference on Professional Knowledge Management, Postdam, Germany. Retrieved from http://publications.andreas.schmidt.name/Maier_Schmidt_KnowledgeMaturing_WM07.pdf
- Marenzi, I., Kupetz, R., Nejd, W., & Zerr, S. (2010). *Supporting active learning in CLIL through collaborative search*. Paper presented at the International Conference on Advances in Web-Based Learning (ICWL 2010), Shanghai, China. Retrieved from <http://www.l3s.de/web/upload/documents/1/Supporting%20Active%20Learning%20in%20CLIL%20through%20Collaborative%20Search.pdf>

- Margaryan, A., Littlejohn, A., & Milligan, C. (in press). Self-regulated learning in the workplace: Learning goal attainment strategies and factors. *International Journal of Training and Development*.
- Marsick, V. J., Watkins, K., & O'Connor, B. N. (2011). Researching Workplace Learning in the United States. In M. Malloch, L. Cairns, K. Evans, & B. N. O'Connor (Eds.), *The SAGE Handbook of Workplace Learning* (pp. 198 - 210). London: SAGE Publications Ltd.
- Mikroyannidis, A. (2007). Toward a social semantic web. *Computer*, 40(11), 113- 115.
- Pata, K., & Laanpere, M. (2008). *Supporting Cross-Institutional Knowledge-Building with Web 2.0 Enhanced Digital Portfolios*. Paper presented at the Eighth IEEE International Conference on Advanced Learning Technologies (ICALT 2008), Santander, Cantabria, Spain. Retrieved from <http://ieeexplore.ieee.org/>
- Shute, V., & Towle, B. (2003). Adaptive e-learning. *Educational Psychologist*, 38(2), 105-114.
- Siadaty, M. (2013). Semantic Web-Enabled Interventions to Support Workplace Learning. *Unpublished Doctoral Dissertation*. Simon Fraser University.
- Siadaty, M., Gašević, D., Jovanović, J., Pata, K., Milikić, N., Holocher-Ertl, T., Jeremić, Z., et al. (2012). Self-regulated Workplace Learning: A pedagogical framework and Semantic Web-based environment. *Educational Technology & Society*, 15(4), 75-88.
- Siadaty, M., Jovanović, J., Gašević, D., & Jeremić, Z. (2010). Leveraging Semantic Technologies for Harmonization of Individual and Organisational Learning. In M. Wolpers, P. A. Kirschner, M. Scheffel, S. N. Lindstaedt, & V. Dimitrova (Eds.), *Sustaining TEL: From Innovation to Learning and Practice - 5th European Conference on Technology Enhanced Learning, EC-TEL 2010 (Lecture Notes in Computer Science, Vol. 6383)* (pp. 340-356). Barcelona, Spain: Springer.
- Siadaty, M., Jovanović, J., Pata, K., Holocher-Ertl, T., Gašević, D., & Milikić, N. (2011). *A Semantic Web-enabled Tool for Self-Regulated Learning in the Workplace*. Paper presented at the 11th IEEE International Conference on Advanced Learning Technologies (ICALT 2011), Athens, Georgia. Retrieved from <http://ieeexplore.ieee.org/>
- Spira, J. B. (2011). *Overload! How too much information is hazardous to your organisation*. Hoboken, NJ: Wiley.
- Tochtermann, K., & Granitzer, G. (2008). *The Long Way towards Workplace-Integrated Learning*. Paper presented at the Eighth IEEE International Conference on Advanced Learning Technologies (ICALT 2008), Santander, Cantabria, Spain. Retrieved from <http://ieeexplore.ieee.org/>
- Tynjälä, P. (2008). Perspectives into learning at the workplace. *Educational Research Review*, 3(2), 130-154.
- Vassileva, J. (2008). Toward social learning environments. *IEEE Transactions on Learning Technologies*, 1(4), 199-214.
- Westerski, A., Kruk, S., Samp, K., Woroniecki, T., Czaja, F., & O'Nuallain, C. (2006). E-learning based on the social semantic information sources. Paper presented at the *1st Latin American conference on Learning Objects*, Guayaquil, Ecuador. Retrieved from <http://aran.library.nuigalway.ie/xmlui/handle/10379/397>
- Winne, P. H. (2010). Bootstrapping learner's self-regulated learning. *Psychological Test and Assessment Modeling*, 52(4), 472-490.
- Zimmerman, B. J., & Schunk, D. H. (Eds.). (1989). *Self-Regulated Learning and Academic Achievement: Theory, Research, and Practice*. New York: Springer Verlag.