Designing Technologies to Support Professional and Workplace Learning for Situated Practice

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I. INTRODUCTION

IN an era of global, organisational, and technological change, all of which are transforming the world of work, professional and workplace learning are critical for both employability and organisational competitiveness: A range of fundamental transformations are changing how people work. Digital technologies replace human labour and, at the same time, accelerate the expansion of job roles and work practices. Work is becoming increasingly specialised, which means that professionals with specific expertise now have to work in collaborative and networked ways. At the same time, labour is increasingly decentralised, making it more distributed across sites. Finally, work is increasingly time- and place-independent, as people work and connect via digital technologies. These changes mean that workplace learning is needed on a greater scale than ever before [1]. One way to provide learning at scale is through the integration of technology and learning in workplaces [2]. Yet, most advances in learning technologies have been made within K-12 and higher education settings, and in formal learning environments rather than in workplace contexts [3].

Designing the future of workplace learning is an interdisciplinary challenge that mandates bringing together disciplines including learning sciences, computer science, and human-computer interaction (HCI) in order to integrate work, learning, and technology [2]. Theories and methods from all these disciplines need to be brought together to identify problems and engineer solutions.

To achieve this goal, this special issue of the *IEEE Transactions on Learning Technologies* on "Designing Technologies to Support Professional and Workplace Learning for Situated Practice" aims to showcase the latest developments in how to design technologies that support professional and workplace learning for situated work, highlighting major issues and trends.

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II. PAPERS IN THIS SPECIAL ISSUE

Workplace learning has unique characteristics that make it different from formal education. Workplace learning is shaped around work practices and organisational efficiency rather than the forms of pre-designed curricula and assessments that formal education is based on. While formal education often is designed around assessing conceptual learning that is graded through written assessments, the knowledge needed for work can take many forms: conceptual, practical, locative, etc. Learning these broad types of knowledge not only requires different system designs but also relies on learners having the ability to be active agents in their own learning. Formal learning usually requires the learner to apply knowledge learned in a classroom setting, however, professional learners need also to be able to apply new knowledge they have learned within the context of their work. This context may not be known in advance at the time of designing for learning unlike in formal learning contexts. Further, each work context is different, so every professional will be applying newly learned knowledge within a bespoke work setting. This reinforces the need for professional learning to be personalised either by the learning system or by the learners themselves. We see these trends and characteristics in the papers that are gathered in this special issue.

One group of papers investigates technologies that specifically support situated learning: Cassola et al. investigate in *Design and Evaluation of a Choreography-based Virtual Reality Authoring Tool for Experiential Learning in Industrial Training* how to author content for virtual reality (VR) in ways that allow the creation of contextualised learning content. In the paper *Vocational Training with Microlearning: How Low-Immersive-360-Degree Learning Environments Support Work-Process-Integrated Learning*, Billert et al. investigate how to contextualise learning with manufacturing processes, supporting the learning by using (360 degree) VR images of the real-world work environment. Although this system created a relatively low-immersive environment, the authors evidenced an increased sense of presence which was motivating for the learners and led to increases in knowledge gained. Wolfbauer et al. investigate *A Script for Conversational Reflection Guidance: A Field Study on Developing Reflection Competence with Apprentices*. These authors found that apprentices can be guided by a conversational agent that helps them reflect on typical professional tasks as part of their vocational training. It further seems that the agent helps apprentices learn how to reflect on their work over time.

A second group of papers examines what kinds of learning

analytics are useful for professional learning: Barthakur et al. propose a classification algorithm that analyses reflective essays in their paper *Understanding depth of reflective writing in workplace learning assessments using automatic classification*. This form of computational analysis had previously been investigated for higher education and is here transferred to workplace learning. Meija et al. propose an *Evolutionary Clustering of Apprentices' Self-Regulated Learning Behavior in Learning Journals*. This algorithm traces the development of apprentices' throughout their apprenticeship to identify any underlying need for specific guidance and mentoring.
A third group of papers provides socio-technical insights by contributing design-relevant knowledge about how technologies can be adapted, configured and used to facilitate professional learning. For example, Sankaranarayananet al. write about *Collaborative programming for work-relevant learning: Comparing programming practice with example-based reflection for student learning and transfer task performance*. In this paper, the authors investigate whether hands-on-practice at work can be improved by reflecting on worked examples. Poquet et al. turn their attention to business leaders' perspectives on technology and learning in their paper *Learning Analytics in the Corporate Sector: What Business Leaders Say*. Tammets et al. propose *A Digital Learning Ecosystem to Scaffold Teachers' Situated Learning*. The authors have implemented and discuss an environment that supports teachers' self-reflection in the context of their professional work. In this environment, multiple applications are integrated that all facilitate different aspects of reflecting on the use of educational technology in the classroom. Buckingham-Shum et al. take a more general view in their paper on *Framing professional learning analytics as reframing oneself*. The authors propose a conceptual shift in understanding learning analytics' role for professional learning and give concrete examples of useful types of learning analytics for such learning.

III. Discussion

The papers in this special issue highlight a number of trends and topics in designing digital technologies for workplace learning:

- Many of these digital technologies *support in-situ knowledge creation*. Whereas in formal education settings, there is a human teacher, in workplace learning, the teaching role could be a manager or a colleague, or could be implemented within a computational learning environment. Several special issue papers constitute technologies for learning without a teacher (Cassola et al., Sankaranarayanan et al., Billert et al., Poquet et al., Tammets et al., Buckinham-Shum et al.). These kinds of technologies could be transferred to formal education settings, albeit with the adaptation that these would support specific learning scenarios embedded in overarching instructional sequences.
- Subsequently, it is important that technologies for workplace learning make use of the *range of design opportunities on the spectrum of low guidance - high guidance* (cp. [4]). This is visible in the submitted papers: Sankaranarayanan et al. and Tammets et al. propose learning environments that structure the learning environment based on background knowledge in the domain of learning (worked programming examples in Sankaranarayanan et al., domain-specific self-assessments in Tammets et al.). In Cassola et al. and Billert et al., virtual reality technologies are developed that support creating highly contextualised learning materials that give guidance via their structure. In Wolfbauer et al., reflection is strongly guided by a conversational agent.
- Some technology systems take into consideration the fact that *learning is an embodied experience*, taking up more recent developments in psychology and the learning sciences, as well as comparatively new technical possibilities. For example the wearable technologies investigated in Cassola et al. and Billert et al. evidence new ideas of how situated learning can be supported digitally through the engagement of diverse human senses (vision, audio, body movement, different forms of interaction). These interaction paradigms allow the realisation of embodied cognition, an area of research that is becoming more mainstream within the learning sciences. They are likely to become more significant as new technologies and systems are created.
- Some digital systems are designed to *create contextualised learning materials*, e.g. (Cassola et al., Sankaranarayanan et al., Billert et al.) or to *contextualise learning with (future) work* (Wolfbauer et al.) Formal curricula are not always helpful for workplace learning, where learning is situated around work. However, the development of contextualised learning materials supports alignment of learning with the work setting.

IV. Summary

This special issue and the papers in it constitute a snapshot into ongoing research on situated workplace learning and the role that learning technologies play in this context. In this editorial, we have tried to connect such ongoing research with state-of-the-art in learning sciences, computer science, and HCI; and to identify issues and trends. We hope our synthesis and the papers within this special issue can inform current research, and inspire novel thinking around digital technologies for situated professional and workplace learning.

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