Intelligent Mentoring Systems for Making Meaning from Work Experience

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Abstract. This position paper presents a forward-looking view on addressing a long standing professional learning challenge faced by higher educational institutions, namely assisting students to make meaning from work-based experience and develop as reflexive professionals. We suggest that a synergetic approach, building on existing research in professional lifelong learning and intelligent learning environments and taking advantage of new opportunities provided by emerging technologies, will underpin a new breed of intelligent mentoring systems for professional learning. They will foster the learners' meaning making process, as well as assist tutors in their roles as coaches/mentors.

Keywords: Professional lifelong learning, reflexive practitioners, work-based learning, intelligent learning environments, intelligent mentoring systems

1 Motivation

It is vital that higher education meets the growing demands for professionals who are able to adapt to dynamically changing contexts, respond to new sociocultural challenges, and play leadership roles within complex heterogeneous systems. Education has to prepare reflexive practitioners who are lifelong learners capable of creating, transferring and modifying knowledge across different settings. One of the most effective ways to meet these aims is to include work-based activities within subject-based education [1]; indeed, this is seen as a key priority for the development of better-skilled workforce and boosting economic growth and social prosperity [2]. Educational institutions are progressively introducing work-based practical experience, ranging from fully embedded practice throughout the whole curriculum, to short-term industrial experience in the form of placements and internships, to problem-based learning drawing on realistic situations.

However, there remains a longstanding and seemingly intractable challenge, namely connecting formal subject-based education and informal work-based learning. This manifests as the need to support re-contextualisation of knowledge across different learning settings [3]. Reflexive practitioners explore their experiences to better understand their practice and improve themselves and the work environment. Unlike reflection, which is perceived as a somewhat passive instrument of observation, reflexivity

takes the form of a meaning-making activity in which the learner considers assumptions, makes interpretations, identifies perspectives, draws connections, and decides on actions [4]. This is in essence a creative process which involves the construction of personal narratives that represent the individual's perceptions of their work experiences. Meaning making is insufficiently supported in higher education settings:

- Learners produce shallow, often inaccurate or superficial, reflections on their work-based experiences: they overlook key points, fail to recognise crucial cues, cannot make comprehensive interpretations, are unable to see all perspectives, and make poor connections across activities.
- Learners do not make the best use of their work-based opportunities: they do not prepare adequately, fail to ask appropriate questions, do not seek out experiences which will help them develop, do not solicit timely help from those they work with, and they fail to use tutor support appropriately.
- Tutors are unable to provide effective coaching/mentorship support: from the limited data available, they may have a very partial understanding of the learners' experiences, limitations or inadequacies across various work activities; they are unable to facilitate learners to be pro-active and engage with their work practice.
- Workplaces may have to undertake remedial education with new employees: although new workers always require training, employees who are inadequately prepared through their education will need substantial training, coaching and support if they are to succeed in their transition into work.

Technology can play a key role in innovating education practice in general, and reflexive learning through work-based experience in particular, by providing scalable and cost-effective interventions. We present here a forward-looking view of the role of intelligent technology in augmenting reflexive learning by supporting learners to make meaning from their work-based practice and assisting tutors to act as coaches/mentors facilitating the linking between work-based experience and formal education. The paper outlines a vision for developing intelligent mentoring systems for professional learning (IMS-PL). It draws on research in reflexive learning which provides the pedagogic underpinning, and points at requirements for the role of technology (Section 2). We then briefly review existing strands in intelligent learning environments that can provide the starting point for IMS-PL (Section 3). Finally, we list key challenges and suggest possible ways to address them when shaping IMS-PL.

2 Pedagogic Underpinning

The pedagogic underpinning for IMS-PL is based on contemporary approaches for reflexive learning and professional development, which identify key aspects of making meaning from work experience.

The embedding of work-based learning activities within formal education provides stimulating means for deeper learning, allowing learners to apply not only their subject knowledge and skills but also their interpersonal and intrapersonal skills [5]. Transitions from formal education to the work-place, or between different work-place settings, can be framed as critically intensive learning periods which challenge the

learner/practitioner to quickly acquire new knowledge specific to the new setting, to understand new organisational structures and cultures, and to establish new working relationships [6].

Most commonly, education focuses on reflection, i.e. learning and developing through examining what we think happened on any occasion, and how we think others perceived the event and us. Reflexivity is potentially more complex than being reflective: reflexivity requires understanding the myriad ways in which one's own presence and perspective influence knowledge and actions [7]. In other words, reflexivity is a stance of being able to locate oneself in the picture, and to appreciate how one's own self influences actions. Reflexivity means "finding a way to stand outside of ourselves to get a more objective view of ourselves" [7]. Reflexive learners are those who are able to contextualise and re-contextualise their knowledge and skills when moving between different settings of formal, workplace and informal learning. They engage actively with the development of their own knowledge and skills, and also with the social and organisational context in which their learning or workplace practice is taking place.

Reflexivity is associated with meaning making from work practice where the learner assesses, makes deeper interpretations, explores connections and alternatives, and decides on actions [4]. Meaning making is rooted in work practice that is inherently contextualised (it exists in a particular setting, and in a particular social and organisational context) and embodied (practitioners carry it out in both mind and body) [8]. Thus, aspects such as emotion, motivation and self-awareness cannot easily be separated from cognitive aspects, and reflection on practice will necessarily comprise subjective, as well as objective elements. Engaging in 'learning conversations' helps students to articulate and critique their growing understanding of practice [9]. In order to capture this dialogical dimension of learning, "confrontation either by self or others must also occur" [9].

Confrontation by self can occur through the creation of narratives, which allow learners to link their current experiences with previous experiences in an inherently personal way, enabling them to critique both themselves and their environment [10]. Bolton proposes the use of writing for exploring our own actions and those of others around us, and argues for narrative writing as a fundamental tool for meaning-making [7]. This enables the learner to see not only 'in-the-mirror' but 'through-the-mirror', exploring different perspectives and setting a course of action. Collier brings to the fore the place of creativity in the reflection process, arguing that the imaginative aspect of reflection allows movement away from a "tick-box" mentality [11].

Narratives facilitate meaning making from experience to interpret what has happened, make sense and reflect. This resonates with the vision of designing intelligent systems for inclusion, self-esteem, recognition of different perspectives, self-awareness, and reflexivity [12]. Narrative has been used, e.g. as theatre role play activity or as story writing activity, to foster creative thinking and make reflection more motivating and deeper [13]. However, recent studies show that today's millennial learners are exposed to a vast amount of interactive media which imposes a radical change to the production and consumption of content [14]. Hence, new forms of narratives will be required which are closely aligned with digital media production.

The timing of reflexive activities is also very important as it can influence the quality and nature of the reflections: if reflection occurs immediately after an event of heightened emotions it is likely to be more subjective than if it occurs some time later, and thus a sequence of reflections over time is needed to draw out a deeper interpretation and understanding of the experience [15]. Guidance and supervision are key to reflective practice and are factors that learners perceive to be beneficial to their learning; and hence tutors have to be effective coaches and mentors [16].

Following these arguments, it can be expected that IMS-PL need to help learners to become aware of their emotions during work practice and can use emotion inci*dents as triggers of 'confrontation with self' in t*he form of personal digital narratives linking personal reflections across various work practice contexts. At the same time, acknowledging the key role of tutors in facilitating productive reflection, IMS-PL need to support them to *gain a better understanding of their learners' experience*s and thus provide more engaging and meaningful coaching/mentoring.

3 Technological Underpinning

The technological underpinning for IMS-PL is provided by recent developments in intelligent environments for adult learning. We list below some of the current models and techniques which can be the basis for IMS-PL. Note that this is not an exhaustive list, we have only selected technological solutions that can be related to the requirements drawn in Section 2. For example, social systems and collaborative environments have been used for reflective learning from work-based practice (c.f. [17]) but the effective use of such environments implies that the learners already possess critical thinking and creative imagination to produce useful reflections. They have been used to support reflective learners who are already progressing in their professional career (e.g. doctors or public administration employees). The key challenge that inexperienced professionals, such as students at universities or vocational training colleges face – how to make meaning from their work-based activities – remains largely unaddressed and unsupported. Although collaborative environments can provide 'confrontation by others' to trigger reflection, they do not tackle the important problem of developing learners' critical and creative thinking abilities so that they can more effectively remember and interpret their work experience, draw connections and associations, consider alternatives and link with professional development. It is the fostering of this intertwined thinking for augmenting reflexive learning that is the prime focus for the IMS-PL vision we shape here.

Intelligent learning environments are now a mature topic in research and practice. They build on the considerable body of research in Artificial Intelligence in Education (AIED) to create adaptive learning environments capable of adapting to learners and of providing personalised support. AIED researchers are starting to look outside the mainstream educational environments towards adult education and workplace learning, to provide innovative learning models that are universal, inclusive, lifelong and seamlessly integrated in everyday practice (c.f. [18]). As stressed in a recent review [19], in the next 10-15 years AIED will play a key role in supporting adult lifelong

learning. A possible way to do this is by providing 'lifelong learning companions to advise, recommend, and track learning' [19]. We expect that IMS-PL will include such companions and envisage that personalised virtual assistants for reflexive learning from work experience will be part of the next generation of AIED for adult learning.

IMS-PL will have to address cognitively complex domains which are associated with 21st century transferable skills, e.g. communication, collaboration, critical thinking, creativity, emotional intelligence, decision making. These skills are gaining growing attention in the AIED community, within the well-established stream of intelligent learning environments for ill-defined domains [20]. Example systems to support learning in ill-defined domains include collaborative spaces building on social interactions or situational simulations where the learners can 'experience' complex situations in a safe environment, e.g. military training [21] or simulated internships [22]. Critical for supporting learning in such open environments, where multiple interpretations and perspectives exist, is to provide effective learner support, adapted to the learner's cognitive and affective states. We envisage that adaptation to both cognition and affect will be a key feature of IMS-PL.

Open learner modeling, where the learner is presented with a model that the system has obtained about them based on interactions monitored by the system, can foster reflection and meta-cognition [23]. Furthermore, when the open learner model is used as a trigger for interaction with the learner, i.e. interactive open learning modelling, the learner can be provided with reflective scaffolds to help learners to understand themselves [24]. We envisage that IMS-PL will leverage interactive open learner modeling substantially extending the interaction to provide mentor-like assistance to help the learners develop an understanding of their strengths and abilities, see and interpret different perspectives and opportunities, make sense of personal experiences, develop strategies and set goals, and improve their confidence and self-esteem.

In addition to the above, we expect that IMS-PL will offer new interaction spaces to promote reflection and self-awareness contextualised in practice, which will build on the blurring boundaries of the physical and digital worlds. This will leverage emerging technologies that enable the development of smart coaches empowering people to take control of their lifestyle (e.g. the quantified self), as outlined below.

4 A Vision for IMS-PL

Following the discussion in the previous sections, we hypothesise that IMS-PL will include a new generation of personalised virtual learning assistants which will be embodied and situated in real-world practice and will provide scalable, contextualised and longitudinal support for making meaning from work experience. They will leverage key emerging technologies, such as wearables and personalised mobile assistants. This technology ensemble has already brought disruptive innovation in other areas (e.g. quantified self) empowering people to become aware of their behavior and take control of their lives. We list below key research questions that have to be addressed to achieve this vision, and outline possible ways to tackle these questions.

RQ1: How to capture, in an unobtrusive way, the learner's emotions and affect during his/her work practice and make the learner aware of the emotions he/she has experienced during work activities?

This can be addressed by using wearable sensors (e.g. on smart watches or bands) which can detect low-level signals and 'emotion episodes' with spikes of positive or negative emotions. This can be combined with emotion detection from speech/text (e.g. the learner taking notes on a smartwatch or mobile phone before, during, or immediately after a work activity). An emotion dashboard can be provided to the learner to make him/her aware of their emotions.

RQ2: How to trigger critical and creative thinking to promote reflection-on-action by utilising the sensed emotions during work experiences?

This can be addressed by extending existing note-taking tools with interactive contextualised 'nudges' to foster the learner's critical and creative thinking. This will help the learner to recall relevant aspects of their experience, interpret it, link it with past experiences, and set goals for future actions. A nudge framework can be implemented in the form of short dialogue games, using the sensed emotions as triggers for interaction and utilising knowledge-enriched semantic analysis of the learner's notes.

RQ3: How to help learners to create digital narratives, linking their current experiences with previous experiences and exploring alternative ways for interpreting work activities?

This can be addressed by offering an interactive story-telling environment where learners can inspect their experiences and 'make a story', i.e. a coherent narrative linking together different experience assets, such as notes and digital objects (e.g. pictures or presentations related to the experience). Support can be provided by offering story templates to create narratives linked to transferable skills and by personalised prompts directing the learner to aspects they may explore further.

RQ4: How to assist tutors in their new roles of coaches/mentors who facilitate meaning making from work experience?

This can be addressed by providing an experience exploration dashboard for tutors, so that they can inspect their learners' reflexive narratives and become aware of key aspects related to their work experiences. Tutor support can include notification and visualisation tools based on semantic analysis and exploration of the learners' experiences, reflections and narratives, enabling tutors to provide timely and meaningful feedback to their students.

Experimental studies will be required to assess to what extent the above features support reflexive learning and meaning making from work experience. These will focus on selected work-based activities, e.g. work placements or project internships, within specific domains where the technology has already been used in similar settings and where work experience is a crucial addition to formal education (e.g. Medicine or ICT). It would also be useful to trial any system in environments that are not technology rich, e.g. filed-based construction work. This will provide constraints that

will bring sharper focus. Evaluation of our proposed pedagogical and technological framework will also require selecting and examining the development of specific transferable skills, e.g. communication, collaboration and innovation, as well as looking into the broader skills of learning to learn and professional development. Such evaluation can be undertaken using qualitative methods, engaging with all stakeholders in co-design and co-evaluation. In addition, quantitative methods (e.g. surveys) can be used to assess technology acceptance and perceived usefulness. Evaluation of the tutor support will need to similarly examine its benefits and possible drawbacks in assisting tutors in their roles as coaches and mentors.

Individual differences will play a major role, and additional evaluation studies will need to examine whether, and how, individual differences affect the effectiveness of IMS-PL. Possible factors to include are demographics (gender, age, nationality); cognition, emotion regulation, and personality traits; self-regulation and curiosity. These user characteristics can be combined with analysis of the learners' and teachers' interaction data with IMS-PL during user pilots. Based on this, strategies informing how to include personalisation and adaptation in IMS-PL can be derived.

Acceptability of the new technology will be a key driver for the new research stream. It is possible that the new technology impinges on the practitioner's work practice and relationships with colleagues. This would raise various kinds of issues related to social acceptability and ethics – these would have to be identified at the outset and carefully monitored as research progresses.

5 Concluding Remarks

In this paper we have motivated and presented a forward-looking view on addressing a long-standing challenge faced by higher education institutions, namely assisting students to make meaning from their work-based experiences in order to develop as reflexive professionals. We have identified possible roles of intelligent technologies – including wearable sensors, personalised mobile assistants, interactive open learner modelling, contextualised nudging frameworks for creative critical thinking, interactive story-telling environments, and notification and visualisation tools for tutors – in innovating reflexive learning through work-based experience by providing scalable and cost-effective interventions for both students and tutors.

Our ultimate goal is to shape a new breed of intelligent learning environments, which we term intelligent mentoring systems for professional learning (IMS-PL), which include mentor-like features to help learners become reflexive practitioners and establish themselves in their professional careers, while at the same time recognising the key role of tutors as coaches/mentors facilitating learners' productive reflections and learning.

References

[1] Hoffmann, N. Let's Get Real: Deeper Learning and the Power of the Workplace, Deeper Learning Research Series, Jobs of the Future, 2015.

[2] Rethinking Education: Investing in Skills for Better Socio-economic Outcomes, EU Policy Communication, 2012.

[3] Gulie, D., Evans, K. Putting Knowledge to Work: Recontextualising Knowledge through the Design and Implementation of Work-based Learning at Higher Education Levels, UK ESRC report, 2010.

[4] Dochy, Filip, Gijbels, D., Segers, M., Van den Bossche, P. Theories for learning at the Workplace: building blocks for training and professional development programs, Routledge, 2011.

[5] Cox, E. Adult learners learning from experience: using a reflective practice model to support work-based learning, Reflective Practice, 6:4, 459-472, 2005.

[6] Kilminster, S., Zukas, M., Quinton, N., Roberts, T. Preparedness is not enough: understanding transitions as critically intensive learning periods. Medical Education, 45 (10), pp. 1006-1015, 2011.

[7] Bolton, G., Reflective Practice: Writing and Professional Development, 2010.

[8] Boud, D., Relocating Reflection in the Context of Practice. In H.Bradbury, N. Frist, S. Kilminster, M. Zukas, Beyond Reflective Practice: New Approaches to Professional Lifelong Learning, Routledge, 2010.

[9] Day, C. Reflection: A necessary but not sufficient condition for professional development. British Educational Research Journal, 19, 83-93, 2013.

[10] Clark, C., Rossiter, M. Narrative learning in adulthood. New Directions for Adult and Continuing Education, Vol 119, 2008.

[11] Collier, K. Re-imagining reflection, in Beyond Reflective Practice. In H.Bradbury, N. Frist, S. Kilminster, M. Zukas, Beyond Reflective Practice: New Approaches to Professional Lifelong Learning, Routledge, 2010.

[12] Brna, P., Luckin, R. Narrative and interactive learning environments. Interactive Learning Environments, 16(3): 195-197, 2008.

[13] Vettraino, E., Linds, W., eds., Playing in a House of Mirrors: Applied Theatre as Reflective Practice, Springer, 2015.

[14] Millennials & Enterntainment, Verizon Report, March 2014.

[15] Lawrence-Wilkes, L., Ashmore L. The Reflective Practitioner in Professional Education, Palgrave Macmillan 2014.

[16] Mann, K., Gordon, J., MacLeod, A. Reflection and reflective practice in health professions education: a systematic review, Advances in Health Science Education: Theory and Practice, 14: 595-621, 2009.

[17] Prilla, M., Supporting Collaborative Reflection at Work: A socio-technical Analysis, AIS Transactions of Human-Computer Interaction, vol. 7, 2015.

[18] Hetzner, S. Steiner, CV., Dimitrova, V., Brna, P., Conlan, O., Adult Self-regulated Learning through Linking Experience in Simulated and Real World: A Holistic Approach. Proceedings of EC-TEL 2011: 166-180.

[19] Luckin, R., Holmes, W., Griffiths, M, Intelligence Unleashed An argument for AI in Education, Open Ideas at Pearson, March 2016.

[20] Mitrovic, A., Weerasinghe, A.: Revisiting Ill-Definedness and the Consequences for ITSs, Proceedings of AIED 2009, pp. 375–382.
[21] Sottilare, R.A review of adaptive training research at ARL, GIFT Report, 2015.
[22] Chesler NC, Ruis AR, Collier W, Swiecki Z, Arastoopour G, Williamson Shaffer D. A novel paradigm for engineering education: Virtual internships with individualized mentoring and assessment of engineering thinking. Journal of Biomechanical Engineering, 137(2), 2015.
[23] Bull & Kay, SMILI☺: a Framework for Interfaces to Learning Data in Open Learner Models, Learning Analytics and Related Fields, International Journal of Artificial Intelligence in Education, 293-331, 2016.
[24] Dimitrova, Brna, From Interactive Open Learner Modelling to Intelligent Mentoring: STyLE-OLM and Beyond, International Journal of Artificial Intelligence in Education, 2016.