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DESIGN PROPOSITIONS FOR TECHNOLOGY-ENHANCED WORKPLACE LEARNING

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ABSTRACT

The goal of higher professional education is to enable students to develop into reflective practitioners, having both a firm theoretical knowledge base as well as appropriate, professional attitudes and skills. Learning at the workplace is crucial in professional education, because it allows students to learn to act competently in complex contexts and unpredictable situations. Reflection on learning during an internship is hard to interweave with the working process, which may easily result in students having little control over their own learning process while at work. In this study, we aim to discover in what way we can effectively use technology to enhance workplace learning, by synthesizing design propositions for Technology-Enhanced Workplace Learning (TEWL). We conducted design-based research which is cyclic in nature. Based on preliminary research, we constructed initial design propositions and developed a web-based app (software program for mobile devices) providing interventions based on these propositions. In a pilot study, students from different educational domains used this app to support their workplace learning. We evaluated the initial design propositions by carrying out both a theoretical and a practical evaluation. With the insights obtained from these evaluations, we developed a next version of the design propositions and improved the app accordingly. The research result is a set of design propositions for TEWL. For daily practice, the developed web-based app is available for re-use and further research and development.

INTRODUCTION

The goal of higher professional education is to enable students to develop into reflective practitioners, having a firm knowledge base with professional attitudes and skills. Becoming, being and remaining a professional is a choice and involves responsibilities, capacities and gains (Simons & Ruijters, 2014). Simons & Ruijters argue that professionalism is a self-chosen characteristic closely related to learning. Higher education should prepare students for this professionalism.

Learning at the workplace is crucial in professional education, since it allows students to learn to act competently in complex contexts and unpredictable situations. However, reflection on learning is hard to interweave with the working process, which may result in students having little control over their learning process while at work. In this study, we explore in what way technology can support learning in the workplace by offering support to create awareness of learning and the underlying learning process, as well as triggers to stimulate the learner to make decisions, and take actions, regarding their learning process.

THEORETICAL BACKGROUND

Workplace Learning

Billett (2001) describes the duality inherent to workplace learning. On the one hand, the workplace should afford opportunities to learn, for example by offering autonomy, a variety of tasks, engagement in knowledge sharing, etc. On the other hand, the learner has to choose to engage purposefully in the workplace by actively using the afforded opportunities to learn. This duality is also reflected in the term *supported participation*, recently coined by Nieuwenhuis et al (2017). Learning in the workplace is achieved by participation of the individual learner, but this learning should be supported in order to achieve the learning potential offered by the workplace.

According to Ruijters & Simons (2006), there are three main ways to learn in the workplace:

1. Practicing: learning experientally. This is mostly implicit learning taking place while performing work activities. This type of learning results in experiental knowledge and skills.
2. Researching: learning through inquiry. The learner acquires new knowledge and skills, often by explicit, self-directed learning. This type of learning results in new and explicit knowledge and skills.
3. Creating: learning through design. Developing a concrete product makes it possible to transfer knowledge and skills by creating something that can be

shared with others. This results in design knowledge, as well as insights into what is not known or possible yet.

To connect these three basic forms of learning in the workplace, it is necessary to reflect and connect learning experiences. It is essential to be(come) aware of one's learning and the underlying learning process to share the outcomes & improve their way of learning (Simons & Ruijters, 2014).

Workplace Learning in Higher Education

Learning in professional workplaces often is implicit in nature and results in tacit knowledge (Eraut, 2000). This makes it hard to explicate what is learned. In an effort to overcome this, educational institutes generally ask their students to set their own learning goals and reflect on them, to assess their workplace learning (Tynjälä, 2008). Achieving the full potential of workplace learning in higher education needs more profound study and a more elaborate design and integration of workplace learning in educational programs. The last decade this has been the subject of several studies (Billett, 2009; Nieuwenhuis et al., 2017) and theories have been developed on the pedagogy of workplace learning in higher education (Tynjälä, 2013; Zitter, Hoeve, & de Bruijn, 2016).

In higher education, workplace learning generally has three goals (Nieuwenhuis et al., 2017):

1) Orientation on professional practice;
2) Acquisition of professional skills; and
3) Participation in (future) community of practice.

Educators have to design support for learning in the workplace in a broad sense to achieve these goals. This implies a careful integration of workplace learning in their educational programs and corresponding learning environments.

A recent model to design such learning environments is the model of hybrid learning environments (Zitter et al., 2016); see Figure 1. In this model, learning processes are positioned according to two dimensions. Vertically, we see the dimension that positions learning processes on a spectrum from *Acquisition* to *Participation*. Horizontally, we see the dimension that positions the setting in which learning takes place on a spectrum from *Constructed* to *Realistic*. Pure workplace learning takes place in the lower right quadrant of *Realistic Participation*. However, to keep developing professionalism, learning processes should be triggered in the other quadrants as well. In this study, we focus on designing technology to support learning by learners that participate in realistic settings (workplaces) while making

connections to the other quadrants to enrich the workplace learning experience. These connections are illustrated by the dashed arrows in Figure 1.

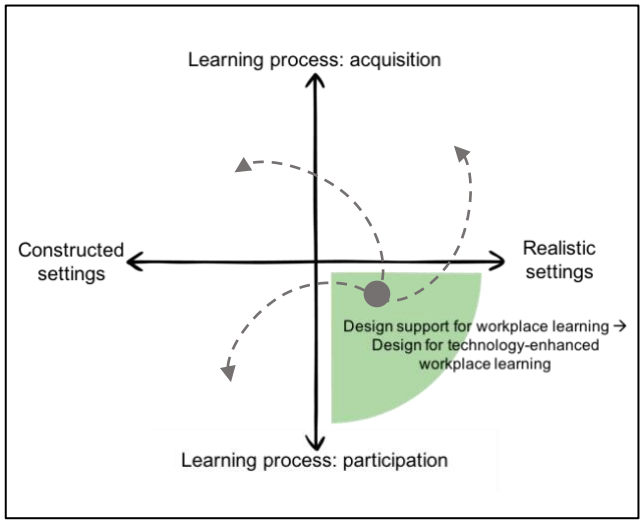

Figure 1: Hybrid curriculum model (Zitter, Hoeve & de Bruijn, 2016).

Technology-Enhanced Workplace Learning

The field of Technology-Enhanced Learning (TEL) studies the use of technology to enhance learning. In this study, we want to distil design knowledge on designing technological support for workplace learning.

In previous research, we identified two initial design principles for Technology-Enhanced Workplace Learning (TEWL): ease of technology use and technology-enabled surprise effect (van der Stappen & Zitter, 2016). Based on these results, we iteratively developed a prototype mobile application (app) together with ICT Bachelor students. This app provides data-driven personalized feedback and triggers feedforward to stimulate and facilitate increased awareness and reflection.

RESEARCH GOAL & QUESTION

This study aims to advance the domain of TEWL by synthesizing design knowledge in the form of design propositions. We cast these propositions in the form of CIMO-logic (Denyer, Tranfield, & van Aken, 2008), which describes that in a certain problematic context (C), an intervention (I) should be carried out, in order to trigger mechanisms (M) to achieve specific outcomes (O); see Figure 2.

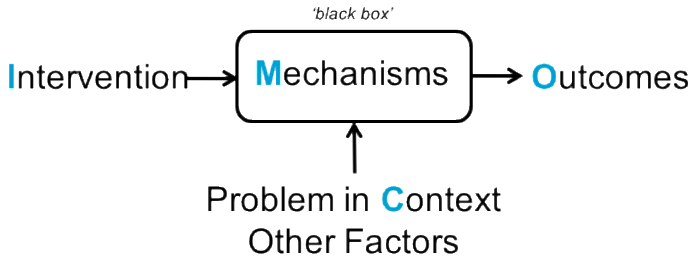

Figure 2: Illustration of CIMO-logic (adapted from (Andriessen & Kliphuis, 2011)).

Since reflection on learning is hard to incorporate into the working process, the number of TEWL tools is increasing rapidly. Our design propositions can guide practitioners and researchers designing and developing such tools. Tools based on these propositions will facilitate reflection and enable their users to increase control over their own learning process, which should ultimately result in improved outcomes.

As such, the main research question of this study is: *"Which design propositions can be formulated for technology that enhances workplace learning in higher professional education?"*.

METHODOLOGY

We take a design-based, cyclic research approach following Wademan's Generic Design Research Model (van den Akker et al., 2007; Wademan, 2005); see Figure 3.

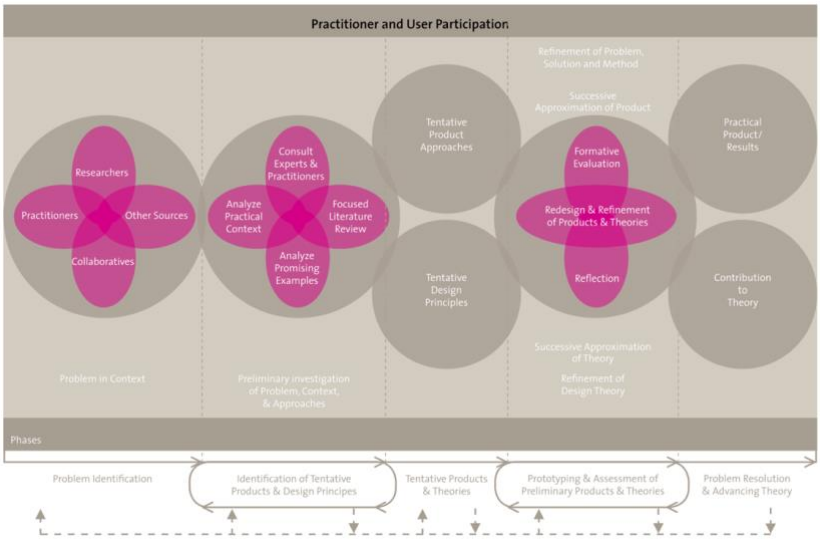

Figure 3: Generic Design Research Model (van den Akker, Bannan, Kelly, Nieveen, & Plomp, 2007; Wademan, 2005)

As mentioned above, based on preliminary research (van der Stappen & Zitter, 2016), we co-created a prototype app with ICT Bachelor students. Simultaneously, we constructed initial design propositions; the prototype provides interventions based on these propositions. These endeavours made up the first two phases of Figure 3 (*Problem Identification* and *Identification of Tentative Products & Design Principles*) and resulted in the Tentative Products & Theories depicted in the centre of the diagram.

Next, we conducted phases four and five of Figure 3 (*Prototyping & Assessment of Preliminary Products and Theories* and *Problem Resolution and Advancing Theory*).

In a pilot study performed in Spring 2017, 15 students from two different educational domains used the prototype. For practical validation, we used an online questionnaire. As one of the preliminary design principles was ease of use (van der Stappen & Zitter, 2016), we first measured the usability of the app. Usability can be defined as the degree to which a product or system can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use (ISO, 2011). To measure this construct, we adopted the widely used System Usability Scale (SUS; Sauro, 2011). In the same questionnaire, we asked the students to evaluate the initial CIMO-logic. Finally, a free text field was provided for other feedback and suggestions.

For theoretical validation, we used theory about workplace learning stipulating that even though a workplace might offer a positive learning climate, 'individuals will decide how they will participate in and what they learn from what they experience' (Billett, 2004, p.7). The design logic we propose is intended to facilitate and trigger individuals to make such decisions and ultimately *support participation* of the learner in the workplace (Nieuwenhuis et al., 2017).

RESULTS

Tentative Products

Over the course of six months, we simultaneously developed both the tentative product and theory. With a group of ICT Bachelor (Software Engineering) students, we co-created a mobile app. Meanwhile, the researchers developed the initial CIMO design propositions. As a result, we synthesized eight design propositions of which the first four were implemented in the mobile app; see Figure 4.

Design proposition	C	I	M	O
Awareness #1	Learner is submerged in working process and less aware of learning process	Easy way of registering learning activities with details (such as with whom, which theory, which problems, etc.)	Learner is actively becoming and staying aware of learning process	Learner builds awareness of learning process, which enables them to develop control over this process
Awareness #2	Learner is focused on work process, possibly not using learning potential	Provide clear overview of registered learning situations & activities	Learner is actively becoming and staying aware of learning process	1) Getting new ideas for learning actions 2) Knowing when to ask for support from colleagues or coach for these new ideas
Awareness #3	Learners don't know which subjects to discuss with the coach at work	Provide overview & analysis of registered learning situations & activities	Learner is actively becoming and staying aware of learning process	By having more insight into their own learning process, learners know when to ask support from the coach at work
Distanced coach	Coaching teachers are distanced and have little insight into learners' work	Provide coaches with an overview of working & learning activities	Coaching teachers gain detailed insight into their students' work	Coaches can give relevant & necessary coaching - in those areas the learners need it most
Using potential	Learners don't see which actions can utilize the learning potential in their workplace	Provide data-driven feedforward / triggering questions	Learners get stimulated to try new / other learning actions	Learner gains a broader repertoire of (learning) actions to use while working
Learning goals	Learners are having a hard time to formulate relevant learning goals	Give data-driven suggestions for (focus areas for) learning goals	Learners formulate data-driven learning goals together with coaches	Learners with learning goals that are more 'thought through' and linked to competences in which development is relevant
Reflection at fixed times	Learners only reflect on fixed moments, when asked by the university	Provide data-driven, just-in-time reflection questions	Learners reflecting at relevant times in the working process, when the experiences are 'fresh'.	More realistic and relevant reflections that are closely linked to experiences & functioning
Reflection aversion	Students are hardly motivated to reflect	Give data-driven suggestions for registered activities that are suitable for reflection and provide easy exports of these reflections	Learners reflect with less effort and start using reflection actively	More relevant reflections, which will enable learners to use reflection as a tool for professional development of learners

Figure 4: Initial design propositions.

Evaluation

As described above, we simultaneously performed both a practical and a theoretical validation of our tentative product (mobile app) and tentative theory (initial CIMO design propositions).

For practical validation, students from two educational domains (IT and Teacher Education) used the app during their work placement or internship. After ten weeks of using the app, we sent out a digital evaluation questionnaire to collect their opinions on both the usability and the proposed design logic. The students scored the prototype app on SUS with 65.8, which is marginally below the average SUS-score of 68 (Bangor, Kortum, & Miller, 2008; Sauro, 2011). This indicates that on the one hand, improvements should be made to increase the ease of use of the mobile app, while on the other hand the usability of the prototype is sufficient for students to evaluate the proposed design logic. Five of the seven initial CIMO-rules were recognized and valued by most of the respondents. The pilot participants also indicated valuable feedback in the open fields of the questionnaire, mainly suggestions to increase the usability.

For the theoretical validation, we carefully evaluated all initial design propositions against the theory about workplace learning indicated earlier (Billett, 2001, 2004; Simons & Ruijters, 2014). For example, let us observe the following initial design proposition.

Learning goals	Learners are having a hard time to formulate relevant learning goals	Give data-driven suggestions for (focus areas for) learning goals	Learners formulate data-driven learning goals together with coaches	Learners with learning goals that are more 'thought through' and linked to competences in which development is relevant

When evaluating this rule, we observed that the learner has a passive role in this rule. According to Billett (2001), the agency of the individual learner is a key aspect in workplace learning. Thus, we reformulated the rule to include a more active role for the learner.

Learning goals	Learners are having a hard time to formulate relevant learning goals	Give data-driven suggestions for (focus areas for) learning goals	Learners gain data-driven insight into their learning process, which is input to discussion on learning goals with their coaches/trainers	Learners with learning goals that are more 'thought through' and linked to competences in which development is relevant

We observe that with this set of design propositions, we aim to enable learners to increase their awareness of their learning process, which will eventually enable them to work (and learn) towards the three goals of workplace learning as recently stated by (Nieuwenhuis et al., 2017).

Consequently, based on the insights from both the practical and theoretical validation, we improved the design propositions to synthesize a next version of this logic; see Figures 5 and 6.

Initial CIMO-logic pilot study TEWL

Implemented for all students in pilot
Implemented for one educational domain in pilot study
Not implemented yet

Design proposition	C	I	M	O	Evaluation
Awareness #1	Learner is submerged in working process and less aware of learning process	Easy way of registering learning activities with details (such as with whom, which theory, which problems, etc)	Learner is actively becoming and staying aware of learning process	Learner builds awareness of learning process, which enables them to develop control over this process	57% positive Enhancement for app: Increase maximum size of text for reflection, add upload functionality for e.g. images.
Awareness #2	Learner is focused on work process, possibly not using learning potential	Provide clear overview of registered learning situations & activities	Learner is actively becoming and staying aware of learning process	1) Getting new ideas for learning actions 2) Knowing when to ask for support from colleagues or coach for these new ideas	67% positive Keep rule
Awareness #3	Learners don't know which subjects to discuss with the coach at work	Provide overview & analysis of registered learning situations & activities	Learner is actively becoming and staying aware of learning process	By having more insight into their own learning process, learners know when to ask support from the coach at work	100% positive Keep rule
Distanced coach	Coaching teachers are distanced and have little insight into Learners' work	Provide coaches with an overview of working & learning activities	Coaching teachers gain detailed insight into their students' work	Coaches can give relevant & necessary coaching - in those areas the learners need it most	36% positive Enhancement for app: Make sharing overview with coaches much easier

Figure 5: Evaluation of implemented CIMO-logic for TEWL.

Using potential	Learners don't see which actions can utilize the learning potential in their workplace	Provide data-driven feedforward / triggering questions	Learners get stimulated to try new / other learning actions and to exchange these ideas with peers	Learner gains a broader repertoire of (learning) actions to use while working	71% positive Reformulate rule
Learning goals	Learners are having a hard time to formulate relevant learning goals	Give data-driven suggestions for (focus areas for) learning goals	Learners gain data-driven insight into their learning process, which is input to discussion on learning goals with their coaches/trainers	Learners with learning goals that are more 'thought through' and linked to competences in which development is relevant	79% positive Reformulate rule
~~Reflection at fixed times~~	~~Learners only reflect on fixed moments, when asked by the university~~	~~Provide data-driven, just-in-time reflection questions~~	~~Learners reflecting at relevant times in the working process, when the experiences are 'fresh'.~~	~~More realistic and relevant reflections that are closely linked to experiences & functioning~~	50% positive Drop rule. Opinions differ largely. Subject to further research.
Reflection aversion	Students are hardly motivated to reflect	Give data-driven suggestions for registered activities that are suitable for reflection and provide easy exports of these reflections	Learners reflect with less effort and start using reflection actively	More relevant reflections, which will enable learners to use reflection as a tool for professional development of learners	93% positive Keep rule

Figure 6: Evaluation of not-yet implemented CIMO-logic for TEWL.

Finally, we analysed the open remarks with suggestions and feedback to conclude with the two most important app enhancements recommended by the students:

- Increase maximum word count for reflection; add upload functionality for e.g. images;
- Make sharing overview with coaches much easier.

We improved the app accordingly. In the figure below, screenshots of the app illustrate a sample of its functionality, based on the interventions from the proposed CIMO-logic.

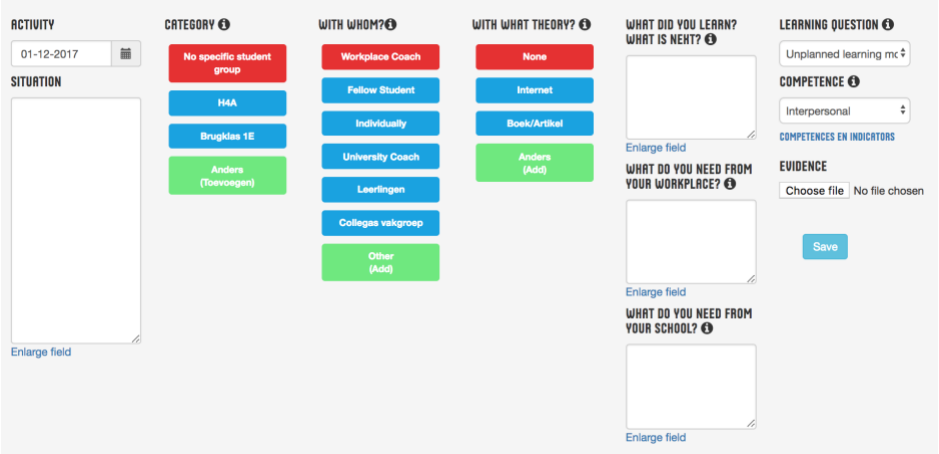

Figure 7: Screenshot of learning input functionality of the app.

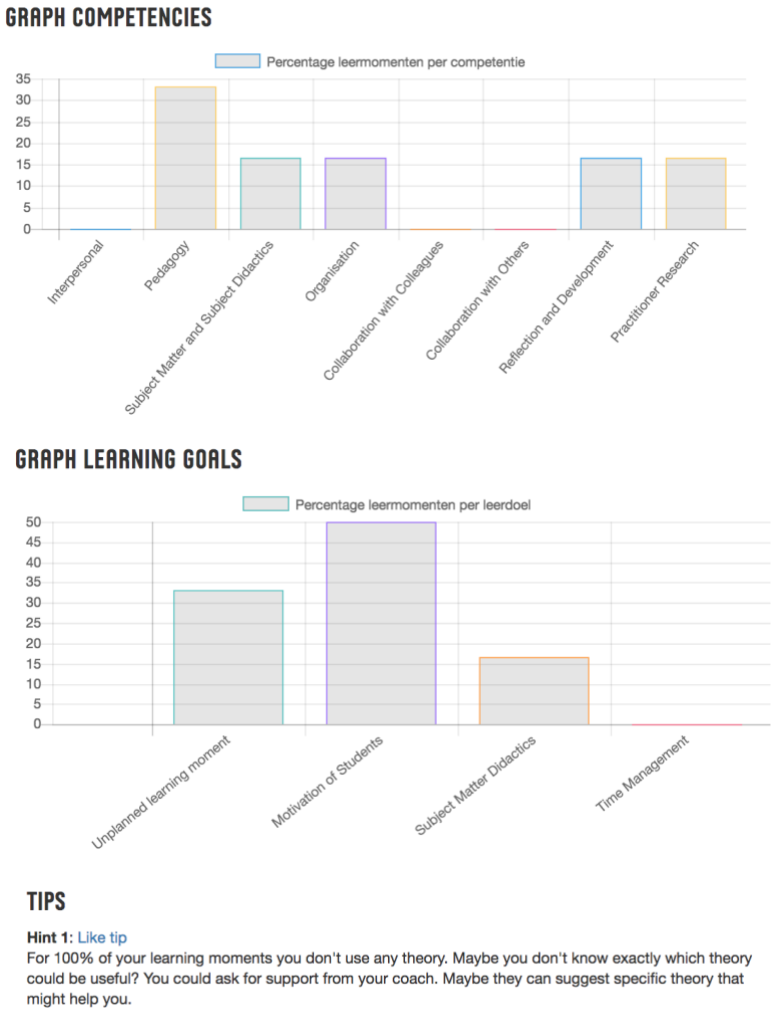

Figure 8: Screenshots of analysis and data-driven feedforward functionality of the app.

CONCLUSIONS

We constructed design knowledge for TEWL, cast in the form of a set of CIMO-logic design propositions. Tools based on these design propositions will facilitate reflection and enable their users to increase control over their own learning process, which should ultimately result in improved learning outcomes.

The design propositions are based on theory about workplace learning and have been improved after a practical and theoretical evaluation in a pilot study in two different educational domains. The design propositions are geared towards known problems of learning at the workplace, such as, learners being submerged in the working process and being less aware of his/her learning process.

We also developed a web application, consisting of a set of interventions from the CIMO-logic, which might contribute towards learners overcoming such known problems. For daily practitioners, researchers and TEWL-developers, this application is published as open-source software on GitHub (HU Institute for ICT, 2018), for re-use and further research.

DISCUSSION

We have constructed a set of design propositions, improved after evaluation in practice within two educational domains. Although the two domains we considered – Information and Communication Technology and Teacher Education – are quite different from each other, we cannot be certain that our design knowledge is applicable to all other educational domains. Further study on the design of TEWL in other educational domains is needed in order to pursue our goal of generalised TEWL design knowledge.

There is a broad knowledge base on workplace learning and of course we could not incorporate all existing theories in this study. Also, new research on workplace learning appeared recently (e.g. (Nieuwenhuis et al., 2017)). Future studies extending our theoretical evaluation can thus elaborate the presented design knowledge. We believe that adding new theories to the theoretical evaluation can both deepen and broaden our set of design propositions.

Implications on Research and Practice

Prescriptive design knowledge for Technology-Enhanced Workplace Learning is scarce. Our research results add to this knowledge base by proposing design propositions in the form of CIMO-logic. This knowledge is generic in the sense that it transcends individual tools or technologies for workplace learning.

The design propositions can be used to develop other technological tools to enhance workplace learning. The developed app itself may be re-used or developed further. It is also available for immediate use, for which we ask to reciprocate in the form of evaluation data.

In the near future, this app will provide us with (large amounts of) data about the learning process of our students in the workplace. A next step is to develop a dashboard that presents this data in an insightful way to individual practitioners or entire educational institutes. This could be a step towards Workplace Learning Analytics in higher education, which is an emergent field of research (Ruiz-Calleja, Prieto, Ley, Rodríguez-Triana, & Dennerlein, 2017).

Another next step is to design & develop interventions that support the coaching process for teacher coaches and work coaches. CIMO-logic again seems a suitable approach to synthesize design knowledge on technological support for coaching processes in workplace learning.

REFERENCES

Andriessen, D., & Kliphuis, E. (2011). Het gebruik van CIMO/logica om kennis expliciet te maken. In J. van Aken & D. Andriessen (Eds.), *Handboek ontwerpgericht wetenschappelijk onderzoek. Wetenschap met effect* (pp. 329–344).

Bangor, A., Kortum, P. T., & Miller, J. T. (2008). An Empirical Evaluation of the System Usability Scale. *International Journal of Human-Computer Interaction*, *24*(6), 574–594. http://doi.org/10.1080/10447310802205776

Billett, S. (2001). Learning through work: workplace affordances and individual engagement. *Journal of Workplace Learning*, *13*(5), 209–214. http://doi.org/10.1108/EUM0000000005548

Billett, S. (2004). Workplace participatory practices: Conceptualising workplaces as learning environments. *Journal of Workplace Learning*, *16*(6), 312–324. http://doi.org/10.1108/13665620410550295

Billett, S. (2009). Realising the educational worth of integrating work experiences in higher education. *Studies in Higher Education*, *34*(7), 827–843. http://doi.org/10.1080/03075070802706561

Denyer, D., Tranfield, D., & van Aken, J. E. (2008). Developing Design Propositions through Research Synthesis. *Organization Studies*, *29*(3), 393–413. http://doi.org/10.1177/0170840607088020

Eraut, M. (2000). Non-formal learning and tacit knowledge in professional work. *British Journal of Educational Psychology*, *70*(1), 113–136. http://doi.org/10.1348/000709900158001

HU Institute for ICT. (2018). GitHub Repository Prototype App. Retrieved from https://github.com/HUInstituteForICT/workplacelearning

ISO. (2011). ISO/IEC 25010:2011(en). Retrieved January 9, 2018, from https://www.iso.org/obp/ui/#iso:std:35733:en

Nieuwenhuis, L., Hoeve, A., Nijman, D.-J., & van Vlokhoven, H. (2017). *Pedagogisch-didactische vormgeving van werkplekleren in het initieel beroepsonderwijs: een internationale reviewstudie*. Retrieved from https://www.nro.nl/wp-content/uploads/2015/09/reviewwerkplekleren_405-15-710.pdf

Ruijters, M. C. P., & Simons, R.-J. (2006). Het leerlandschap van organisaties. *Develop*, (2), 54–63.

Ruiz-Calleja, A., Prieto, L. P., Ley, T., Rodríguez-Triana, M. J., & Dennerlein, S. (2017). Learning Analytics for Professional and Workplace Learning: A Literature Review. In *EC-TEL 2017, LNCS 10474* (pp. 164–178). Springer International Publishing AG 2017. http://doi.org/10.1007/978-3-319-66610-5_13

Sauro, J. (2011). MeasuringU: Measuring Usability with the System Usability Scale (SUS). Retrieved April 11, 2017, from https://measuringu.com/sus/

Simons, P. R.-J., & Ruijters, M. C. P. (2014). The Real Professional is a Learning Professional (pp. 955–985). Springer, Dordrecht. http://doi.org/10.1007/978-94-017-8902-8_35

Tynjälä, P. (2008). Perspectives into learning at the workplace. *Educational Research Review*, *3*(2), 130–154. http://doi.org/10.1016/j.edurev.2007.12.001

Tynjälä, P. (2013). Toward a 3-P Model of Workplace Learning: A Literature Review. *Vocations and Learning*. http://doi.org/10.1007/s12186-012-9091-z

van den Akker, J., Bannan, B., Kelly, A. E., Nieveen, N., & Plomp, T. (2007). An Introduction to Educational Design Research. In T. Plomp & N. Nieveen (Eds.), *Proceedings of the seminar conducted at the East China Normal University*. Shanghai, China: SLO •Netherlands institute for curriculum development.

van der Stappen, E., & Zitter, I. (2016). Exploring Design Principles for Technology-Enhanced Workplace Learning. In *29th Bled eConference: Digital Economy* (pp. 472–478). Bled, Slovenia. Retrieved from https://domino.fov.uni-mb.si/proceedings.nsf/Proceedings/09D2882CFD2A6C2EC125800D00482C2E/$File/3_vanderStappen.pdf

Wademan, M. (2005). *Utilizing development research to guide People Capability Maturity Model adoption considerations*. *Instructional Design, Development and Evaluation - Dissertations*. Syracuse University. Retrieved from

http://surface.syr.edu/idde_etd/12

Zitter, I., Hoeve, A., & de Bruijn, E. (2016). A Design Perspective on the School-Work Boundary: A Hybrid Curriculum Model. *Vocations and Learning*, *9*(1), 111–131. http://doi.org/10.1007/s12186-016-9150-y