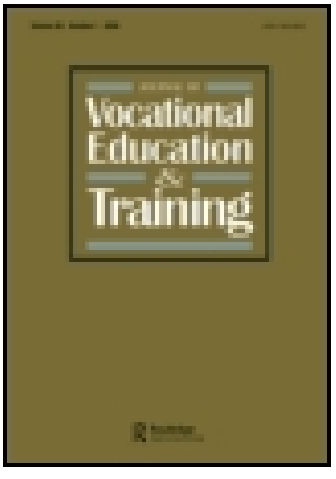

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Vocational education taking place in the dual contexts of workplace and school often lacks integration of concrete experiences with theoretical knowledge. The interplay between workplace and school contexts and their often antagonistic priorities call for a specific model that transforms these divergences into learning opportunities and connects different forms of knowledge into an integrated body of knowledge that contributes to developing vocational competence. This paper presents a multidimensional pedagogical model, called the 'Erfahrraum', for the design and implementation of educational technologies as a way to foster this integration in initial dual vocational education and training (VET). The 'Erfahrraum' model informs the design of shared spaces for capturing and reflecting on experiences made in different contexts in which VET takes place. The model particularly emphasises the importance of shared reflection processes to turn concrete experiences into relevant integrated knowledge. Examples of implementations in different professions using a range of different technologies illustrate the power of the 'Erfahrraum' model.

Keywords: vocational education and training; learning technologies; learning by experience; learning by reflection; dual system

1. Introduction

There has been an increasing demand from employers for workers with more integrated knowledge that allows them to understand the whole labour process, and to deal with new and unpredictable situations (Ertl and Sloane 2004). Work environments are undergoing radical social and technological changes. Apprentices need to learn how to operate in such changing environments (Dall'Alba 2009, 4). Vocational education and training (VET) systems are challenged to prepare apprentices not only to excel at routine work but also to be able to adapt to complex changing work environments.

VET is a complex blend of formal, non-formal and informal learning environments (Werquin 2010) that includes implicit and explicit forms of knowledge (Eraut 2000). Apprentices in Swiss vocational education programmes learn in the

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dual contexts of workplace and school. The term 'dual' can have four meanings, reflective of (a) dual training venues (workplace and vocational schools); (b) shared financial responsibilities for vocational education between government and industry; (c) split legal responsibilities; and (d) participants assuming the dual identities of trainees and students (Raggatt 1988). The dual context VET model is of great importance to the Swiss education system as over two-thirds of young people coming out of lower secondary school enrol in a VET apprenticeship programme (SBFI 2014). The dual context model reflects the view of the Swiss VET system that aims to teach both theoretical and practical knowledge (Brockmann, Clarke, and Winch 2008). As a result of the separation of the two contexts, knowledge is often situated in one of these two contexts and does not get used in the other context. The dual context approach often leads to disconnected, inert and fragmented knowledge that cannot be applied to solve problems (Renkl, Mandl, and Gruber 1996). Bridging the gap between workplace and school experiences is expected to improve the formation of more integrated labour process knowledge (Brockmann, Clarke, and Winch 2008) that is necessary for adaptive expertise development. Hatano and Inagaki (1986) distinguish between routine and adaptive experts. Routine experts acquired selected procedural knowledge and physical skills to perform certain routine tasks. Adaptive experts connect theoretical and practical knowledge that allows them to adapt to novel situations.

This paper proposes a model to inform the design and implementation of technology-enhanced boundary-crossing spaces that bridge the dual contexts in VET. Information and communication technologies can serve as mediating tools to support crossing the boundaries between different contexts. Digital spaces can bridge the gap between school and workplace learning contexts in both directions. From the workplace to school context, experiences made in the workplace can be used for reflective activities to build connections to knowledge learned in the school context. From the school to workplace contexts, theoretical knowledge can become more understandable and relevant by connecting it to specific examples of workplace experiences (perceived usefulness). Bridging the gap in both directions aims to contribute to a deeper understanding of work processes towards the formation of adaptive expertise.

Our boundary-crossing spaces concern educational technology use in the initial vocational education of 16–22 year-olds who are learning a profession such as carpenter, chef, salesperson, mechanic, health care assistant, etc. The responsibility for training apprentices is often shared between a company in which apprentices work a large part of their training time, and a school where they attend classes for the remaining time. The tensions between these two worlds and the different types of knowledge they foster call for a specific pedagogical model that turns these tensions into learning opportunities and connects the different types of knowledge into a unique body of integrated competences.

This article reports how learning technologies can facilitate the connection between different learning locations, and in particular between school and workplace. The first section is devoted to a brief review of VET and its main characteristics. The second section describes the 'Erfahrraum', a multidimensional pedagogical model that informs the design of technology-enhanced spaces for VET. The third section gives examples about instantiations of the model in different VET contexts.

2. Vocational education and its challenges

2.1. *Dual systems organisation*

In Germany, Austria and Switzerland, the VET systems are mainly organised around the alternation of work-based segments and school-based segments, and is known as the 'dual' track approach. Although some differences exist due to varying curricula, apprentices generally spend between three and four days in the company with whom they have signed an apprenticeship contract and the rest of the week at school. In the latter, they study general subject matters (such as language and civics) and more theoretical aspects of their specific vocation. In such dual systems, school teaching is mainly devoted to the instruction of standardised procedures and to the acquisition of conceptual knowledge, while the workplace is a powerful context for learning practical skills and acquiring professional ways of working. In addition to vocational schools, some professions offer yearly intercompany courses (which usually take place in dedicated training centres) in which apprentices practice practical procedures by working on a specific product. In the workplace, apprentices face concrete situations, in which knowledge is integrated in practices, while at school they are proposed more abstract knowledge (Landwehr 2002; Tynjälä 2008).

2.2. *Different contexts, different knowledge*

By alternating between these two spaces, apprentices are expected to connect different forms of knowledge learned in different contexts. The dual-track VET system implies that learning emerges from the interaction of multiple contexts (Horn et al. 2008; Gurtner et al. 2012).

However, apprentices often perceive gaps between the learning locations (Eteläpelto 2008; Filliettaz, de Saint-Georges, and Duc 2008; Taylor and Freeman 2011) and complain about the inadequate relationship between what they face and learn at school, and what they do in practice (de Bruijn and Leeman 2011). As Renkl, Mandl, and Gruber (1996) put it, what is learned remains often encapsulated in its original context and is hardly transferred to the other context: first, students' knowledge in vocational schools and in workplaces differs (Boshuizen 2003). Knowledge acquired in the workplace is often implicit (for example, procedures executed without explanations) but can also include explicit knowledge, for example, direct instructions and handbooks. Workplace knowledge is situated in the target context and usually concrete. In the school context, apprentices learn mostly abstract explicit knowledge that is situated outside of the target context (workplace). Second, learning in school (academic) and workplace (experiential) are each context-dependent and only weakly linked (Stavenga Jong, Wierstra, and Hermanussen 2006). While students are expected to learn from their mistakes at school, such pedagogy is not appropriate for an apprentice repairing a car or treating an elderly patient. If the school is based on a *learning-oriented* rationale, the workplace is based on a *production-oriented* rationale (Illeris 2011). Workplaces also have much less flexibility to make pedagogical choices which topics apprentices should work on a given day. Moreover, apprentices often see themselves as 'hands-on' learners rather than 'book' ones and are critical towards abstract knowledge (Lehmann 2007; Brockmann 2010; Taylor and Freeman 2011).

The reasons for the gap between the dual contexts are complex. The different nature of knowledge experienced in the different VET contexts could serve as an

epistemological explanation. To connect knowledge from different contexts, knowledge needs to be made explicit, selected, and systematically integrated with related knowledge. From a technological viewpoint, there is often no systematic capturing of workplace-context knowledge and a space that allows connecting it with school-context knowledge. There is a strong need for a boundary-crossing space for VET education (Illeris 2009). Additionally, apprentices in the same vocational school class are usually doing their training in different companies. For instance, within the same logistics (warehouse employees) class, we met apprentices working alone with their boss manually storing goods, and others working for a multinational company where everything has been automated.

2.3. *The importance of experience and reflection*

Scholars have proposed different models to describe learning within and across contexts. For example:

- In the expansive model, learning foresees active participation by the learners in different and multiple communities of practice, where they (should) continuously reflect on the possible integration of different types of knowledge encountered in different experienced situations (also see Lave and Wenger 1991; Wenger 1998; Fuller and Unwin 2003, 424).
- The connective model puts much more emphasis on the connection between school and the workplace. Connectivity refers to the pedagogical approach educators adopt to take explicit account of the relationship between theoretical and everyday knowledge in their attempt to mediate the different demands arising in the contexts of education and work (Griffiths and Guile 2003).
- Integrative pedagogics is "a principle which states that in any learning situation key elements of expertise – that is, theory, practice and self-regulation – should be integrated" (Tynjälä 2008, 144). This integration process is facilitated by mediating tools, as for example writing, discussing, tutoring and others.

All three models suggest that bridging the school and workplace is not a simple 'store & retrieve process': "What is transferred is not packages of knowledge and skills that remain intact; instead, the very process of such transfer involves active interpreting, modifying and reconstructing the skills and knowledge to be transferred" (Tuomi-Gröhn, Engeström, and Young 2003, 4).

In VET, the starting point for boundary-crossing is concrete experience in the workplace context. Empiricists view experience as source of knowledge. However, the term 'experience' is complex and can be described in different ways. Experience can be understood as 'to experience' (the constant stream of sensory experiences that enter our consciousness (Carlson 1997) or as 'having had an experience' (such an experience has a beginning and an end and changes the user and sometimes the context in return (Dewey 2005). From the seminal work of Dewey (1933, 1938/1963) to Boud, Keogh, and Walker (1985), Kolb (1984), Schön (1983) and Engeström (1987), many agree that experience *per se* is not enough: to learn, one needs to reflect on experiences. However, such a reflective attitude is (usually) not spontaneous. For example, apprentices often do not reflect on their experiences (Stavenga Jong, Wierstra, and Hermanussen 2006; Taylor and Freeman 2011). They need scaffolding to report and explicate their experiences (Raizen 1994). Reflective

practice on experience (possibly referring to participation in multiple communities of practices) and boundary crossing are essential elements of our model.

Vocational educators (both teachers and supervisors) have a key role to play in fostering students' reflection by asking critical and reflective questions and using specific reflective prompts (Raizen 1994; Krause and Stark 2010; de Bruijn and Leeman 2011; Schaap, Baartman, and de Bruijn 2012). Strategies to develop reflective behaviour can be more suitable for school than for the workplace (Van Woerkom 2004; Van Woerkom and Poell 2010). As there is not much time to reflect at the workplace, and no time for practice at school, maybe there is some time to reflect on practice at school (Avis 2004; Aarkrog 2006). Nevertheless, reflection by students is not yet diffused as a didactical practice (Schaap, Baartman, and de Bruijn 2012). Therefore, the model we are proposing fosters reflection on one's own and peers' experiences.

Boundary crossing is a category of cognitive processes triggered by the participation in different contexts and situations in which knowledge is applied and developed (Engeström, Engeström, and Kärkkäinen 1995). It addresses 'ongoing, two-sided actions and interactions between contexts' (Akkerman and Bakker 2011, 136). Crossing boundaries, students have to face and overcome sociocultural differences (Engeström, Engeström, and Kärkkäinen 1995): the process of crossing boundaries requires them to reflect on their activities to gain understanding of their learning in different contexts. The concept of boundary object was introduced by Star (1989) to refer to objects that "both inhabit several intersecting worlds and satisfy the informational requirements of each of them" (Star and Griesemer 1989, 393).

Connecting experience and information, theory and practice, school and workplace learning, is neither obvious nor spontaneous, and needs to be fostered (Eraut 2004). Furstenau (2003) admits that transferring abstract knowledge requires specific learning environments, such as simulations. Other scholars come to the same conclusion: a specific design of the learning environment is a necessary preliminary condition. Schaap and colleagues (2012) proposed the concept of *hybrid learning environment* (see also Zitter and Hoeve 2012), based on connectivity, on boundary crossing, and on *re-contextualisation* (Guile 2010) i.e. understanding how a concept varies in different contexts. Hence, many researchers have pointed out that students need support to integrate theoretical knowledge into vocational practice and vice versa (for example, Billett 2001; Lindberg 2003; Bakker 2008; Tynjälä 2008; Filliettaz 2011). We propose a model that seeks to specifically support the instructional design of such expansive, integrative and connective learning in VET. Technology can help integrating experiences from different contexts as well as producing and exploiting boundary objects. The model is not thought to be a learning theory but a pedagogical model that can inform the design and implementation of technology-enhanced VET learning activities.

3. The 'Erfahrraum' model

3.1. Technologies to 'bridge the gap'

The basic idea of our model is that *technologies could serve as bridges* between the school and the workplace as well as between the actors of these different locations. Across the fields in which we conducted our research, we encountered several examples of misalignment between the school and the workplace, confirming the

existence of the 'gap' we already reported about in the framework above. Here are some examples of school–workplace gaps.

- In logistics, apprentices are supposed to learn how to optimise storage in a warehouse. For instance, narrow alleys increase storage space but decrease the fluidity of forklifts. However, logistic decisions are generally taken by the boss and not left to the apprentices. At school, the objective of the logistics course is to develop these skills, but they are not meaningful to apprentices since they do not match what they experience in their company. It is a good thing however that the school has ambitions for the students that go beyond the immediate needs of the company. We therefore should not erase the gap by removing this point from the school curriculum, but instead address ways to acquire them.
- A dental assistant should be able to undertake the radiography steps adequately and to identify when the outcome is not satisfactory and why, in order to perform it again correctly. Nevertheless, radiographs are rarely performed by apprentices in the workplace.
- Bakers' and chefs' curricula require apprentices to complete a learning journal, to be discussed regularly with their supervisors. The professionals though are more interested in having the apprentices complete a recipe book with the ideal production process rather than a learning journal showing the progress without hiding earlier failures.

It is important to clarify that we agree with Illeris (2011) differences between school and workplace should not be eliminated because they are vital to the dual system. Our point is that a dual approach requires space and time to integrate what is learned in both places. The challenge of the dual system is to articulate these two worlds, without denying their specificity. We hypothesise that learning technologies have the potential to connect these two worlds.

3.2. A space for reflecting on experience

Each of the above examples addresses a different type of 'gap'. It can be a question of abstraction (as in the case of logisticians), skill (as in the cases of dental assistants), culture (as in the case of bakers and chefs) and so on. In each case however, technologies create some kind of third space, a reflection space within which knowledge can be transported back and forth from one context to another, reflected upon and shared with all actors. We call this digital space an '*Erfahrraum*' (Dillenbourg 2009; Dillenbourg and Jermann 2010; Aprea et al. 2012; Boldrini and Cattaneo 2013), a portmanteau consisting of the two German words 'Erfahrung' and 'Raum'. The German term 'Raum' (room) can refer to physical, digital or cognitive spaces related to learning. The German term 'Erfahrung' (reflected experience) refers to experiencing something relevant that leads to knowledge through subsequent reflection. The term highlights that (unprocessed) experiences alone do not lead to knowledge (Herzog and von Felten 2001, 23). Knowledge cannot be directly experienced but needs to be constructed through reflection processes.

The Erfahrraum model (see Figure 1) facilitates creating 'Erfahrungen' through the processes of experiential learning and reflection. Through systematic reflection

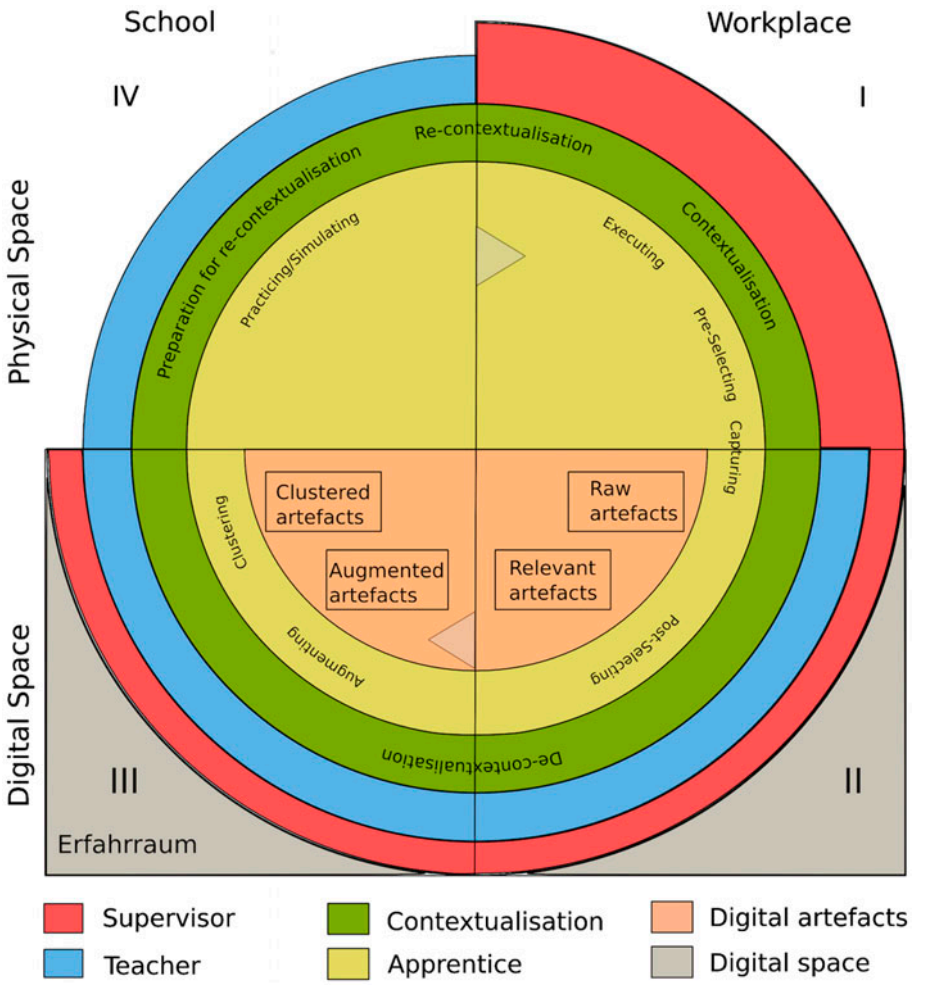

Figure 1. The 'Erfahrraum' model.

of experiences, apprentices can construct 'Erfahrungen' that integrate VET-relevant knowledge from different contexts.

The Erfahrraum consists of technology-enhanced spaces that facilitate conversations between work and school (referring to vocational schools and intercompany courses) contexts in iterative loops. Bridging the two contexts, the Erfahrraum provides boundary-crossing spaces to capture, share and process experiences through scaffolded reflection activities that turn them into integrated VET-relevant knowledge.

The Erfahrraum model is grounded in the difference between *learning contexts*, namely the school and the workplace, with the multidimensional differences in terms of culture and nature of knowledge developed in the first section. The model is seen from the apprentice's point of view. Building on Pask's Conversation Theory (Pask 1976), Sharples, Taylor, and Vavoula (2007) described learning as 'a continual conversation with the external world and its artefacts, with oneself, and also with other learners and teachers' (p. 7). Activities in the Erfahrraum can take place in different social settings, such as individual reflection (self-reflection) (Chi 2000) or as

dialogical processes in conversations within communities of practice (Lave 1990), for example, teachers, supervisors and peers can comment, rate, annotate and compare shared digital artefacts in the Erfahrraum.

In this iterative circular model, knowledge elements flow from one context to the other back and forth. The Erfahrraum model distinguishes four sequential phases ('quadrants'), but the point of departure can vary. Building on the SECI model (Nonaka and Tekeuchi 1995), the Erfahrraum model distinguishes between physical and digital spaces of learning (vertical axis), which can be found in school or workplace contexts (horizontal axis). The rings distinguish between the role of supervisors (red ring / outermost circle), the role of teachers (blue ring / second circle), the contextualisation of vocational knowledge (green ring / third circle), apprentices' actions (yellow ring / fourth circle) and digital artefacts (orange half-circle / innermost circle). The digital 'Erfahrraum' space is represented by the grey box enclosing quadrants II and III.

The green ring describes how vocational knowledge is contextualised and transferred between contexts. The yellow ring lists a sequence of apprentices' actions, in physical spaces (upper half) or inside the digital Erfahrraum spaces (lower half). The digital spaces of the Erfahrraum connect workplace and school contexts through capturing, processing and sharing of artefacts that facilitate reflection processes.

The technologies that create the Erfahrraum spaces aim to facilitate capturing and selecting digital artefacts (including photos, texts, audio and video) (orange half circle), which can then be processed through augmentation and clustering. Each process can take place in different physical (workplace, school, intercompany courses or elsewhere) and social contexts (individually, under supervision or in collaboration with peers). The model highlights the importance of involving both supervisors (red circle) and teachers (blue circle) (overlapping red and blue circles). In the Erfahrraum spaces, supervisors, learners and teachers can interact with the digital artefacts (overlapping red, blue and orange areas). Next, each phase of the model will be described in more detail. Examples of the design and implementation of scenarios based on the Erfahrraum model are reported in the second part of this paper.

Quadrant I: The top right quadrant represents apprentices' rich experiences in the physical workplace context. The majority of their VET experiences is expected to be made in the workplace context but they can occur in any context, for example, simulated experiences in vocational schools or training centres. The focus of actions in the workplace is on executing given procedures. One or multiple supervisors (red circle) oversee the apprentices' actions in the workplace. The product-focused nature of the workplace does often leave limited time for reflection in action. Artefacts of apprentice's experiences can facilitate reflective processes at a later time and place, for example, in school or in intercompany courses[1] (Quadrants III and IV). To foster reflections on workplace experiences, apprentices capture self-selected or assigned situations in the form of digital artefacts in the Erfahrraum spaces.

- Pre-selection: Not all experiences need to be captured as not all experiences apprentices make are equally educative (Dewey 2007, 25). Apprentices need to decide which experiences could be potentially relevant for future processing and sharing with others (teachers, supervisors or peers) and should be captured as digital artefacts. The metacognitive process of selecting relevant experiences allows learners to identify situations that are novel, surprising, unique or confusing (Schön 1983). At the beginning, teachers and supervisors can play an important guiding role on apprentices' selection process e.g. suggesting exemplary

procedures to be monitored. Over time, Erfahrraum activities can refine apprentices' understanding which experiences are worth documenting and encourage seeking specific experiences through experimentation (deliberate practice) that can contribute to their expertise development. Such deliberate practice can strengthen self-monitoring one's own learning progress. Collecting more experiences (quantity) does not automatically lead to continued improvements of performance. Different from novices, experts deliberately seek out particular kinds (quality) of experiences that contribute to improving specific aspects of their performance (Ericsson, Krampe, and Tesch-Römer 1993).

- Capturing: Externalising experiences is central to enable learning conversations between people and across contexts. To externalise knowledge from experiential learning, apprentices store traces of their experiences as raw digital artefacts in the Erfahrraum for further reflection (in Figure 1, the Erfahrraum is represented by the grey box in the lower half connecting the workplace and school context). Typically, collecting means taking pictures or videos, recording audio, sketching, creating diagrams, filling in online forms, drawing sketches or diagrams, or writing down on what happened in the workplace. Digital technologies allow capturing experiences when and where they happen. Creating digital artefacts[2] out of these experiences allows turning fleeting occurrences into reified objects so as to store them for later reflection and sharing. The act of capturing an experience itself can be considered a form of reflection, as it requires remembering and externalising an experience as an artefact.

Quadrant II: Post-selection: After adding digital artefacts to the personal space in the Erfahrraum, apprentices select which artefacts should be further processed and maybe shared with others. Apprentices need to learn which kinds of artefacts are relevant for processing in the Erfahrraum. Elaboration activities in the Erfahrraum by the apprentice and/or the community can refine learners' understanding of which digital artefacts are relevant and valuable for reflection which in turn can motivate them to process and share more such experiences. Post-capture selection leads to a selection of VET-relevant experiences captured as digital artefacts ('relevant artefacts'). In partnership with teachers and supervisors, specific scenarios can be developed to facilitate making specific experiences to reflect upon and learn about the relevance of experiences (Gruber, Harteis, and Rehrl 2006). Both pre- and post-capture selection processes can scaffold reflection processes and contribute to a refined metacognitive understanding of what experiences are VET-relevant.

Quadrant III: Turning experiences into VET-relevant knowledge requires not merely capturing and selecting experiences but also subsequent steps of organising and processing. Experiences can only become 'Erfahrungen' if they are considered relevant by the learner (selecting) (Gruber, Harteis, and Rehrl 2006) and after processing (Herzog and van Felten 2001). Reflection activities can happen in different contexts, although most of them probably occur in formal contexts (school, training centres and intercompany courses) orchestrated by teachers. Additionally, reflection can be an individual (self-reflection) (Chi 2000) or a social process, for example, reflection activities with peers, teachers or supervisors. Processing concrete experiences aims (a) to elicit experiences, (b) to de-contextualise experiences and (c) to integrate different forms of VET-relevant knowledge. Processing can take place in the workplace in close temporal proximity to the experience (reflection in action) or time-delayed after the experience (reflection on action). As time for reflection is

often limited in the workplace, scaffolded reflection activities (especially for extended periods of time) are expected to take place mostly in school contexts where teachers can make use of selected artefacts collected by apprentices to orchestrate processing activities to make sense of workplace experiences. Experience can go through one or several distinct processing processes, conducted by either the individual who captured the experience and created the digital artefact (the 'owner' of the artefact) or by any other member of the community (who has been granted access to the artefact).

For example, processing of artefacts can include the following sub-processes (one or both in no particular order):

- Augmenting: Digital artefacts can be augmented for example through tagging, commenting or ranking – either by the owner of the artefact or the community. Augmentations add a secondary enriching layer of information ('augmented artefact') to the initial digital artefact. Augmentation processes support reflecting on what elements of the document are important or controversial. Augmentations can add theoretical knowledge to workplace experiences, for example by circling an important element in a photo of a workplace event or by adding a theoretical concept as a caption or comment. Ranking can indicate the relevance of a digital artefact (to the owner or other learners).
- Clustering: Artefacts can be used for reflection activities through compare and contrast processes. Contrasting different cases (Schwartz and Bransford 1998) can help people notice specific features that make the cases distinctive (Collins 2010). Contrasting activities may include comparisons of similar cases (e.g. baker apprentices comparing different recipes for the same type of bread) or different cases (for example, chef apprentices comparing different recipes for preparing the same dish or by comparing the same recipe executed in different workplaces). Related artefacts can be grouped into meaningful groups through tagging. Additionally, apprentices may compare routine experiences to extraordinary cases such as mistakes or masterpieces. Especially learning from mistakes is an important form of learning from experience (Gruber, Harteis, and Rehrl 2006; Bauer, Gartmeier, and Harteis 2012; Wuttke and Seifried 2012; Leicher, Mulder, and Bauer 2013). Ryle (2002) and Oakeshott (1991) observed that practical work may initially be based on following rules without reflection. Contrasting activities can facilitate revisiting understandings of procedures that have become implicit in the experienced situation.

The processes of augmenting and clustering aim to support the construction of de-contextualised knowledge. Abstract elements of similar or different concrete cases can be identified through inductive reasoning and indicated in digital artefacts through labelling (through tagging or adding descriptions). For example, chef apprentices can learn about the conditions for deglazing through comparing several concrete experiences with varying conditions. The augmenting processes of identifying and labelling meaningful patterns can contribute to form mental 'chunks' ('clustering') that are important for the formation of expertise (Bransford, Brown, and Crocking 2000). Clusters allow experts to identify underlying patterns that connect seemingly different situations. Expert-novice research suggests that experts interpret situations in their field of experience differently from novices due to different cognitive constructs that influence their perception.

Quadrant IV: To prepare for re-contextualisation of knowledge back to the workplace, teachers can organise opportunities to apply knowledge through practice exercises or simulations. Practice exercises or simulations (in school or in intercompany courses) can make theoretical knowledge more relevant and facilitate making sense of practical situations in the workplace. The whole cycle can be considered effective if apprentices improve the quality, speed and/or satisfaction of their workplace activities. The Erfahrraum cycle models systematic reflective practice by orchestrating the conversion of workplace experiences into VET-relevant Erfahrungen through reflective (individual and social) activities that augment and link different forms of knowledge. Apprentices may learn to deliberately seek experiences that generate a new understanding of a phenomenon and lead to changes of the situation (deliberate practice). It creates a 'spiral of knowledge' (Nonaka and Tekeuchi 1995). Over time, the process of systematically reflecting on workplace experiences can become internalised (Vygotsky 1980) and contribute to the development of adaptive expertise (Hatano and Inagaki 1986).

In the idealised Erfahrraum model, the reflection processes of capturing workplace experiences, selecting and processing VET-relevant experiences aims to facilitate reflective processes that lead to an integration of different forms of knowledge that can be re-contextualised in the workplace.

The Erfahrraum model aims to facilitate quantitative and qualitative improvements of connections between learning contexts. Quantitative improvements can include increasing the number of captured artefacts, feedbacks given by supervisors and teachers, comments by peers and reflections on documented experiences. The goals of qualitative improvements are to refine learners' filter to capture more relevant documents (selection processes), to capture qualitatively different experiences (for example new routines and extraordinary incidents (e.g. mistakes and masterpieces) in different forms (including texts, photos, videos, sketches, audio and diagrams) and to improve the quality of reflections (e.g. through prompts or by supporting and training all stakeholders). As part of the community, experts (for example teachers or supervisors) can model what experiences they find relevant and how they interpret digital artefacts in the Erfahrraum.

4. Applying the model to different VET contexts

The Erfahrraum model informed several empirical studies conducted in different vocational contexts (Table 1), such as different professions, different linguistic regions, and different technologies. Dozens of teachers and supervisors as well as hundreds of apprentices participated in these experiments. We illustrate how each study operationalized the Erfahrraum model and how technologies have been used.

4.1. Scenarios of the Erfahrraum model

4.1.1. Scenario 1: Online learning journal and recipe book for bakers and chefs

Baker and chef apprentices are confronted with different forms of gaps. First, the learning culture and the learning objectives at the workplace and at school are different. At the workplace, the objective is to become able to execute professional techniques to produce good quality products (procedural knowledge and routine expertise) as fast as possible. At school, the objective is to develop conceptual knowledge (for example chemical processes of nutritional elements) through

Table 1. Overview of the contexts in which the Erfahrraum model has been implemented.

	Vocational context	Main activities	Technologies	Research focus
1	Bakers and chefs	Construction and discussion of e-portfolios	Mobile technologies, picture upload apps and online learning environments	– Usability of mobile device – Perceived usefulness – Development of metacognitive skills – Interaction between apprentice and supervisor
2 + 3	Dental and health care assistants	Peer writing	Blogs, wikis and online portfolios	Development of: – Conceptual understanding of procedures – Reflective attitude – Professional self-efficacy beliefs
4	Car mechanics and chefs	Experience-based classroom discussions	Mobile technologies and Hypervideos	– Usability of mobile device – Perceived usefulness – Acceptance (by apprentices, teachers, supervisors)
5	Commercial employees	Reflective writing activities	Wiki, blogs and e-portfolio platforms	– Procedural knowledge – Reflective attitude – Professional identity
6	Logistics	Problem solving	Tangible augmented reality simulation, 2D–3D visual representation	– Spatial ability skills – Abstraction skills – Transfer – Connectivity

explanations and exercises. Second, regulations by professional unions require apprentices to keep a learning journal to document their learning process at the workplace. Supervisors are expected to regularly discuss learning journals with their apprentices. However, such exchanges often do not take place. Additionally, the learning journals usually remain at the workplace and are not available for learning activities at school. Third, apprentices rarely carry out all the steps of a recipe from start to final product. Executing only an isolated step, apprentices' experiences are often fragmented into many pieces that need to be integrated. Fourth, each company has its own professional practices (e.g. different ingredients, different tools, different techniques and different divisions of labour). At school, the teacher has to deal with the multitude of experiences that apprentices bring with them. Conceptual knowledge from school could contribute to improve their practical vocational knowledge, for example, by reflecting on the reasons leading to failed products.

The implementation of the Erfahrraum model for baker and pastry cook apprentices ($N = 16$ for five consecutive semesters (5 women, 11 men) as well as chef apprentices ($N = 22$ for four consecutive semesters (4 women, 18 men) covered the workplace-based de-contextualisation part of the cycle. Apprentices used smartphones at the workplace to take pictures, store them and re-use them later to build their personal online recipe books and learning journals (see Figures 2 and 3). Doing this, they had to operate successively 'pre-selecting', 'capturing' and 'post-selecting' operations.

The learning journal was set up as a series of pages attached to each recipe, which allowed the apprentice to keep track of her/his learning process for a given recipe in the following reflection phase. To facilitate their work and foster reflection, a standard form (see Figure 3 on the right) provided prompts (Kicken et al. 2009). In addition, an entry field for an overall reflection was available. The learning journal was designed to facilitate discussions between apprentices and supervisors.

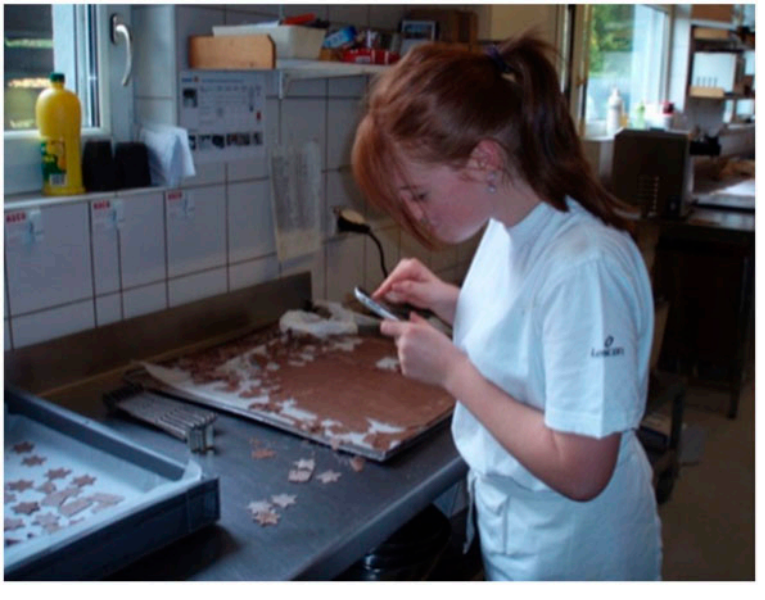

Figure 2. A pastry cook apprentice using her smartphone to document her workplace experience.

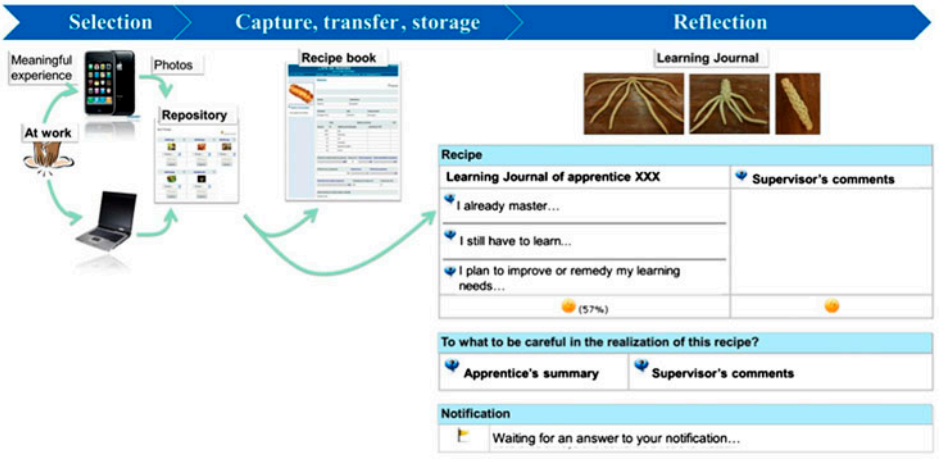

Figure 3. The online recipe book and learning journal for baker, pastry cook and chefs apprentices.

For this reason, it was structured into two columns: the left one was for apprentices, the right one was accessible by supervisors to comment on apprentices' reflections.

In parallel, the teachers regularly tasked them to upload digital evidence of workplace procedures that could be used during school lessons. During these lessons, apprentices had to exploit their own pictures, recipe books and learning journals to accomplish various small group activities. By comparing their own artefacts to those of their classmates, they had an opportunity to work on 'augmenting' and 'clustering' processes, under the guidance of the teacher.

Beside the usability of the system and educational questions regarding how to make the best use of the system at school (Hämäläinen and Cattaneo 2015), issues related to learning outcomes have been examined in the present project. Results indicate that mobile devices were generally considered by apprentices as easy-to-use and useful (Dehler Zufferey et al. 2011; Motta, Cattaneo, and Gurtner 2014), especially to connect experiences across locations (Cattaneo, Motta, and Gurtner 2015). Together with the pedagogical scenarios built around them by the professional teacher, they also lead apprentices to build more articulated learning journals than apprentices from a control group taught by the same teacher but outside of the Erfahrraum model (Cattaneo and Aprea 2014). Finally, the more apprentices used metacognitive learning strategies in their answers to the prompts proposed in the learning journal, the better they performed at the final exam (Mauroux et al. in press). The learning journal platform has been implemented nationwide in the training of baker and pastry cook apprentices. Currently, about 700 supervisors and approximately 2000 apprentices throughout Switzerland are using the platform.

4.1.2. Scenario 2: Peer writing with dental assistants

This scenario has been designed to teach radiography practice, which is highly technical and rarely practiced by apprentices in the workplace. Apprentice dental assistants should be able to undertake the radiography steps adequately. Moreover,

they should be able to identify when the outcome is not satisfying and especially why, in order to perform it again correctly and to acquire deep knowledge on the topic.

In this example of the Erfahrraum model, apprentice dental assistants used a web-based collaborative writing environment (e.g. a wiki) to evaluate a work artefact on the basis of their experience and, after discussion with the whole class, to complete and comment on their peer's evaluation. In the first phase of the scenario, apprentices collected traces of unsuccessful actions (e.g. defective radiographies) from their dental practice (quadrant II: capturing of raw artefacts). Afterwards, the teacher uploaded those that best corresponded to the issues she/he wanted to teach (quadrant II: post-selection of relevant artefacts) and organised the environment according to the learning scenario designed for the reflection phase (in this case, apprentices had to fill in a table with four columns). If necessary, the teacher added other pictures representing defects that did not occur in the original sample. Each apprentice had to comment on a different radiography in the wiki, indicating what was wrong in the radiography (second column) and what incident should have occurred in the procedure to produce such outcome (third column) (quadrant III: augmenting). This phase lead to a collection of commented artefacts after individual reflection (quadrant III: clustering). In the following phase, the teacher showed and discussed each case with the class, indicating the correct interpretation of the radiographs, in order to get to a collective understanding of the situation (second step of augmentation by collective reflection). Then, every entry was revised and completed by a peer, taking into account their own experiences and the whole class discussion. Finally, the peer had to write a procedural 'solution' in order to solve the problem of the radiograph (fourth column). A final teacher correction took place at the end of the class and this final result was uploaded to the knowledge repository to support the preparation for the exam and for re-contextualisation in the workplace (quadrant IV). Empirical data indicated that the peer's contribution significantly increased the quality of the entries, and that both students and teachers perceived such activity as useful (Gavota et al. 2010).

4.1.3. Scenario 3: Collaborative writing on critical work situations for health care assistants

In the context of health care assistants, even seemingly common situations can be valuable opportunities for reflections on experiences, for example, the critical events that can occur in everyday interactions with different patients (how to handle reluctant patients, how to respect the person in intimate acts, or how to communicate with nervous family members). Due to privacy issues these situations are seldom sharable with peers or even supervisors. In this scenario, apprentices produced a written critical analysis of a difficult situation they encountered in the workplace (see Figure 4). Following the critical incidents methods, they not only described the event, but also reflected on how they reacted and why (quadrant II, de-contextualisation through selection and individual reflection). In a second step, each apprentice commented on one or two episodes encountered by a peer. The apprentices were instructed to ask questions what they considered critical for interpreting the situation and to offer complementary or alternative approaches (quadrant III: augmentation through peer discussion). In a third step, each apprentice answered the peers' questions and revised the original episode by describing a better way to react in a similar

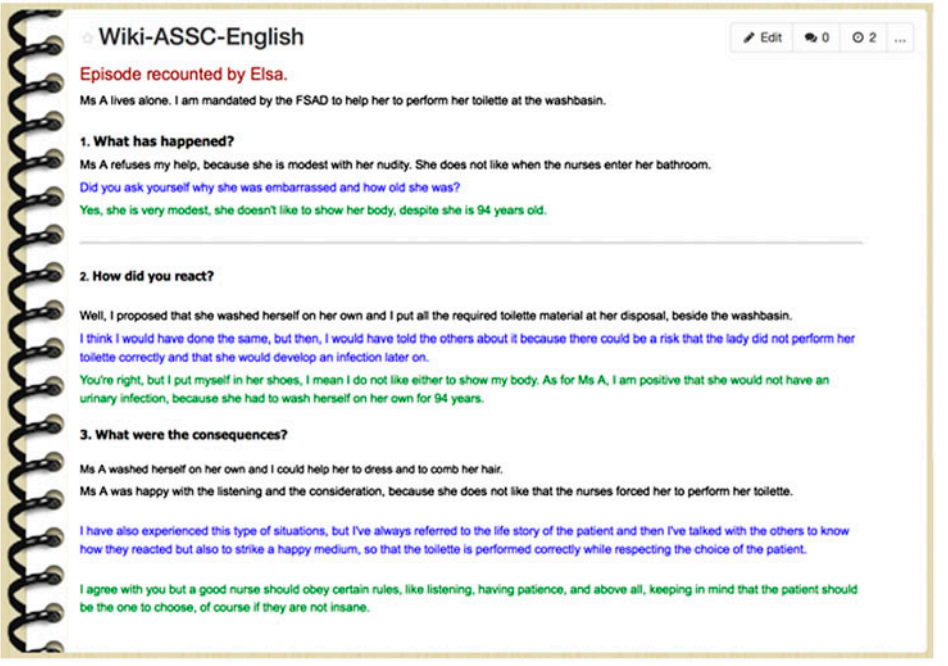

Figure 4. Screen capture of a wiki page (wikispaces service http://www.wikispaces.com) with the text of one apprentice in black font and the comments from one peer in green font.

future situation, taking into account the comments received from peers. After class, the teacher read the episodes and grouped them in meaningful clusters, thus promoting abstraction from a specific event to a class of situations, associated to conceptual explicit knowledge. The activity concluded with a whole class discussion in which the clustering and interpretations were discussed, at the end of which the apprentices were prompted to revise their conclusion. This conclusion ('how would you react next time and why') is a step preparing for re-contextualisation (quadrant IV). The whole scenario was spread across two or three two-hour learning sessions, and was repeated for several topics.

Besides checking for acceptability and practical relevance of the learning design, our research investigated the impact of writing and commenting on learning outcomes, (conceptual understanding of typical situations), the development of self-efficacy beliefs, as part of professional identity, and the apprentices' perception of learning. Results of a preliminary study ($N = 31$ second-year apprentices) showed a correlation between participation in the commenting activity (number of words) and post-test performance (Ortoleva, Schneider, and Bétrancourt 2012, 2013). Further research involved a full implementation of the scenario with two classes of apprentices over one month ($N = 15$ first-year apprentices, and $N = 25$ second-year apprentices). Pre–post-test comparisons indicate that students in both years improved their conceptual knowledge of the general class of situations. However, only first-year students gained in self-efficacy beliefs (Ortoleva and Bétrancourt 2015). The qualitative analysis of the written productions provided a description of high-quality written interactions, from which a series of instructional recommendations can be

drawn. For example, the most productive peer interactions occurred when students provided concrete suggestions and reported their personal experience in similar situations in their comments (Ortoleva and Bétrancourt submitted).

4.1.4. *Scenario 4: Video recording for car mechanics and chefs*

Apprentice car mechanics and chefs used a headband camera at the workplace to record videos of professional procedures (see Figure 5) and re-use them later at school during their lessons. Videos allow capturing whole processes, whereas pictures only capture snapshots of single moments, for example of a finished product. If an apprentice makes a mistake during the procedure, pictures before and after might not be enough. At the beginning, apprentices were assigned what to record by their teachers, according to the topics outlined in the curriculum. Technologies allow capturing professional procedures while performing them. This scenario has been designed to capture important workplace procedures that are not practised in every garage or restaurant ('contextualisation') and use them for orchestrated classroom reflection activities ('de-contextualisation').

Videos were made available to the teacher, who selected the most meaningful sequences and edited them into 3–5 min videos. The teacher annotated the video to highlight important elements ('augmenting') (Zahn, Barquero, and Schwan 2004; Chambel, Zahn, and Finke 2006).

A lesson was typically based on the exploitation – through different instructional strategies – of these visual materials for connecting theory and practice ('de-contextualisation'). For example, the teachers tested scenarios based on expository teaching, on individual analysis (e.g. exploiting a video annotation tool), on group working or on plenary discussions. In all cases, apprentices participated in these phases – individually or collectively, depending on the scenario – to include additional layers of information ('augmenting' again). Afterwards, the teacher always orchestrated a discussion favouring comparisons of different cases coming from different apprentices ('clustering'). In fact, the scenarios often aimed to distinguish similarities and differences of the same procedures in different professional contexts. With chefs, for example, the same cooking method can be differently performed in an upscale restaurant, a large company cafeteria, or a family restaurant. Looking at

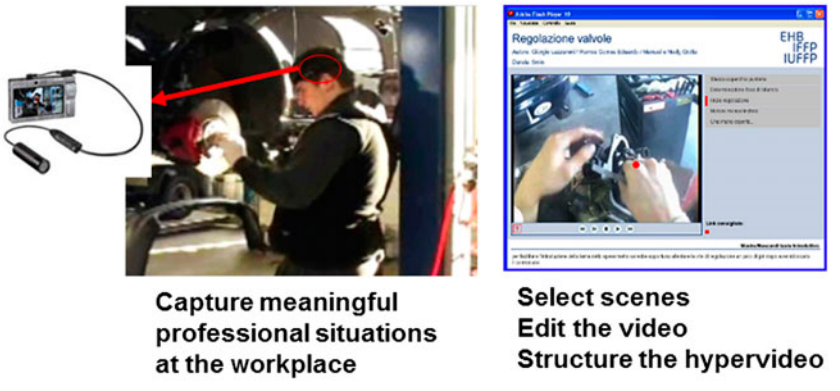

Figure 5. The headband camera collection and the hypervideo scenario.

and identifying these differences can serve to better connect different forms of VET-relevant knowledge.

Research in this scenario investigated the acceptance of the headband cameras worn by the apprentices and the perceived usefulness of the videos by teachers. Results indicate that headband cameras were well accepted by the actors of the system (apprentices ($N = 53$), workplace bosses ($N = 15$), teachers ($N = 62$)) and considered easy to use (Motta, Cattaneo, and Gurtner, 2014). They were perceived as an added value for learning activities by teachers and led to positive learning outcomes measured in terms of declarative knowledge acquisition through the use of the vocational school learning tests (Aprea et al. 2012; Boldrini and Cattaneo 2013).

4.1.5. Scenario 5: Individual and collaborative portfolio development with commercial employees

Apprentice commercial employees used a web-based platform, similar to the one described above for the dental assistants. The objective was to analyse professional practices in different contexts. Computer-supported individual and collaborative writing activities have been designed to foster their reflective attitude and their professional identity. In this case, given the characteristics of the profession, we didn't use visual technologies to capture professional processes. On the contrary, we exploited the use of writing as a mediation tool to recall some relevant experience. The scenario was repeated several times during the different school years and took place mainly at school ('de-contextualisation'). The apprentices first captured a workplace experience in an online journal ('pre-selection'). The teacher prepared a wiki environment with prompts to scaffold the learning task. Apprentices had to exploit the materials collected, commenting and revising their peers' texts in the wiki ('augmenting'). Revising peers' journal entries can be an authentic opportunity for apprentices to ask for more details about the procedure, to point out differences between contexts and to emphasise critical moments in the procedure ('clustering'). After that, they were asked to revise their entries by integrating their peers' comments ('augmenting' again). Final texts were used to trigger whole-class activities orchestrated by the teacher to reflect on methodological and operational issues ('clustering' again). Specific texts were selected to be added to a 'collective portfolio' that could be used as a resource for studying and for practical purposes ('preparation for re-contextualisation') (see Gavota et al. 2010, for further details).

Building on our findings with baker and chef apprentices, we designed and implemented an online platform for apprentice commercial employees (see Figure 6). Apprentices developed their personal learning journals, (a) described specific workplace situations following prompts, (b) documented their experiences with digital artefacts attached to the journal entries, (c) self-evaluated their progress in mastering specific procedures, (d) received an graphical overview of their own competence development and (e) could ask and/or receive comments and feedback from peers and teachers. In the same environment, the teacher could (a) select prestructured individual and collaborative writing scenarios, (b) structure new scenarios from scratch and (c) monitor ongoing activities within the platform.

Findings support the feasibility of these Erfahrraum-compliant scenarios, as well as their effectiveness for fostering reflective attitude and competence development. More in detail, collaborative writing proved to be effective for learning (Gavota et al. 2010; Boldrini and Cattaneo 2013) and the writing-to-learn approach was

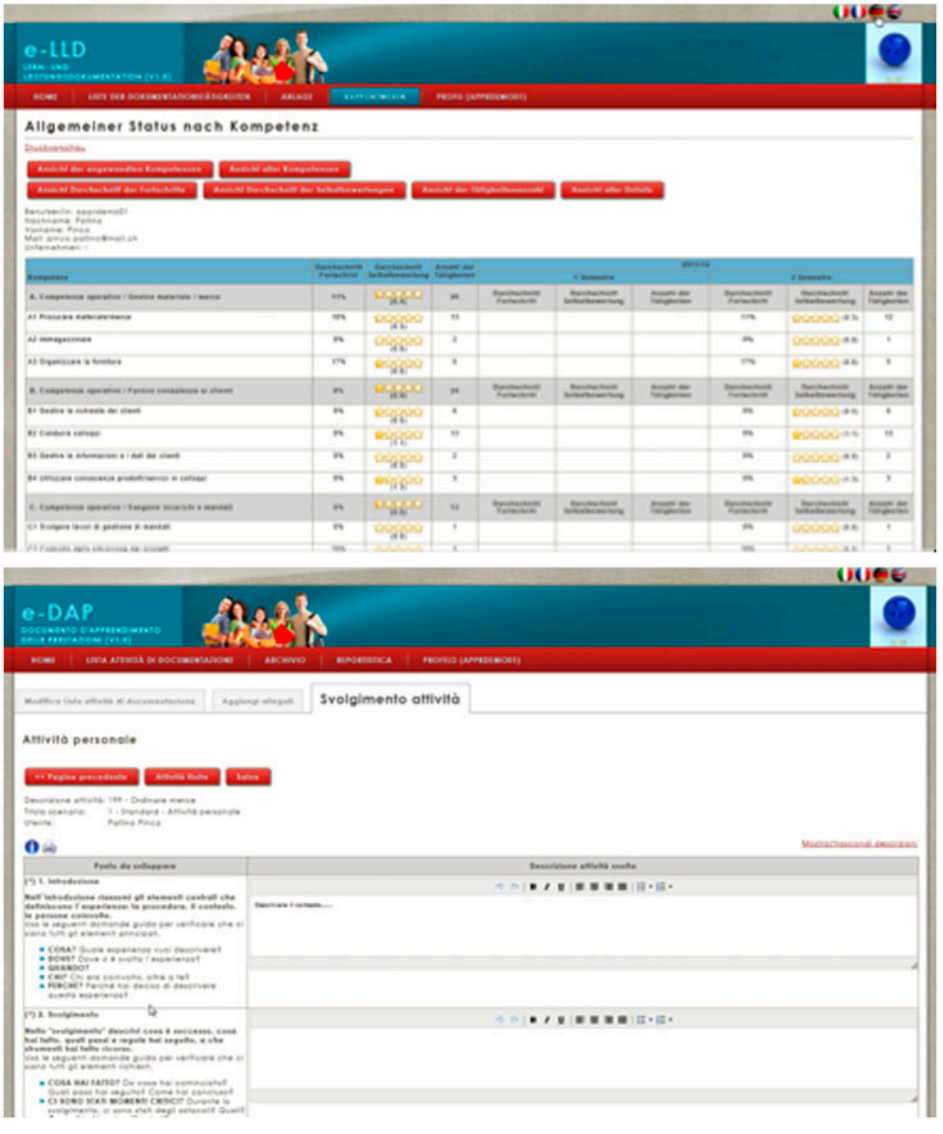

Figure 6. The environment for commercial employees: on the left side the apprentice's view of the overall professional development, based on the learning journal entries; on the right, an example of a description form supported by scaffolding prompts.

confirmed to be effective as well especially in combination with the analysis of errors (Boldrini and Cattaneo 2013) and when supported by specific prompts-based scaffolding strategies (Boldrini and Cattaneo 2014).

Making apprentices used to the Erfahrraum cycle described above proved to have strong effects on their attitude to reflect on professional procedures, measured through a qualitative analysis of produced texts ($N = 298$) (see Cattaneo and Aprea 2014). As well, new experiments on the analysis of errors revealed video annotation to be a feasible and effective way to give technologies once again a prominent role

to support augmenting, also in the under-investigated context of intercompany courses ($N = 136$) (Cattaneo and Boldrini 2015).

4.1.6. Scenario 6: Augmented-reality simulation for logistics assistants

Apprentices in logistics have to learn how to optimise the storage and movement of goods within a warehouse. Their work consists of bringing goods from the shelves to the delivery docks and vice versa, often with forklifts. In parallel, they have to manage the dataflow i.e. what comes in and what goes out, keeping track of where items are and managing the stock (e.g. anticipating stock shortages) ('contextualisation'). The logistics scenario illustrates the Erfahrraum cycle from contextualised knowledge (workplace) to de-contextualised knowledge (vocational school) back to re-contextualised knowledge.

The Erfahrraum model stresses the need for linking concrete experiences from the workplace to theoretical knowledge through reflection activities. To simulate and discuss different warehouse layouts and their effect on moving goods around, we developed the 'TinkerLamp', a camera-projection system that can augment simulated warehouse. This activity allows capturing apprentices' experiences and de-contextualising them (moving from concrete to abstract knowledge). Apprentices had to develop and explore different designs for what they considered to be a well-performing warehouse. To make their design realistic, we provided them with a mock-up of a warehouse in the form of a set of miniature plastic shelves that they could rearrange on a table. This set of shelves served as the tangible interface for the simulation augmented by a 'TinkerLamp' ('augmenting'). The TinkerLamp camera placed above the table (see Figure 7) identified the position of each shelf and the system elaborated a 3D model of the warehouse. The TinkerLamp projector placed above the table displayed augmented information on top of the shelves and on the table, for example the distance between a shelf and the dock. When running the simulation, the projector displayed the movement of forklifts as well as indicators of the efficiency of the warehouse.

A lesson typically included two parts. The students were organised into triads. First, the teacher gave them a challenge such as 'try to store as many goods as possible without perturbing forklift movements'. This 'collect/evoke' phase lasted for about 1 h ('capturing'). Then, the teacher asked teams to use the central blackboard to compare layouts. Students had to explain why performance was better in one solution than in another ('clustering'). This reflection phase was conducted in the form of a plenary debriefing led by the teacher, but could also be done on worksheets ('reflection sheets'). The 'TinkerLamp' provided opportunities for logistician apprentices to reflect on the warehouse layouts they built. Worksheets and the teacher scaffold activities that connect practical experience with theoretical knowledge.

Reflection sheets provided apprentices with an opportunity to reflect on and integrate practical and theoretical knowledge ('preparation for re-contextualisation'). Apprentices could also compare the different layouts they built through an individual 'fieldwork' sheet (Figure 8), with the layouts built in classroom. Apprentices were asked to bring the sheet to their workplace, discuss it with their supervisor and select three layouts among the saved ones: the best, the most similar and the most different from their warehouse (re-contextualisation). The answers were discussed during the following class at school. 90% of participating apprentices (2 classes; $N = 33$ apprentices) completed the assignment and returned their completed sheet

Figure 7. The exploitation by the teacher of optimised warehouse designs produced by logistics apprentices using a simulation device.

(which is remarkable as the teachers warned us that his students usually hardly do any homework). Furthermore, 82% of the participating apprentices reported that they discussed the worksheet with their supervisor for an average of 16 min – a sizeable time considering the workplace constraints discussed above.

Findings support the usability and usefulness of the TinkerLamp to support Erfahrraum activities with logistics learners. The augmented model shelves served

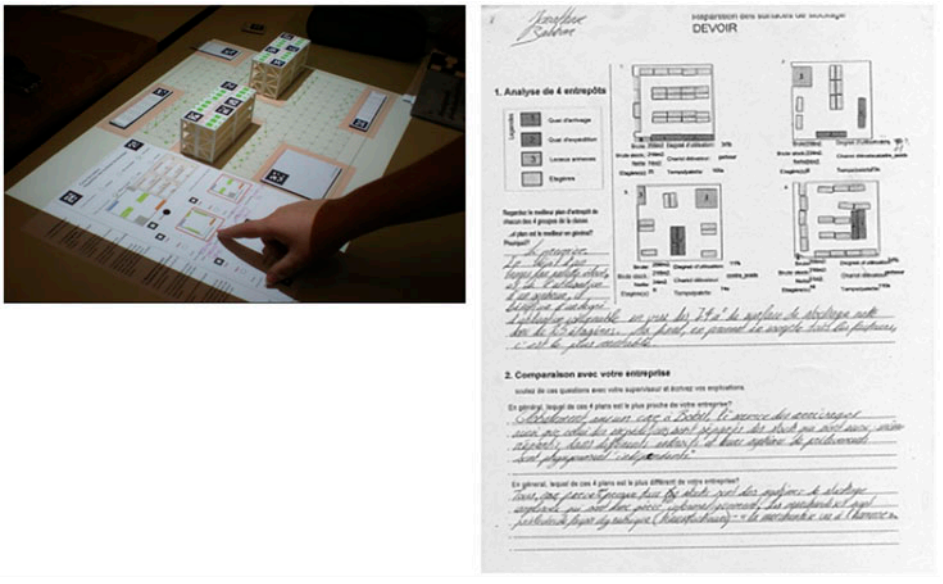

Figure 8. The TinkerLamp activity allowed apprentices simulate the effectiveness of different warehouse layouts (left), fieldwork sheets were used to save their designs to discuss them with their supervisors at the workplace (right).

as boundary objects connecting concrete experiences with abstract knowledge. Similarly, the reflection sheets facilitated crossing boundaries between the classroom and the workplace (Zufferey, Jermann, Lucchi et al. 2009; Zufferey, Jermann, Do Lenh et al. 2009).

5. Discussion

VET learning happens within and across different formal and informal contexts. Apprentices and professionals have to continually connect theory and practice, abstract and practical knowledge, implicit and explicit knowledge, thinking and acting, in order to facilitate the integration of knowledge, skills and attitudes (Baartman and de Bruijn 2011). As this articulation process is neither obvious nor takes place spontaneously, we developed the Erfahrraum model to design supporting technologies. The underlying hypothesis that learners are able to aggregate information gathered in two (or more) contexts into a coherent body of knowledge has been questioned (Stenström and Tynjälä 2009; Illeris 2011). However, our results indicate that the Erfahrraum model can successfully inform the design and implementation of boundary-crossing activities in a variety of different VET environments. As illustrated by the scenarios above, the Erfahrraum model can be applied to a wide range of learning technologies to bridge the gap between learning contexts, make experiences explicit and facilitate reflection.

The Erfahrraum model does not aim to be an ontology of knowledge or a theory of learning, but a *pedagogical* model that informs the design and orchestration of VET learning activities. As such, the model does not predict learning gains but needs to be tested for its usefulness by applying it to different dual context learning scenarios.

The Erfahrraum model builds on the role of reflecting on experiences to promote learning. Learning by reflecting upon one's experience is not a new idea. The Erfahrraum model shares elements with Kolb's experiential learning model (Kolb 1984), which is deeply rooted – in spite of some differences (Miettinen 2000) – in Dewey's conception of learning from experience (Dewey 1933; 1938/1963). The Erfahrraum model builds and extends on Kolb and Dewey's notion of learning from experience. Like Kolb's model, the Erfahrraum model understands learning as an iterative circular process. While Kolb's model remains limited to the path gone through by the learner alone, our model takes advantage of the duality of contexts and the social aspect of the plurality and the diversity of people involved in each of them, for example peers, teachers or supervisors. By doing this, we extend the learning-by-doing approach by adding a social learning approach. We understand reflection not only as an individual operation but also as a collectively enriched process. The Erfahrraum model describes an iteratively refined selection process that distinguishes VET-relevant experiences. Experiences require scaffolded reflection (such as the processes of augmenting and clustering) to become 'Erfahrungen'. As illustrated in the scenarios from diverse professions, the Erfahrraum model is a powerful pedagogical model that can inform the design and implementation of learning scenarios in different settings. As already stressed by Kolb and other representatives of experiential learning (for example, Schön 1983; Mezirow 1991), reflection not only leads to a better understanding of one's actions and experiences, it should also lead to the development of vocational competence that affects actions in the original context. This is why the whole Erfahrraum process cannot simply end at school but needs to link back to the workplace from where it originated. This part of the process is analogous to what Perkins and Salomon (1988) have called 'bridging', a process through which the learner integrates knowledge by applying it to as many contexts as possible where that knowledge could be helpful.

The Erfahrraum model is a technology-based model, but at the same time it is not restricted to a particular learning technology. The scenarios illustrated how the Erfahrraum model can be implemented in different vocations using a range of different tools. Technologies can serve as boundary-crossing tools to support ongoing collection, selection, sharing and reflection processes. The power of the Erfahrraum model lies in informing the design of new technologies as well as the combination and orchestration of existing tools. The objective of the Erfahrraum model is to inform workflows that facilitate the integration of various technologies in different learning scenarios that facilitate bridging different contexts. The Erfahrraum model connects VET-specific formal, non-formal and informal contexts but the model could also be applied to other areas of learning.

The Erfahrraum model can be considered as closely related to the concepts of boundary crossing and boundary objects, at different levels and in different ways. First, the Erfahrraum model informs the creation of boundary spaces shared with other actors of the vocational system, creating the possibility for those actors to interact and bridge the gap discussed in the theoretical part of this paper. Secondly, the Erfahrraum model forms spaces for reflection. Thirdly, the Erfahrraum model sets the apprentice centre stage. The apprentice plays the role of a broker (Wenger 1987) and of a boundary crosser, being in a unique position to act as a mediator. In the scenarios we described, for example, the portfolio used by chefs provided common grounds for teachers and supervisors to meet each other. Going a step further, this connectivity process promoted by the Erfahrraum model can include other

stakeholders from VET system. For example, in some of our experiences, we started from small interventions involving one or two classes leading to the whole vocational school being interested in using the model. The Cantonal office for VET asked to implement some of the solutions developed and several corporate associations are planning to evaluate the possibility of extending the model to their whole professional domain.

The Erfahrraum model thus can become a transformative mechanism at the individual, institutional and political levels. For the individual, we already stressed the potentialities for improving learning from experience. Evidence from our studies indicates the effects the model can have on learning outcomes, self-efficacy perception, professional identity and metacognitive skills development. Further research is needed to clarify under which conditions this can happen. At the institutional level, most of the experiences we monitored suggested that the model is feasible and that schools see the potential of setting up boundary crossing in their own contributions. Working with boundary objects requires ongoing joint work at the boundaries and continuous negotiation of meanings. At the political level, this transformation can lead to profound changes, for example, the (re-)definition of the interaction processes between contexts, of the learning curriculum, and of the qualification procedures (Akkerman and Bakker 2011). Further research will explore the scalability of the Erfahrraum model to other VET contexts and investigate mechanisms for effective orchestration.

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Conflict of interest

The authors declare that there are no conflicts of interest.

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Notes

1. In compliance with the Swiss law on VET that came into force in 2002, the Swiss apprenticeship model also includes a 'third learning place', an additional training segment known as 'intercompany courses'. These courses are conceived as a 'complement to the work-based and school-based segments' (Swiss Confederation VPETA, art. 16, par. C) and include both theoretical and practical aspects.

2. In some workplaces, apprentices do not experience all the skills they are expected to learn (see the logistics example). Although they will not be in a position to collect this type of experience from the workplace, they remain able, as we could see in our observations, to evoke such events mentally later on.

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