

Chapter 3

Designing for Boundary Crossing and ICT-Based Boundary Objects in Dual VET



Marianne Riis and Anna Brodersen

3.1 Networked Learning in Relation to Vocational Education and Training

In 2020, by way of merging texts from previous research in networked learning and as a means to better encapsulate the diverse theoretical foundations that constitute the field, the Networked Learning Editorial Collective (NLEC, 2020) put forward a new description of networked learning:

Networked learning involves processes of collaborative, co-operative and collective inquiry, knowledge-creation and knowledgeable action, underpinned by trusting relationships, motivated by a sense of shared challenge and enabled by convivial technologies. Networked learning promotes connections: between people, between sites of learning and action, between ideas, resources and solutions, across time, space and media (NLEC, 2020, p. 9).

The emphasis on promoting connections makes networked learning relevant in the Danish Vocational Education and Training (VET) system, given that it is based on a *dual* principle, which means that students alternate between school and workplace (apprenticeship) periods throughout their education. During this alternation, students are required to learn a complex set of skills and acquire highly specialized knowledge, and at the same time come to terms with shifts in their roles, responsibilities, and their positions in two distinct types of hierarchies at the school and in their

M. Riis (✉)

Digital Learning Environments and Educational Design, University College Absalon, Roskilde, Denmark

e-mail: marr@pha.dk

A. Brodersen

National Center for the Development of Vocational Education and Training, University College Copenhagen, Copenhagen, Denmark

e-mail: AHBR@kp.dk

workplace, respectively. While learning a trade, students are also becoming professionals, meaning that for VET students, and by association for VET teachers, education is very much a matter of coming to be as well as coming to know.

Nonetheless, making sense and use of learning in and from different contexts and experiencing continuity between school and work have long been considered major pedagogical challenges in Danish VET research resulting in a continuous focus on the transfer phenomenon (Tanggaard 2007; Illeris, 2009). Transfer is, however, a contested concept both in research (Engle, 2012; Hager & Hodkinson, 2009; Lobato, 2006) and among practitioners. In this chapter, the concepts of boundaries, boundary crossing, and boundary objects are adopted as a way of challenging the traditional notion of transfer understood mainly as a one-time and one-directional transition between a context of acquisition and that of application. Boundaries in education and learning processes are intuitively apprehended as something that needs to be avoided or diminished, but according to research on boundaries and boundary crossing (Bakker & Akkerman, 2017; Tuomi-Gröhn et al., 2003; Wenger, 1998), this may not be the best approach. In fact, Wenger-Trayner and Wenger-Trayner claim:

Rather than hindering boundaries under an illusion of seamless applicability across contexts, it is better to focus on boundaries as learning assets (Wenger-Trayner & Wenger-Trayner, 2015, p. 18).

As stated by several authors (Motta et al., 2014; Nortvig & Eriksen, 2013; Wals et al., 2012), ICT can be used to bring about some of the learning potentials in and between domains, practices, and contexts in dual education. However, in Danish VET research knowledge of pedagogical use of ICT is highly limited (Ørngreen et al., 2016). To remedy this lack of knowledge, a research project investigating Danish VET teachers' understanding and use of ICT-based boundary objects in boundary-crossing activities was conducted between 2015 and 2018 (Riis et al., 2019).

In this chapter, we present selected findings from the research project. In the first phase of the research project, interviewed VET teachers pointed to the need for new materials directed at the planning stage in their work with design for boundary crossing. As part of the project a design framework, including design principles and a design matrix that focuses on boundary crossing mediated by ICT-based boundary objects, was developed and tested. In this chapter, we focus on the development of the design matrix, convey main findings regarding the development and usefulness of the matrix, and point to further research.

3.2 Research Design, Methods, and Main Questions

The research project has been designed as a multiple case study (Yin, 2009) with the involvement of nine VET schools and two workplaces. In different phases of the project, we conducted 20 interviews (35 VET teachers, students, trainers) and 30 h of classroom observations as primary methods to generate and collect data.

Table 3.1 Connection between research questions, methods, and expected outcome

Research question	Methods	Expected outcome
RQ1: In what ways and why do VET teachers use ICT-based artifacts as boundary objects to design for boundary crossing and continuity in and across different contexts?	Interviews and classroom observations	New knowledge of how VET teachers understand and use ICT in relation to boundary work and design for boundary crossing
RQ2: What pedagogical recommendations and materials can support VET teachers' future work with establishing enhanced school-workplace interaction through the use of ICT?	Design iterations tested among in-service VET teachers in workshops and teaching sessions	A design framework consisting of design principles, a design model/matrix, and additional scaffolding materials

Furthermore, the study was inspired by Educational Design Research (McKenny & Reeves, 2013) in so far as the design framework and the design matrix were developed, tested, and refined in three iterative cycles. However, even though the goal of the study was focused on the development of theory and a design framework, the research project did not provide the opportunity to conduct experiments in the participating VET schools or workplaces. Instead the design matrix was tested in workshops and in teaching sessions, predominantly involving in-service VET teachers. While students, trainers, pedagogical leaders, and consultants have participated in different phases of the project, the VET teachers are the main target group of the project. Table 3.1 shows the connection between the two main research questions, methods, and expected outcome.

3.3 Theoretical Background

The research project is based on a sociocultural understanding of knowledge, skills, and practice requiring a sensitivity towards participation in boundary contexts. From a sociocultural perspective learning is defined as constructed, social, situated, mediated, distributed, and becoming (Dysthe, 2001). Here, we emphasize *learning as becoming*, as we see this perspective in close connection to the aforementioned overreaching pedagogical challenge in the dual-VET system and also as something having a unique potential to be unfolded in the VET system through ICT-based networked learning.

In the definition of learning as becoming, learning is understood as more than epistemic construction and also as a process of becoming *someone* through participation in activities connected to a specific craftsmanship which enable the participants to gradually build an identity as such craftsmen (Riis et al., 2019). This is not to be mistaken as something material that is being adopted in a reproductive way, but in relation to how Wenger (1998) defines learning through participation, which entails an understanding of identity as negotiated experience, community membership,

learning trajectory, nexus of multimembership, and a relation between the local and the global. This understanding also points to a way of seeing identity and practice (and so participation in practice) as a whole, or as Wenger states as “. . . *mirror images of each other*” (ibid., p. 149).

Nonetheless, research in students’ participation in dual VET highlights challenges in designing education in ways that promote the students’ experiences of the combination of school and workplace periods as a meaningful whole (Tanggaard 2007; Illeris, 2009). Rather, students experience differences between domains, practices, and context, which, if left unrecognized and unresolved, often result in differences becoming unproductive boundaries for learning and development of professional identity. Based on a review of 181 educational studies, Akkerman and Bakker contend:

All learning involves boundaries. Whether we speak of learning as the change from novice to expert in a particular domain or as the development from legitimate peripheral participation to being a full member of a particular community (Lave & Wenger, 1991), the boundary of the domain or community is constitutive of what counts as expertise or as central participation (Akkerman & Bakker, 2011a, p. 132).

Akkerman and Bakker (ibid., p. 133) define a boundary as “a sociocultural difference leading to discontinuity in action or interaction” with discontinuity indicating actions or interactions that do not result in the intended or desired progress or when they require substantial effort. One typical boundary in dual VET is the difference in epistemic cultures, and thus practices and possibilities for participation, in and between the school and the workplace. Although Akkerman and Bakker (2012) assert that boundaries can function as learning resources, the authors also emphasize that intersecting sociocultural practices do not per se lead to boundary crossing but rather necessitate deliberate pedagogical design in order to reach the full potentials of dual education.

Inspired by Star and Griesemer (1989), Akkerman and Bakker suggest the use of boundary objects as a means to facilitate boundary crossing. Boundary objects are “artefacts doing the crossing by fulfilling a bridging function” (Akkerman & Bakker, 2011a, p. 133). In our understanding of boundary objects, we also draw on Illich’s (1973) notion of *convivial tools*; we use the term boundary object as an artifact or a tool enabling people “not only to obtain things” (ibid., p. 11), such as “delivering” one piece of information to one another. In our data we find several examples where the tool is just a tool in a more instrumental and one-sided way, such as passing information from school to workplace or the other way around but without having a dialogue—whereby the convivial potential of the tool is missed. As opposed to this, convivial tools are enabling people “. . . to give shape to them according to their own tastes and put them to use in caring for and about others” (ibid.). Illich further elaborates:

Tools are intrinsic to social relationships. An individual relates himself in action to his society through the use of tools that he actively masters, or by which he is passively acted upon. To the degree that he masters his tools, he can invest the world with his meaning; to the degree that he is mastered by his tools, the tool determines his own self-image. Convivial tools are those which give each person who uses them the greatest opportunity to enrich the environment with the fruits of his or her vision (Illich, 1973, p. 21).

For this reason, we see conviviality in connection to Akkerman and Bakker's description of boundary objects as tools conveying meaning and enabling people to negotiate meaning and establish a shared understanding. In both conceptions, the tool is being used in a way that makes it possible for people to participate on their own terms.

While Akkerman and Bakker are not particularly focused on the use of ICTs as boundary objects, Heilesen et al. (2012) found that ICT can extend formal learning into the workplace during apprenticeship periods. According to the authors, this will lead to empowerment of apprentices and give the learners a more active and responsible role in their learning. Correspondingly, Nortvig and Eriksen (2013) state that new and easily accessible technologies provide opportunities for construction of a third, intermediary space of learning and integration of theory and practice, thus pointing to a boundary-crossing potential.

Akkerman and Bakker (2011b) have identified four learning mechanisms or processes that potentially occur in and between the boundaries of sociocultural systems. These learning processes constitute the core of boundary crossing:

1. *Identification*: Boundary crossing can lead to the identification of the intersecting practices, whereby the nature of practices is (re)defined in light of one another.
2. *Coordination*: Boundary crossing can also lead to processes of coordination of both practices in the sense that minimal routinized exchanges between practices are established, to make transitions smoother.
3. *Reflection*: Reflection is a more profound effect of boundary crossing. It is about learning to look differently at one practice by taking on the perspective of the other practice.
4. *Transformation*: In the case of transformation boundary crossing leads to changes in practices or even creation of a new in-between practice, for example a boundary practice (Akkerman & Bakker, 2011b, p. 3).

Central to these learning processes is a dialogical demand, which necessitates scaffolding from either the VET teacher in the school periods or the VET trainer in the workplace periods, preferably both in collaboration. Given that research shows that Danish VET students more often than not are expected to cross the boundaries in and between school and work on their own, potentially leading to confusion, lack of meaning and coherence, and general dissatisfaction (Louw, 2015), this dialogical and collaborative demand is important.

Akkerman and Bakker primarily focus on the processes of boundary crossing. With regard to boundary objects we have been inspired by Henningsen and Mogensen (2013) who, based on the research in dual education, propose the use of different types of mediating artifacts in boundary work. Such mediating artifacts have the capability of mediating the development and transformation of knowledge and skills, and Henningsen and Mortensen identify four main types of artifacts aimed at interaction, reflection, construction, and simulation (ibid. p. 109). We understand these four action possibilities as inherent properties or affordances of different artifacts, e.g., ICTs.

3.4 Selected Findings Related to the Design Process

As previously mentioned, in the initial phase of the research project, VET teachers pointed to the need for new materials to guide them in the planning of their designs for boundary crossing. In line with foundations in sociocultural theories, such as boundary crossing theory, the VET teachers called for a focus directed at *activities* undertaken by the learners. By way of combining ideas from Akkerman and Bakker and Henningsen and Mogensen, we created a model focusing on boundary crossing mediated by ICT-based boundary objects, which has been refined through three iterations. In all three iterations, the model has been tested by different practitioners (mainly VET teachers). It is beyond the scope of this chapter to present the full design process, but the following account provides the reader with an impression of the type of reflections the iterations resulted in and how we tried to accommodate suggestions from the practitioners who were involved in the process.

From the conception, the design model was intended as a pedagogical tool for the VET teachers to use in their planning of designs for boundary crossing. The first iteration of the model depicted the four boundary-crossing processes combined with four main affordances related to the boundary objects. Based on the initial research and testing of ideas in teaching sessions, we decided to revise and reduce Henningsen and Mogensen's (2013) original suggestions and ended up with documentation, simulation, construction, and interaction as main affordances of the boundary objects. This iteration of the model was tested in two workshops: (1) a workshop with 16 in-service VET teachers enrolled in a further education program, where one of the authors were teaching, and (2) a workshop with approx. 40 participants from the VET sector (mainly pedagogical leaders and pedagogical consultants from VET schools) (Fig. 3.1).

During the workshops, the participants were, among other things, asked to discuss and decide where in the model different ICTs (of their own choosing) could be placed and why, and this resulted in the suggestions shown in Fig. 3.2.

As seen in Fig. 3.2, the workshop participants pointed to many different types of ICTs. Nonetheless, even though the participants found the model useful as a "planning tool," which could trigger reflections on different ICTs and their relation to boundary-crossing processes, the model was conceived as misleading. This first iteration seemed to indicate that the ICT-based boundary objects were related to only two of the four processes. Further, many of the mentioned ICTs are complex technologies with more than one affordance, and while the participants decided the position of the ICTs based on perceived *main* affordance, this was unsatisfactory. As the participants stated, they would often choose a specific ICT precisely because of its *various* affordances. Thus, the participants called for a different type of model, which could encompass such considerations.

Based on these experiences, we developed a second iteration of the model, which as it turned out still did not meet the expectations or needs of the VET teachers. The testing of the second iteration also pointed to another challenge in using the model, which led us to conclude that a narrow focus on boundary processes and affordances

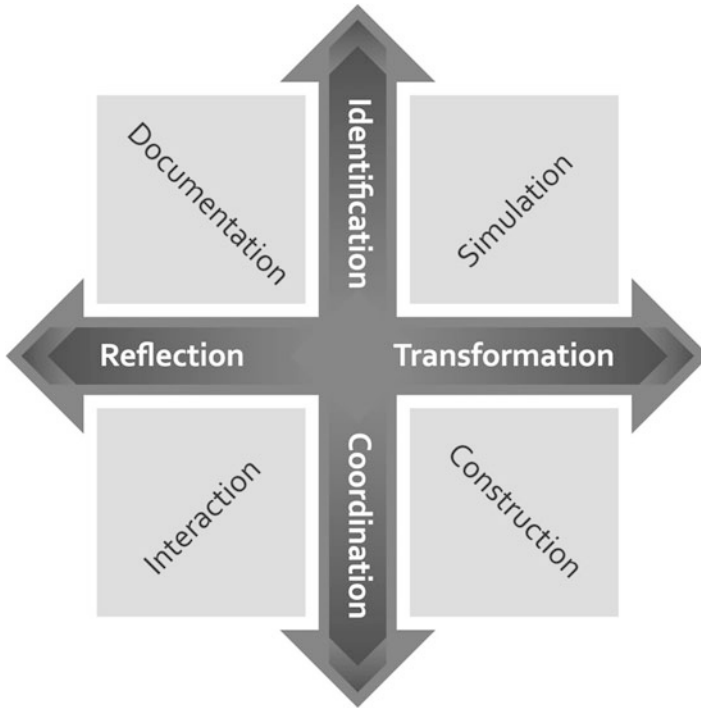


Fig. 3.1 The first iteration of the design model

was not sufficient. Testing in this phase showed that the VET teachers often neglected to consider other crucial elements in design for boundary crossing such as the purpose of the activity, the learners' (and teachers') prerequisites, and the curricular content. In other words, there was a need to complement the model with additional pedagogical design questions for the VET teachers to consider, when using the model.

In the third iteration, the model was changed to a matrix as depicted in Fig. 3.3, which illustrates the many ways (16) it is possible to combine the boundary-crossing processes with different affordances of the ICT-based boundary objects resulting in ICT-mediated *activities*. Figure 3.3 also includes specific ICTs based on our findings from the final data collection period.

In working with the matrix as part of our data collection, the VET teachers were asked to start by defining a pedagogical challenge they wanted to solve and then focus on (a) the ICTs they had access to, and thought might be useful as boundary objects, or (b) the boundary-crossing processes they wanted to design. In any case, the teachers were asked to work with the design of both boundary objects and boundary-crossing processes.

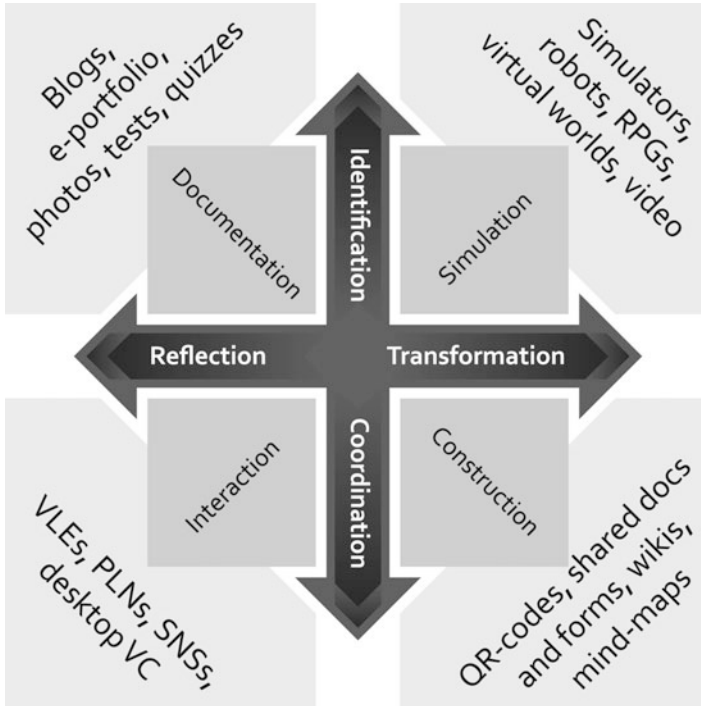


Fig. 3.2 The first iteration of the design model with examples of ICTs

3.5 Selected Findings Related to the Design Matrix as Analytical Tool

In the final data collection phase of the project, we decided to interview 14 VET teachers focusing on their actual use of ICT, and in our analyses, we used the design matrix to map our findings. Overall, our data show that the interviewed VET teachers did not recognize the full potentials of ICT in relation to boundary-crossing activities. The study shows that VET teachers employ different pedagogical strategies for integrating ICT in their teaching practices, e.g., enhancing student activity or accommodating students' prerequisites through multimodal approaches, but that the use of ICT in relation to boundary-crossing activities is limited.

With regard to the elements in the design matrix, our data show that the VET teachers designed ICT-mediated activities aimed at boundary crossing through identification, coordination, and reflection, whereas data point to no activities directed towards transformation. In terms of ICT-based boundary objects, the VET teachers were mainly focused on ICTs that afford documentation with only little focus on construction and interaction. Among the interviewed VET teachers, the rare mentions of simulation were in connection to the use of physical simulation dolls and the use of a flight simulator, which was used as a training object, and not as an intentional boundary object.

ICT-based boundary objects – based on affordances				
Boundary crossing processes – based on dialogical learning mechanisms	Documentation	Simulation	Construction	Interaction
Identification	Video OneNote Self-made app		Video Thinglink Self-made app	Facebook Google+ Self-made app
Coordination	Facebook, Google+ Elevplan ItsLearning OneNote Self-made app		Video Thinglink OneNote Self-made app	Facebook Google+ OneNote Self-made app
Reflection	Facebook, Google+ Elevplan ItsLearning OneNote Self-made app		Video Thinglink OneNote Self-made app	
Transformation				

Fig. 3.3 Third iteration: the design matrix with examples of ICTs

3.6 Selected Findings Related to Boundary Crossing as Learning Process

According to Akkerman and Bakker (2011a, b) a key component of boundary crossing as learning process is the ability to “make and take” the perspective of others, thus delineating the differences in order to enhance understanding and potential change in actions and interactions in communities.

Several of the VET students, we interviewed, described how they were taking on new perspectives in their understandings of being professionals, when they were participating in different practices in their apprenticeships. We find many examples of students mentioning that theory makes sense in another way, or that they reach new understandings or even are able to see several other solutions to specific problems. An example, of how a student develops an expanded understanding of theory, by experiencing the use in practice, we find in this quote from a student observing her trainer in health care work:

That thing about appreciative communication . . . I had an understanding, that you should just always agree with the citizen and active listening and all that, right? But then, when I saw that, I thought; ‘okay, that is also appreciative communication’. Because she shows a respect to the citizen, as she’s saying; ‘well, I would like to try to help you, but it’s not. . . you can’t have to great expectations. Where I thought; ‘ahh, you don’t always have to agree with the citizen’ (Riis et al., 2019, p. 49—our translation).

From a sociocultural perspective, this quote points to particular elements in the understanding of learning as being constructed, social, situated, and becoming; the student meets this situation in one of her workplace periods with some idea of what appreciative communication is about, but—when the idea is realized in interaction within a social and situated practice—the idea is unfolded, reorganized, and constructed into new knowledge as a step in this student’s way of becoming a healthcare worker. In this respect, we share the sociocultural understanding of learning as a process, where each learner needs to construct his or her own structures of knowledge. It is not possible to seamlessly transfer other people’s knowledge; rather it needs to be translated and transformed. In the interaction within a social and situated practice, the piece of knowledge, that the student picked up in class, is now being reconstructed with a new meaning (translated) and transformed into the student’s own structure of knowledge. Furthermore, the example illustrates the boundary-crossing learning process *reflection*, where one learns to look differently at one’s practice by looking at oneself “... through the eyes of other worlds” (Akkerman & Bakker, 2011b, p. 145).

In another example, a student is confronted with her ethical judgement in a specific episode during her apprenticeship. This demonstrates how the journey of becoming a professional also at times entails moments, where you discover *who you want to be* as a professional through the experience of the opposite:

[...] and of course, mistakes also happened, while I was out there, and it made me really upset. It hurt me, because it had done harm to someone. And they hadn’t been listening, when she [a citizen, ed.] . . . because her authority had been taken from her. So, they didn’t listen to her, they just did, what they thought was best for her. And it did more harm than good. And so, it hurt to see this (Riis et al., 2019, p. 53—our translation).

This student is at the boundary between practice and theory, or between what she conceives as bad practice and her own ideals. In this confrontation at the boundary, she is discovering her own values (boundaries) and in all likelihood unstated assumptions. By way of reflecting on the situation, she is constructing new knowledge through a social and situated practice which may transform her identity as a professional healthcare worker and perhaps lead to transformed professional practice in the future.

As both examples illustrate, there is a particular potential in the dual-VET system given that the experiences between school and workplace can contribute in different ways to the students’ gradual journeys of becoming professionals, but this potential also entails a risk. In dual VET the students are participants in two overreaching but different communities of practice, and so they alternate between different contexts and different roles—but still within the same education—where they have to find meaning and coherence between the two communities for having the best opportunities to develop an identity as professionals. When people alternate between communities of practice, Wenger uses the term *boundary work* to capture this type of activity as something requiring hard work: “The work of reconciliation may be the most significant challenge faced by learners who move from one community of practice to another” (Wenger, 1998, p. 160).

Akkerman and Bakker define a *boundary worker* as a person standing on both sides being able to take on different perspectives by giving them a coherent meaning. Conversely, this also means that there is an inherent risk of boundary workers continuing to stay peripheral on both sides and act as “. . . marginal strangers ‘who sort of belong and sort of don’t’” (Akkerman & Bakker, 2011a, b, p. 140). In our interviews, the students often found themselves left alone to do this kind of reconciliation between contexts, and while their teachers utilized different types of ICTs, the tools were rarely used as deliberate boundary objects.

3.7 Selected Findings in Relation to ICT-Based Boundary Objects

As already mentioned, examples of ICT-based boundary objects were sparse in our data. However, in one VET school, the teachers and the workplace trainers collaborated on using a digital portfolio (MS OneNote) as a deliberate boundary tool. In this case, the teachers introduced the tool in the beginning of the education when the students enrolled in their first school period, and the students were instructed in using the portfolio throughout their education in both contexts. Typically, the students were expected to document and reflect upon their experiences, and both teachers and trainers scheduled designated time to discuss with the students. The teachers highlighted the possibility of gaining access to the students’ “world outside the school” and in particular to their experiences in the workplaces. Often the students posted photos and videos of their work, and when the students returned to school such documentation would be utilized to promote reflection and dialogue among all the students in order to discuss both differences and similarities between domains, practices, and context.

According to the teachers, the digital portfolio served as a tool for communication and learning, but they also warned that making information (more) accessible does not automate boundary-crossing activity. Such learning processes still need to be scaffolded by the teachers and trainers. This is consistent with theory. As an example, Akkerman and Bakker (2011a) advise that the processes of coordination entail “efforts of translation” (p. 144) or as Wenger puts it, reconciliation between contexts consists of hard work.

The students, we interviewed in this particular case, were generally quite satisfied with the digital portfolio mentioning the advantage of having one, easily accessible place “to store everything” and to make personal notes independent of space and time. While it was evident that the teachers used the students’ portfolios in their teaching, it was less evident if the students used the portfolios for actual boundary work or simply for documentation and storage. This underscores that the processes of boundary crossing also need to be learned and continuously cultivated and scaffolded.

In an interview with a teacher from another VET school, we found an example of how the use of an app, which the teacher had developed for the purpose, gave the students a space for uploading videos and pictures during their workplace periods and reflecting upon these in interaction with other students and the teacher. Contrary to the previous example with OneNote, this teacher asked the students to collaborate or at least share their experiences not only with the teacher and a trainer, but also with their fellow students. The students were asked to make videos of specific professional practices in their different workplace contexts to stimulate their own construction of relevant knowledge, and also to enable them to interact with each other about relevant questions in their workplace periods. As such, the app can be seen as an ICT-based boundary object that mediates between school and workplace, giving opportunity for the students to interact with each other during workplace periods, sharing experiences that helps them to see similarities and differences and reflect upon their own practice in interaction with others.

The examples with OneNote and the app point to the potential of ICT-based boundary objects used as mediating artifacts for VET students' boundary crossing. Even though it is mainly the example with the app that shows perspectives on how actual boundary work can be scaffolded, both examples highlight the potential, especially regarding the learning processes Akkerman and Bakker refer to as identification, coordination, and reflection. The artifacts, OneNote and the app, can, if being used as actual boundary objects, support the students' boundary crossing by making a communicative connection between school and workplace periods which promotes dialogue and possibility of translation and transformation of knowledge between the VET students' two learning contexts. Further, the design of a dual-learning environment based on boundary-crossing activities and boundary work has the potential of strengthening the student's reflection and identification of how different contexts shape their learning trajectories of becoming craftsmen and women.

3.8 Discussion

As an analytical tool the design matrix was useful in terms of mapping the existing use of ICT-based boundary objects related to specific boundary-crossing processes. However, in order to better understand *why and how* VET teachers use ICT in boundary work, the matrix was insufficient pointing to a need for a more elaborate framework, if such questions were to be uncovered solely through design analyses.

Looking back at the many different types of ICTs, and combinations with boundary-crossing processes, the participants pointed to the two initial workshops, and the findings in the final interviews seemed relatively sparse with regard to diversity and use of ICTs in practice. The data show that the VET teachers used a variety of ICTs; often these were, however, not used as intentional boundary objects.

For all the interviewed VET teachers, the theory of boundary crossing and boundary objects was new, and even if they were thinking in lines of designing for connections and transformation of knowledge and skills, they were accustomed

to think about traditional transfer, mainly focusing on creating similarities and reducing differences. Considering boundaries as “learning assets” (cf. Wenger-Trayner & Wenger-Trayner, 2015) was quite new to most of the teachers. Among the four boundary-crossing processes, reflection was the most recognized and used.

In relation to the boundary objects, many of the VET teachers did not acknowledge the affordances of the ICTs and thus found it difficult to envision the use of ICTs in relation to the four boundary-crossing processes. Some affordances are complex and need to be learned, in particular when combined with the boundary-crossing processes.

Throughout the project, most of the VET teachers expressed the need to know more about ICT and more precisely how different types of ICT can afford different types of action possibilities and how they can be combined with the four boundary-crossing processes. This points to a general need of enhancing in-service VET teachers’ *pedagogical imagination*, which would require additional research.

Further, in this project focus has been on what we would term “pedagogical” ICT. Most of the ICTs used by the teachers and students in the study are characterized by being heavily institutionalized. Only few teachers promoted and accepted the use of social media as legitimate educational tools, thus missing out on the possibility of connecting to the students’ medialized lifeworld and the students’ use of such tools also in the apprenticeship periods. As Pallitt, Gachango, and Bali show (Chap. 4), there are advantages and disadvantages of using both institutionalized ICT and more private ICTs such as social media given that no design *or tool* fits all, and this calls for further research.

Our data also reveal that VET teachers use a variety of subject matter-related ICTs and not least ICT directly related to the vocations of the different VET educations. A fair account of VET teachers’ understanding and use of ICT-based boundary objects in boundary processes should also include such types of ICT. By way of using ICT more directly related to the students’ vocations, we assume that the conceptions of boundary objects and boundary crossing would benefit from extending the sociocultural perspective to include a more dominant material component (Riis & Dirckinck-Holmfeld, 2020) encompassing the nuances and differences in VET. This, however, would also demand further research.

With regard to our understanding of boundary objects as convivial tools, some of the ICTs documented in this project hold the potential to be used as such, but as it is the case with ICTs used as deliberate boundary objects, the tools in and of themselves are not convivial. While some tools afford conviviality better than others, it is still in the actual practice of using the tools that the potential is realized. We would also argue that the majority of ICTs documented in this project (e.g., digital learning management platforms) are still more resemblant to industrial tools, tools where the designers and/or administrators determine the meaning and expectations of others—the very type of tools Illich opposed. In “Deschooling Society,” Illich envisioned the creation of “learning webs” consisting of “things/objects, peers, and elders” as entangled arrangements that would ensure ample learning opportunities for anyone who would want such opportunities (Illich, 1971, pp. 76–77). In our view, designing for networked learning through ICT-mediated boundary-crossing activities in dual

VET holds the potential to honor Illich's vision. However, as stated by Goodyear (2011) designing convivial learning environments that afford certain kinds of valued human activity—with or without ICT—is no easy task, and we have only begun to explore the ideas of Illich in this study.

Finally, as a field, networked learning is concerned with educational endeavors across the educational system. In relation to VET and other types of professional and further education, we propose that the new description of networked learning could benefit from including stronger elements of learning as more than epistemic knowledge creation and knowledgeable action. The theoretical foundations of networked learning (cf. NLEC, 2020, Table 1, p. 4). include several authors for whom *learning also is a matter of coming to be* in and across networks of people, tools, and not only sites of action, but also sites of reflection and transformation.

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