



Connecting school and workplace with digital technology: Teachers' experiences of gaps that can be bridged

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Abstract

The aim of this study is to gain more knowledge about the gaps vocational teachers identify between school and workplaces in upper secondary vocational education, and their experiences of using digital technology as boundary objects to bridge these gaps. This study builds on theories of boundary crossing and is carried out through in-depth interviews with six vocational teachers. For the analysis, a model is used, where the concept *learning mechanisms* is borrowed from Akkerman and Bakker. In our model, the learning mechanisms *coordination*, *reflection* and *transformation* represent three levels to which all the gaps identified by the teachers relate. The teachers' pedagogical aims are qualitatively different on the different levels. At the basic level, *coordination*; gaps with the aim to control and to keep in touch with students in their workplaces, are identified, whereas at the next level, *reflection*; the gaps that need to be bridged, concern creating better conditions for the students to reflect on and connect with what they have learned in the different learning arenas. Those teachers identifying gaps on the most elaborated level, *transformation*, want to create a complete educational experience for their students, as they try to find a seamless way of crossing the boundaries between school and the workplace.

Keywords: vocational education, vocational teachers, boundary objects, educational technology, boundary crossing



Introduction

A gap between school and workplaces as learning arenas is often emphasised in discussions about vocational education (cf. Aarkrog, 2005; Akkerman & Bakker, 2012; Schaap, Baartman & De Bruijn, 2012; Tanggaard, 2007). However, the gap can be versatile, and the ways of bridging it can, therefore, be diverse; thus, it may be more accurate to speak about gaps in the plural (cf. Kilbrink, Enochsson & Söderlind, in press). Research in the area of vocational education has highlighted a range of approaches which can bridge the gaps between school- and workplace-based learning, and can provide a more complete learning experience for students (cf. Kilbrink, 2013; Sappa, Choy & Aprea, 2016; Tuomi-Gröhn & Engeström, 2003). One such approach that has been found to be helpful is to use different kinds of ‘boundary objects’ – such as digital technology – which can serve as a link between learning experiences in school and workplaces (Akkerman & Bakker, 2011; Berner, 2010). However, to date, research on how digital technology can be used to support students in bridging these gaps is scarce (cf. Kilbrink et al., in press). In order to discuss how digital technology can be used to bridge these gaps, we also need to know more about them and to get more detailed insight in which gaps teachers themselves experience can be bridged by using digital technology, and how this can be done. Therefore, this study focuses on one aspect of this, namely teachers’ views on which gaps they experience can be bridged by using various forms of digital technology – such as mobile phones, apps, blogs and portfolios – and how these can be useful as boundary objects in upper secondary vocational education.

An earlier study (Kilbrink et al., in press) showed that teachers’ use of technology in bridging the gap between school and workplaces originated from different purposes and aims. Some teachers did the same thing as before, but technology made these things easier in some way. Other teachers gave examples from their own practice of how technology could totally change their way of working. This diverse outcome pointed in different directions, and in some cases, we noted how teachers described their development over time. Therefore, the aim of this study is to gain more knowledge about the gaps vocational teachers identify between school and workplaces in upper secondary vocational education and their experiences of using digital technology as boundary objects to bridge these gaps. We are interested in the teachers’ own narratives. Our starting point is the following research questions:

- What gaps between school and workplaces do the teachers identify?
- What pedagogical values do they aim for by bridging these gaps?
- How do the teachers experience the role of technology when bridging these gaps?

This study identifies teachers already working with connecting school- and workplace-based learning using digital technology in order to explore how digital technology can be used as a tool to create a more complete learning experience through interaction between the learning arenas. The focus in this study is solely on teachers' experiences, and we, therefore, do not make any claims on reporting results about the students' learning.

Previous research

In recent years, digitalisation and digital technology have been more and more emphasised in education (cf. Cattaneo & Barabasch, 2017). Looking closer at vocational education and boundary crossing between different learning arenas, such as school and workplaces, digital technology can work as a bridging tool and can act as boundary objects between the different learning arenas (Cattaneo & Aprea, 2018; Cattaneo & Barabasch, 2017; Kilbrink et al., in press).

Vocational education focuses on specific professional skills that are trained both at schools and in workplaces (Baartman & de Bruin, 2011). According to previous research, the abovementioned arenas can complement one another in relation to student learning, but they can also cause difficulties for students in connecting their learning and integrating their knowledge across these contexts (e.g. Aarkrog, 2005; Akkerman & Bakker, 2012; Baartman, Kilbrink & de Bruin, 2018; Berner, 2010; Kilbrink, Bjurulf, Baartman & de Bruijn, 2018; Tanggaard, 2007; Tynjälä, 2009). In relation to education, transfer is highlighted as important, and students need to be able to use and build further on previous knowledge in new situations and/or learning arenas (Bransford & Schwartz, 1999; Kilbrink, 2013; Tuomi-Gröhn & Engeström, 2003). In relation to vocational education and learning in the different arenas, research on transfer (boundary crossing, integration, transformation, etc.) has been done from different perspectives and from within different research traditions (cf. Baartman, Kilbrink & de Bruijn, 2018; Eraut, 2004; Kilbrink, 2013; Kilbrink et al., 2018; Tuomi-Gröhn & Engeström, 2003). In this study, we build further on boundary crossing theories in relation to transfer between school and workplaces in vocational education (cf. Akkerman & Bakker, 2011; Kilbrink et al., in press; Tuomi-Gröhn & Engeström, 2003).

In relation to boundary crossing theories, different objects can act as a bridging function and serve as boundary objects (Akkerman & Bakker, 2011; Kilbrink et al., in press). Hence, previous research shows that digital technology, in terms of a range of different tools and platforms, can contribute to integrating student learning in vocational education conducted in school and workplaces; for example apps, blogs, digital portfolios, mobile phones, simulations, social media and video diaries can be used to bridge the learning gap between the arenas (cf. Akkerman & Bakker, 2011; Kilbrink et al., in press; Motta, Cattaneo & Gurtner, 2014;

Schwendimann, et al., 2015; Schwendimann, de Wever, Hämäläinen & Cattaneo, 2018).

One important aspect of supporting boundary crossing is communication between teachers at school and supervisors in the vocational workplaces in order to create a complete learning experience across the learning arenas (cf. Choy & Sappa, 2016; Kilbrink, 2013; Tynjälä, 2009). This communication can concern different content (e.g. feedback, assessment and information exchange) and can be on different levels (e.g., checking, planning and organising) (cf Kilbrink et al., in press). It is also possible to use digital technology in different ways to support this communication (cf. Berg Christoffersson, 2015; Kilbrink et al., in press; Schwendimann et al., 2015). Other aspects include the possibilities for students to reflect on their learning experiences between the arenas (cf. Akkerman & Bakker, 2011; Akkerman & Bakker, 2012; Schaap et al., 2012; Schwendimann et al., 2015) as well as to collaborate on their learning in different ways (Schwendimann et al., 2018). Research also shows that teachers at school and supervisors at workplaces could have different foci. Whereas teachers must focus on the syllabi, supervisors mainly focus on employability, and these perspectives do not always correspond (cf. Gulikers, Baartman & Biemans, 2010; Kilbrink, Bjurulf, Olin-Scheller & Tengberg, 2014; Markowitsch, Luomi-Messerer, Becker & Spöttl, 2008). Therefore, the teachers, who are the ones assessing the students' work, need to find ways to find out what the students are learning at the vocational workplaces as well—for example by using different kinds of boundary objects. Hence, previous research, as well as our own study (Kilbrink et al., in press), shows that this is a diverse area of study that points in different directions. Embracing different views on learning could also be an aspect of different foci, as mentioned above, and create tensions, which Bound (2011) discusses in her study on vocational teachers and digital technology. Tensions between actors with different perspectives is also found in Swedish school inspections (Swedish Schools Inspectorate [SI], 2016).

Since previous research also states that the teacher is one of the most important factors for how learning possibilities at school are arranged and what teaching the students encounter during their education (Fives & Gill, 2015; Haelermans, 2017; Hattie, 2012). In previous studies, narratives have been used as a way to gain a deeper understanding of teacher experiences of teaching in vocational education (Asghari, 2014; Bjurulf, 2012; Kilbrink, 2013; Baartman et al., 2018). For example, Asghari (2014) argues that the vocational engineering teachers in his study build their teaching more on their own beliefs and experiences than on policy documents. This contradicts the result above that teachers actually focus on syllabi. But Nore (2015) has found that there is a difference between programmes regarding the extent to which teachers focus on syllabi. As shown in this overview of previous research, there is a lack of research both in how to use digital technology as boundary objects to support students' learning across

contexts as well as teachers' narratives about their experiences. Therefore, it is important to further study different teachers' narratives on the use of digital technology as boundary objects.

Vocational education in Sweden

Since this study is conducted in Sweden, we will give a short description of the Swedish vocational education context. Since 1971, vocational education has been integrated in upper secondary schools and organised as vocational programmes. In 2011, vocational education programmes got a clearer vocational focus and became more strongly connected to the students' future occupation (Berglund & Henning Loeb, 2013). During the three years of study, work placement of at least 15 weeks should be included (SFS 2010:2039, 4 chap., 12 §). The most common way of organising the work placement is to place these 15 weeks in three or four periods during the second and the third year. The teachers at school, and not the workplace supervisors, are responsible for grading the students' work placement.

The education provider – public or private – is responsible for organising the work placements and also for assuring the quality of the companies involved (SFS 2010:2039, 4 chap., 12 §). The responsible teacher makes the decision on what parts of the courses should be included in the school and the workplaces respectively. Therefore, the structure can look a bit different between schools. It is the principal's responsibility to make sure there is a system in place to assess the workplace-based learning, to grade the learning outcome and also to make it possible for teachers to have contact with the supervisor and the students during their workplace-based learning.

Several Swedish reports have found that the contact and collaboration between schools and workplaces in vocational education are not always satisfactory, which affects the quality of the students' education (Andersson, 2019; SI, 2011, 2013, 2017; Swedish National Agency of Education, 2016). When there is a lack of contact between the two, students do not find the education meaningful (SI, 2014, 2017), and the vocational teachers do not think they have enough time to keep in touch with the students (Swedish National Agency of Education, 2016, 2019). Therefore, it is of importance to find ways to bridge the gaps – by for example using different kinds of boundary objects.

Theoretical framework

This article builds on theories of boundary crossing, where the differences between learning arenas are seen as a learning potential; moreover, the two-sided interaction between contexts is highlighted as an important contribution to vocational programmes (Akkerman & Bakker, 2011; Berner 2010). In order to

emphasise a boundary to be crossed between contexts and to stress the interaction in between them, boundary crossing is a way of theorising transfer as described by Tuomi-Gröhn and Engeström (2003). This theory of boundary crossing is based on activity theory, where activities are seen as systems in which different actors interact.

Different boundary objects can adopt a bridging function, which can help to bridge different contexts (Akkerman & Bakker, 2011). However, those objects can sometimes be taken for granted and be treated like black boxes. When those black boxes are opened and the boundary objects are used in a reflective and thought through manner, they can contribute to students' learning. In their study, Akkerman and Bakker discern 'four mechanisms of learning at the boundary' (p. 142) through a review of studies on *boundary crossing* within the domain of learning and learning mechanisms. Their review reveals four mechanisms: *identification*, *coordination*, *reflection*, and *transformation*. They are four qualitatively different categories without any difference in weight. However, as we understand it, these learning mechanisms are not only used to discuss learning itself; they are also used to talk about requirements for creating learning conditions. Therefore, the stress should be more on *mechanisms* than on *learning*. Nevertheless, we have chosen to keep the concept *learning mechanisms*, even if we use them slightly differently than the original use of the concept. When we used these learning mechanisms as a model to analyse our data in a previous study, we found an iterative progression between the different learning mechanisms, meaning that when one gap had been bridged, new gaps appeared (Kilbrink et al., in press). From this iterative model, we discussed a hierarchical order between the four learning mechanisms in the following order: *identification* > *coordination* > *identification* > *reflection* > *identification* > *transformation* (see Figure 1). Teachers are developing from only seeing coordination as important to then stressing the importance of students' possibilities to reflect and then, finally, to describing an idea of transforming education. Identifying a gap is a prerequisite for the three other learning mechanisms, and, thus, it is closely intertwined with each of them. The figure shows the development along a timeline from identifying a gap between school and workplaces, which leads to coordination, which leads to the identification of a new gap, which leads to reflection etcetera. The dotted line at the end of the figure indicates there can be something we do not know yet.

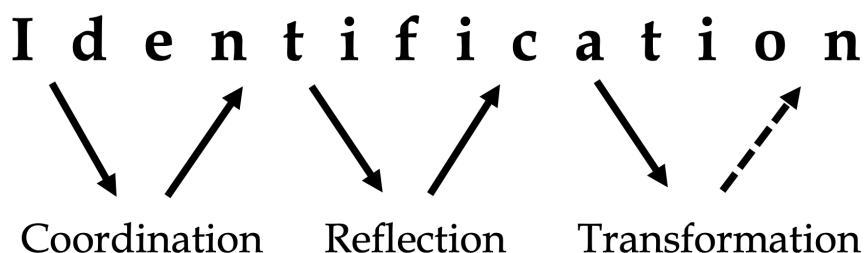


Figure 1. Iterative model of the learning mechanisms showing a development along a timeline.

We also noted that teachers with different views of teaching and learning focused on different learning mechanisms. In this study, we aim to go deeper into the teachers' experiences of different gaps and development in bridging gaps. Thereby, we also aim to further build on the iterative model we used and developed in the previous study.

Methodology and data

This study assumes that people can express experiences through narratives (cf. Polkinghorne, 1995). Telling about experiences is not only about remembering but also a process of creating meaning of one's actions (cf Freeman, 2010). In this article, narratives are seen as a way to access people's experiences and what people find important in relation to the studied phenomenon. Therefore, we have conducted narrative in-depth interviews with teachers in vocational education (Clandinin & Connelly, 2000; Kilbrink, 2013; Kvale & Brinkmann, 2009; Polkinghorne, 1995). To construct their narratives, the respondents were asked to talk about concrete experiences, and the interview questions aimed for the respondents to elaborate their own stories on the research topic (Clandinin & Connelly, 2000); for example, question started with 'can you tell me about... ' or 'could you give an example of when... '. Furthermore, based on the assumption that by telling about their experiences the informants would also reflect on and create meaning for their actions, we chose to interview each teacher twice (Freeman, 2010). Therefore, depending on what the informant tells about and how this is done, the interviews can differ in length.

Participants in this study are six teachers working in Swedish vocational education at the upper secondary level. We purposively selected teachers already working with digital devices and applications in order to bridge the gap between school and workplaces (cf. Cohen, Manion & Morrison, 2000; Yin, 2014). We chose to interview teachers working in different vocational programmes, since the conditions for workplace-based learning differ according to the vocation. The

teachers were selected through our professional networks. Some of us researchers knew some of the informants, and we organised the interviewing as far as possible so as not to interview a person we knew personally for ethical reasons. We also tried to have two interviewers at each interview – one interviewing, the other listening and complementing – but it was not always possible to organise this for all interviews.

The teachers were informed about the project orally and in writing before they accepted to be interviewed and also when the interviews took place. They all gave their written consent. The ethics procedures at our university follow the local and national regulations on ethics and data handling. The teachers have been interviewed at their respective schools or at the university, according to their own choice, on two different occasions, except for one teacher, for whom only one interview was possible. Altogether there are 11 in-depth interviews. The interviewed teachers are all certified vocational teachers working in different programmes and branches (see Table 1), and all names of the teachers are pseudonyms.

Table 1. Interviewees and interview time.

| Name | Vocational subject | Time interview |
|------------------------------|---|-------------------------|
| Bob | Building and construction | 63:54 + 119:48 |
| Isabella | Health and social care | 42:44 |
| Claire | Animal management, Pets | 29:31 + 27:30 |
| Theresa | Hairdressing | 31:06 + 57:16 |
| Ally | Health and social care | 35:34 + 53:06 |
| Christine | Retailing, Sales and customer service, Commerce, Entrepreneurship | 68:22 + 94:34 |
| Total interview time: | | 10h 23min 25 sec |

The interviews were audio recorded and transcribed. Thereafter, the narratives were analysed. As a model to analyse data, we used the *iterative model of learning mechanisms* (see Figure 1), which was developed from Akkerman and Bakker's (2011) learning mechanisms at the boundary. We searched for gaps described by the teachers and related these gaps to the learning mechanisms *coordination*, *reflection* and *transformation*. We also looked for what pedagogical values the teachers aimed for by bridging these gaps and what role they experienced the technology to have. The next step was to see if the different *identification* processes of the gaps followed a timeline (cf. Figure 1), since we had an idea of a developmental hierarchy between the learning mechanisms – that is, the first gaps identified

relate to *coordination*, which means a gap which can be more easily coordinated with the help of technology. From there, the teachers have a new starting point for identifying new gaps. In our model, this is then a gap related to *reflection*, meaning that there is a gap that needs to be bridged in order for students to reflect. Furthermore, to talk about gaps in relation to *transformation*, a more holistic approach to education needs to be taken, and the gaps are more related to education as a whole than to its single aspects (Kilbrink et al., in press). We wanted to know what gaps between school and workplaces the teachers identified, what pedagogical values they aimed for by bridging these gaps and how they experienced the role of technology when bridging these gaps.

Results

The results are organised by presenting the gaps identified by the teachers in relation to the other learning mechanisms: *coordination*, *reflection* and *transformation*. This means that the learning mechanism *identification* relates to all the others in the sense that a gap must be identified in order to talk about the other learning mechanisms (see Figure 1). As we interpret the learning mechanism *identification* from Akkerman and Bakker (2011), it is about how to view what is on the other side of the gap. Here it is about how the teachers view the workplaces, and this affects the way they choose to act.

Gaps in relation to coordination

The teachers highlighted different types of gaps, but a basic problem they all mentioned in different ways was the fact that they, as teachers, have to grade students' performance on a practice they cannot follow closely and, therefore, do not know enough about. Related to this, Christine, for example, tells that 'there's no legal certainty if you work like this [grading without knowing what to grade]. I base the grades on second-hand information'. From this starting point, the teachers identify different gaps they need to bridge in order to grade more fairly.

All teachers work in small cities, which means that their students' work placements locations sometimes are far away from the schools. The traditional organisation is that teachers visit these workplaces, but time and money do not allow more than one visit per student and work placement period. The teachers stress the importance of keeping in touch with the students to be sure that they complete what will be assessed. This *geographical gap* can be bridged for example with technology, which is something the teachers had tried in different ways. To keep in touch easier, they gave examples of using video calls, text messages, chat-groups or just phone calls.

The ideal relationship between school and workplaces should be that two activities with different competencies cooperate by working towards the same goal. In one sense, this is probably true; both arenas work with the aim to educate

skilful professionals. Bob highlights a problem in this relationship by saying that the workplace supervisors do not care about the curriculum. The school has to cover all aspects of the profession, but some workplaces work only with a few of these aspects, due to for example specialisation or just small workplaces. Bob points at an *attitude gap* between the teachers and the supervisors, and the solution has been to communicate with the students to be sure of what they are actually doing at their workplaces. However, it is not always easy. Many supervisors at workplaces do not use communication technology in their daily work, and some even see it as something counterproductive. For example, in construction, the culture discourages workers from checking their phones at work. 'No fucking phones in construction', as Bob says sarcastically.

Some teachers tell about how they have succeeded in engaging the students online during their work placement, but this work has required that students bring their own mobile devices – which are provided by the school for those who do not have their own – and connect them at their workplaces, which is not always possible. This is a *technological gap* when it comes to the physical devices. Ally points at a similar gap. She mentions that in hospitals, the networks are closed for students or they have limited access because of security reasons. Bob has experienced that the software used at school is not compatible with all kinds of devices. Also, Theresa had wanted to collaborate with her supervisors in the system provided by the school, but she discovered that external persons could not get the access needed. This technological gap was mostly due to economic resources, which are difficult to bridge.

The teachers tell that it is common that supervisors are not interested or cannot handle communication technology; thus, there can be a *competence gap* between the school and the workplace. There is technology at the workplaces, but not the same type of technology as at the schools. Ally describes a robot-like working place for care workers with a lot of technological aids – technology that the school cannot afford – and Isabella talks about high-tech farms. Theresa, the hairdresser, gives an example of when the teacher, the students and their supervisors meet through social media. Facebook and Instagram are platforms used by many hairdressers to market their services and products. A problem she experienced was the advent of GDPR (General Data Protection Regulations in Europe). Her school stopped all activities on platforms they could not control themselves, which leads to an *administrative gap*. Another administrative gap is described by Claire, who sees a problem with all the papers that have to be transported by the students to ensure the information exchange between school and workplaces. Many papers run the risk of getting lost. She gives a vivid example of the extra work this creates in her narrative:

I think it's extremely messy, and I swear at it every time [...], because I don't get a system I find smooth and easy. [...] And papers disappear along the way and they [the students] have given it to that and that person. And I just feel like: Oh, my God! I know they've handed them in, but where are the papers? Because they just flutter around, and I go mad. (Claire)

Above, we have shown how the interviewed teachers point to several gaps in relation to the learning mechanism *coordination*: geographical gaps, attitude gaps, technological gaps, competence gaps and administrative gaps. Akkerman and Bakker (2011) discern between two different types of identification: *othering*, which focuses on the differences between the two arenas, and *legitimizing coexistence*, in which the two arenas work together but for example with different competencies. The political base of this way of organising vocational education is an example of legitimizing coexistence, but the teachers do not trust the supervisors at the workplaces. Here, the focus on differences is clear when the teachers describe the geographical and the attitude gaps.

The teachers all use different kinds of technology, such as video calls, text messages, chat-groups or just phone calls, as boundary objects to try to bridge those gaps – with more or less success – in order to gain more knowledge about what their students are doing at the workplaces and to be able to grade students more fairly. The teachers have not always been able to enact what they see as necessary or at least something that could make things easier. From the interviews, we can see that bridging a gap in relation to coordination is some sort of base to make the communication work. And as Akkerman and Bakker put it: 'coordination requires a communicative connection' (p. 143).

Gaps in relation to reflection

The gaps described by the teachers in this section are gaps that need to be bridged in order to create better conditions for the students to reflect on what they have learned. The gaps related to coordination focus on the fact that the teachers need to grade what students do during periods when they are not at school, whereas the gaps related to reflection embrace a wish to use technology to develop teaching further.

In relation to reflection, all of the teachers in this study experience a gap to a greater or lesser extent. Theresa wants her students to reflect on what they do at school and in their workplaces, but she says her students are not so good at it. During the first interview, she talks more about control, as we saw more of when teachers talked about coordination, but Theresa elaborates more on reflection during her second interview:

I love reflections! They [the students] have to write down, after every lesson, two things they think they did well and one thing they need to practice more. Then they add a picture [...]. Now, this is the first term in their first year. Next term, I will ask some questions about it [their earlier work]: 'What could you have done to make it better?' (Theresa)

Bob talks about digital log books as tools for reflection, but he expresses himself a bit like Theresa; to start with, it is difficult to understand if the two of them think reflection should come automatically for the students when given the tools.

The best thing is that they have it [documentation of their work] all in the same place when they see it. They own it; it becomes more of a portfolio. You own your own world and you see it. I'm convinced that when you see there are things added and you can look back. Then you can see the development. (Bob)

Unlike Theresa, Bob talks more about problematising and questioning in general and that those activities are important. To start with, it is a bit unclear if he has been able to realise his ideas in this respect, but during the second interview, he develops his thoughts a bit more. He describes a colleague's work with digital documentation throughout the programme:

If we take for example hairdressers [...] because they have a specific hair set they do at the beginning of the second year, and they have worked with it at school. So, it's already there. It's this app, log, or whatever we call it. And so they go to their workplaces and do it in a real-life situation, and she [the teacher in hairdressing] can go and check: 'You did this at school. It was a bit askew. That was strange'. Then you come to the next: 'Here it looks different. [...] What has happened?' That's the core of it. Then it's benefitting for the student, because they can see they have improved [...]. It's good for their learning. (Bob)

It is not always easy for the teachers to put words to what is needed to make the students reflect. Ally says the students need the feeling of being cared for. She stresses the importance of being present as a teacher if the students have any sort of problem during work placement. This is also something Bob highlights when he describes the importance of relationships and points to the *relational gap*. Theresa wants the supervisors to engage more and to show more interest in the students. All these aspects seem to serve the same purpose, but Bob and Theresa do not stress their own importance as Ally does. Ally tells about caring for her students as a way to help them develop more easily:

I think the students would feel safer, and not only sent out to test their wings, kind of. They feel a bit unsafe when they leave school [for a workplace], and they come to visit us if they are free, start later or have a day off, because our students also work evenings and weekends. They can come and tell us how they're doing, and they have a lot of questions. I think we could stay in touch easier with a digital tool, and I think the students would feel safer. At the same time, I think we could lead them more in their learning, the workplace-based learning - with the help of digital tools. And then I think their supervisors could benefit from some guidance. They are thinking a lot about if they should do more than just walking beside [the students] and looking. Yes, it's fine if they do something. They feel uncertain too, so closer contact with the school could help both supervisors and teachers - or students. (Ally)

This can be seen as an *emotional aspect* of the relational gap - to stay in touch with each other - since the interviewees see relationships as a base for being able to do a good job as teachers. The emotional aspect is qualitatively different from just the importance of relationships, but it is still a relational gap.

When communication is established, some of the teachers highlight different aims beyond grading. They want to make the students reflect on what they are doing and also on how to relate to what they have learnt at school. The learning mechanism *reflection* is, therefore, regarded as a higher level of communication than just *coordination*. What we also see here is that the teachers do not verbalise this from the start. There seems to be more of a tacit knowledge for some of them and that they are not used to talking explicitly about what they are doing.

The gap identified in this section is a *relational gap*, which sometimes has an *emotional aspect* in relation to the students in order to gently push them towards reflection and development. To be able to do this, interactive technology is needed to a greater extent than on the level of coordination. The difference between the emotional and the relational gap may be subtle because the emotional gap is also a relational gap, but we can see from the analysis that there are two different aspects of the relation

Gaps in relation to transformation

In relation to transformation, there are only a few examples of gaps to be bridged in the narratives. One reason for this is that only two of the teachers discuss the gaps from a more holistic point of view. Another reason is that the examples are not condensed, meaning that there are few specific quotes. It is our overall analyses that have allowed us to see the pattern. Christine is the one who puts transformation into context quite clearly. She tells about education and learning as not limited to a classroom with four walls. Bob does it as well but to a lesser extent. Christine's students need to learn for life to be able to work in a specific profession (commerce and service). She tells about how she is creating a complete learning experience for the students and how technology makes this possible. She can keep in touch easily while they are at their workplaces far away from the school, and she can also help them prepare before they leave for their work placements by searching on the Internet:

Core content, subject aim and knowledge standards [...] those will have to 'marry', and there has to be a [...] how can I say...? It's the only way to make them [the students] see the use of what we're doing. (Christine)

This is not about control and grading as we see in the section about *coordination*, and it is not only about the students' *reflections* about their own work. Rather, it is about preparing students for a complicated working life from as many angles as possible:

I cannot predict all kind of professions they will work with in the future. That's why I have to teach them how to pose the right questions. I don't need to give them the answers, but they need to know how to find the answers. This was my basic assumption. And it has been important for me with inspiration that there is input from somewhere and that they [the students] are taken seriously. (Christine)

Christine works a lot with cases and projects to create authentic situations in which the students can train their skills. By creating groups for the students on a social media platform, she allows her students to discuss their learning from their respective workplaces. Bob and Christine try to overcome a *dichotomy gap* and to create a complete learning experience of what their students learn at school and what they are supposed to carry out in their workplaces. An example of a *dichotomy gap* is when the school and the workplace are seen as two totally and qualitatively different learning arenas. Although there can be many perspectives on teaching and learning, all pieces have to fit together. The teachers do talk about setting grades, reflecting on their development, preparing for working life etcetera, but all the time with this complete learning experience in view. Christine stresses the need of an open communication climate in order to listen to what the students have to say and to cooperate with them. In combination with her other projects, this could be seen as *transformation*. Christine is the clearest teacher while pointing at her colleagues' disinterest as a *perspective gap*. She gives examples from when she confronted colleagues. One of these examples is when she asks the Swedish (first language) teacher about why she was not interested in the digital texts the students produced during work placements only because they were digital. Bob is more modest, but he talks in a negative way about people using platforms only as check-lists and about colleagues whose most important aim is to maintain control. This highlights the different views on learning and teaching, which may be the most difficult gap to bridge. As Christine tells:

I think the frustration over long distance communication [mentally] made the Facebook idea come up. The negative ones [...] the negative view from my colleagues on social media, even if we're required to work with them, made me irritated. So I guess it was a combination. (Christine)

Not all of the teachers have developed their thoughts as much as Christine and Bob have. These two teachers are the ones who point to the *perspective gap* as a reason why colleagues do not want to cooperate. Their aim is a seamless education in which different activities 'marry', as Christine puts it. It does not mean the other teachers in our study do not aim for this, but to date at least, they have not put words to it. The technology Bob and Christine use can be anything at hand, including the school's learning platform, social media and Internet search engines to find information about and prepare for future work placements.

Results summary

As shown above, there is not only one gap. The teachers in vocational education identify different kinds of gaps related to learning mechanisms at different levels. In our model, we use the learning mechanisms *coordination*, *reflection* and *transformation*. Gaps identified in relation to coordination are geographical, attitude,

technological, competence and administration gaps. In relation to reflection, there is a relational gap which sometimes has an emotional aspect, and in relation to transformation, we have found a dichotomy gap and a perspective gap that teachers want to bridge.

The pedagogical goals the vocational teachers want to reach are qualitatively different at the different levels. At the basic level, coordination, teachers tell mostly about aspects related to staying in touch and coordinating the two learning arenas. For some teachers, it is enough to use mobile phones for calls and messages, but there are also other examples. At the middle level, reflection, they tell more about the students' development and how it is important to work on that. This level requires a different kind of technology, which is interactive and allows collaboration. The teachers talking about the highest level in the model, transformation, want the students' education to be complete and whole, which makes the learning mechanism at this level the most elaborated. The interviewed teachers say they have a different perspective on education than most of their colleagues. Furthermore, they describe an existing dichotomy even if they do not want to be part of it.

The differences are also reflected in the teachers' narratives about the role of technology. When describing gaps in relation to *coordination*, they tell about how technology makes things easier or faster. When describing gaps in relation to *transformation*, they tell about how technology can change or transform the way of teaching and learning.

Our results confirm our idea of a hierarchy, but the model does not show a timeline as we suggested (Figure 1). With more data, we can see that those teachers who discuss the transformation level also give examples from the more basic levels, and those discussing the middle level build on the basic level, as shown in Figure 2. A basic concern is to be able to control and set fair grades. On the middle level, the teachers go beyond this and try to make the students reflect and develop as much as possible. At the highest level, we find teachers who want to create a complete educational experience, which includes preparing students for a working life. Our results also show the complexity of the vocational teachers' work when trying to connect school and workplaces.

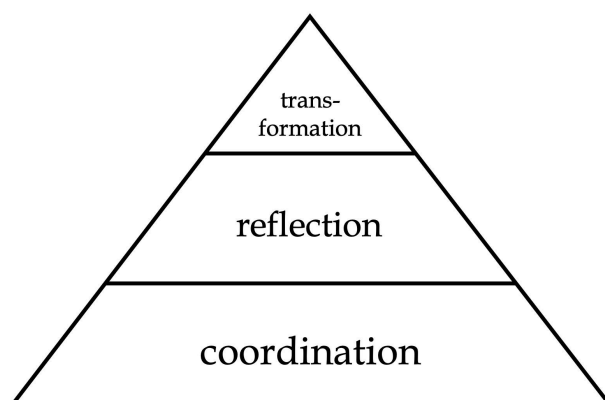


Figure 2. Hierarchical model of the learning mechanisms showing how the learning mechanisms build on one another.

Discussion

Our aim and our research questions originated from our earlier study in which we developed an iterative model including a tentative hierarchy (Kilbrink et al., in press). The results from this study, first, confirm our model and also take it one step further in the sense that the more elaborated learning mechanisms build on and comprise the basic ones. Second, the teachers do not talk about only one gap between school and workplaces in vocational education but different gaps at different levels. When discussing digital technology as boundary objects in this context, we have to be aware of these differences, which also correspond to research showing that technology is used in many different ways (cf. Berg Christoffersson, 2015; Kilbrink et al., in press; Schwendimann et al., 2015) We also want to gain knowledge about how the teachers talk about digital technology over time. We interviewed them twice within a period of several months so that they could develop their ideas and tell about new things they wanted to try (cf. Freeman, 2010), but different kinds of obstacles made it too difficult.

What can the results with the different hierarchical levels tell us? They confirm that not only teachers with a certain perspective on teaching and learning use technology, as sometimes claimed in earlier research (cf. Enochsson & Rizza, 2010); rather, it seems like those teachers who stick to a traditional way of teaching stay at the most basic level in our hierarchical model. In this study, we did not interview anybody who was only reasoning at the basic level, but as mentioned in the introduction, we found teachers in our earlier study who were doing exactly the same thing with technology as they had done earlier, for example used PDF documents instead of booklets. It was only a bit easier with technology (Kilbrink et al., in press). All teachers work at the most basic level, but the more elaborated levels are connected to qualitatively different perspectives on

teaching and learning. This means that at the basic level, different perspectives on teaching and learning are represented. On the surface, the activities look the same, but the teachers are telling differently about them.

It can be questioned whether the digital technology used at the basic level, *coordination*, in our model is used as a boundary object as defined in our theoretical framework (Tuomi-Gröhn & Engeström, 2003; Akkerman & Bakker, 2011). Technology has a bridging function, but it may not always support integration. Just staying in contact or sending documents online does not necessarily integrate the different learning arenas. The teachers telling about gaps in relation to the level of *reflection* discuss a clearer pedagogical aim of integrating the learning in the learning arenas (cf. Schaap et al., 2012; Schwendiman et al., 2015). Only a few teachers and examples relate to the learning mechanism *transformation*. The teachers identifying gaps relating to *transformation* describe not only a gap between school and workplaces but also internal gaps within their respective schools. These internal gaps, which are due to collaborating teachers' different perspectives on teaching and learning, make it even more difficult to overcome the *dichotomy gap* between the school and the workplaces. Those teachers try to bridge gaps in all directions. They describe a holistic approach to teaching and learning. These results show, again, the teacher's importance for vocational education (cf. Fives & Gill, 2015; Haelermans, 2017; Hattie, 2012).

From the six teachers from five different vocational programmes with different prerequisites and ways of working, we recognise a similar pattern as in the interviews from our earlier study (Kilbrink et al., in press), even if the focus differed. In interviews, it is common for interviewees to say what they think the interviewer wants to hear. The teachers also have to integrate digital technology in different ways according to the new curriculum. It is reasonable to believe they want to appear as good teachers. Speaking against this is the fact that some examples appear in exactly the same way in both interviews on a very detailed level.

The teachers in this study tell about different kinds of experiences in relation to what gaps can be bridged by using digital technology as boundary objects in vocational education. Thereby, we get a deeper insight in the complexity and variety of gaps to handle in vocational education. However, focusing on teachers' experiences gives us no insight in the students' learning in these educational settings. This shortcoming can be further elaborated upon in future studies using other research methods. Another aspect that could be studied more in-depth is the supervisors' experiences of how different kinds of digital technology can be used to bridge the school and workplace gaps in vocational education, since they are also part of the communication between the learning arenas (cf. Kilbrink, 2013).

Since the teachers mention different obstacles hindering their ideas to work with digital technology as boundary objects, there is a need for further studies

regarding these hindrances. One step in overcoming these obstacles is to identify them. We can see in this material that the obstacles also vary, and one of the mentioned ones relates to new regulations and laws. A future project should look closer at those obstacles as well as at what makes teachers develop towards the transformation level when working to connect the school and workplaces.

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