Table of Contents

Editorial

Peer-reviewed articles

Nordic Journal of Vocational Education and Training ISSN: 2242-458X

Hosted by Linköping University Electronic Press

Magazine article

Nordic Journal of Vocational Education and Training, 2020

Editorial: Technology-mediated learning in VET – Perspectives on changing educational landscapes in the 21st century

Giulia Messina Dahlberg, Susanne Gustavsson & Ingrid Berglund

University of Gothenburg, Sweden

(giulia.messina.dahlberg@ped.gu.se)

The idea of this special issue started in 2018, when the guest editors together with colleagues at OsloMet – Oslo Metropolitan University and a team of vocational education and training (VET) teachers organised a symposium at the Nordyrk 2018 conference on the theme 'Didaktiska perspektiv på simulatorstödd undervisning i yrkesutbildning' (Didactical perspectives on simulator-based teaching in vocational education and training)[1]. Here, simulators and simulation-based training were of central interest, along with the kinds of issues that the process of inclusion of new digital tools in education often entails, in terms of challenges and opportunities. Some of the contributions in this issue include the results of fruitful collaborative endeavours between scholars and practitioners that deal with the planning, implementation and evaluation of the use of digital tools in the teaching and learning of vocational subjects in VET. In 2019, again at the Nordyrk conference, we took our collaboration one step further during a workshop on 'Virtual vocational education in VET: Analytical explorations' where we could welcome other scholars from Northern Europe in our team[2] with whom we are currently developing new ideas and projects that all deal with the theme in this special issue.

Technologies, and especially digitally-mediated practices of teaching and learning, are connected with change, and in this special issue, change involves

NJVET, Vol. 10, No. 1, iii–xiii Editorial doi: 10.3384/njvet.2242-458X.20101iii

Hosted by Linköping University Electronic Press

the educational landscape of VET more specifically. We constantly live in times of transition, even more so when we deal with the study of educational landscapes. Having said that, institutional educational arenas in their different forms have often been studied in their act of balancing between the need to maintain and transmit their societies' sociocultural heritage to the next generation and the urge to move along with how such societies, and the world, change. VET as an educational arena is particularly interesting when dealing with such tensions and contradictions. The nature and relevance of VET is inevitably intertwined with the ways in which innovation and change shape the world, in terms of providing relevant and sustainable knowledge and competences for future professionals.

At the time of writing, we are experiencing a unique time in history, caused by the COVID-19 pandemic. The everyday lives of individuals, at a global level, have radically changed due to the measures undertaken to control the spread of the virus. One such measure has been, in all of the Nordic countries, to close the secondary schools' physical buildings for the students and move the teaching completely online[3]. The educational landscapes have thus radically changed and are currently changing at a speed never witnessed before. Furthermore, transition to online education has occurred over a fortnight and digital tools are playing a central role in the process. Videoconferencing platforms, learning management systems and other tools for documentation and the training of vocational students are being used as mediating artefacts as we speak, to solve the problem of educating students (both youth and adults) without access to physical common spaces. What consequences such a quick and unexpected transition will bring along is difficult to foresee now. Here, VET will play a particularly important role, we argue, in identifying the kinds of challenges and opportunities that a transition to online distance education could entail for the teaching and learning of upper-secondary vocational education subjects like the ones focused upon in the studies in this special issue.

The individual contributions in this issue all deal with digital technologies and the ways these are implemented as part of the teaching and learning practices in VET. The profound crisis we are facing now, during the forced transition to online education in parts of the globe, is yet another proof of the kind of trust and hope that many professionals (in this case teachers, educators and school managers) put in technology as the solution to a variety of problems. But this is, in fact, nothing new under the sun. Digital technologies have been framed in terms of an educational panacea for a rather long time, envisaging the implementation of so-called digital innovations in schools and other professional arenas as the solutions to a wide range of issues, from inclusion to accessibility and equity, to growing efficiency and marketisation. Issues of professional-based training, control, standardisation, globalisation and sustainability are only some examples of the challenges where digital technologies and online learning environments are seen as possible and relevant solutions in a post-modern era.

Many innovative developmental projects in schools and adult education, including VET, are the outcome of individual efforts and are often delivered as ready-to-use packages from private organisations, rather than emerging from organic pedagogical investments and developmental endeavours based on end-users' professional competence and needs. Thus, critical perspectives have started to raise concerns about the actual benefits of the implementation of digitally-mediated teaching and learning practices in educational contexts, in favour of an approach that takes technology as not inherently likely to bring advancements in education *per se*, but rather as an approach that takes technology *as it is* in a practice. However, there currently exists a paucity of scholarship that focuses on pedagogical issues related to the use and implementation of digital tools in VET. And yet, as we have seen, educational institutions are currently facing several challenges that deal with increasingly digitised teaching and learning practices where more critical and, not least, *theoretically informed* pedagogical development work is urgently needed.

Taking the above as point of departure, this special issue *Technology-mediated learning in VET – Perspectives on changing educational landscapes in the 21st century* has grown from specific research that deal with overarching issues that are central for the development of VET research and practice and whose aim is to shed light on the following issues: i) to investigate and critically review some of the identified challenges and opportunities that arise with the digitalisation of vocational education and training and ii) to shape and develop successful systematic development work as conditions for change in educational practice as well as in the overall organisation. This special issue includes six research articles, five written in English and one in Swedish, and a magazine article, in English.

The first article *Simulation-based training in VET through the lens of a sociomaterial perspective* by Song-ee Ahn and Sofia Nyström discusses the relationship between students, teachers and simulators through a systematic analysis of previous research, enhanced by a sociomaterial perspective. Ahn and Nyström identify three themes in the literature: i) the effect of technology-enhanced simulation training, ii) the fidelity and authenticity of simulation and learning, and iii) pedagogical consideration and underpinnings. The results shed light on the differences between an educational practice and a vocational practice in that the implementation of simulators influences and changes the relations and the overall set-up of the educational practice. Here teachers are expected to be able to understand, interpret and foresee the kinds of vocational learning that simulation as a practice may (or may not) support. The authors conclude that process-oriented research is needed to shed light on the ways in which simulation can be used to its full pedagogical potential to prepare students for their future vocational practice.

The second article *Both novice and expert? How apprentices develop vocational competence in workplaces where technology is continuously changing: Examples from the Norwegian media graphics programme*, by Nina Aakernes, is interested in the ways

in which young apprentices can develop vocational competence in media graphics, a trade where digital technologies continuously change. The article is based on a longitudinal study over two years during which apprentices were observed at various workplaces. Aakernes discusses the paradox of the apprentices being considered novices on the one hand, and the kinds of advanced demands on competence in working life that are put on them, on the other. The results show that to be able to develop relevant competence, the apprentices need to be granted a certain degree of autonomy to make their own decisions and try their solutions to different problems. However, the apprentices also need support and feedback from the colleagues at the workplace. The results show that knowing how to design implies the development of specific skills that are rather stable in time, along with other competences and skills that are continuously changing, like the ability to use certain technologies for instance. Together, these competences are vital parts of a holistic vocational competence wherein the apprentices' active engagement in the performance of work-related tasks and the discussions that occur at the workplace are central.

The third article *Connecting school and workplace with digital technology: Teachers' experiences of gaps that can be bridge*d, by Ann-Britt Enochsson, Nina Kilbrink, Annelie Andersén and Annica Ådefors explores vocational teachers' experiences of digital tools as boundary objects between school and workplace during students' work placements in VET. Enochsson and colleagues start from the assumption that during such work placements, there exists a distance between vocational students, their supervisors at the workplace and the VET teachers. This distance is conceptualised in terms of 'gaps' between school and workplace, gaps that need to be bridged. The study is based on interviews with vocational teachers about their use of digital tools as boundary objects between school and workplace. The results illustrate different kinds of gaps between school and workplace and they show that digital technology has different functions in the attempt to bridge these gaps. Furthermore, the vocational teachers use strategies and make choices that differ depending on the identified gap and where technology plays different roles as a boundary object. These strategies and choices are conceptualised in terms of important elements of the vocational teacher's pedagogical and didactic competence.

The fourth article, written by Stig-Börje Asplund and Janne Kontio, with the title *Becoming a construction worker in the connected classroom: Opposing school work with smartphones as happy objects*, focuses upon the formation of identity as a construction worker in the Building and Construction programme. Through careful analysis of naturally-occurring interaction among students who, in different ways, orient towards their smartphone during task-oriented school activities, the authors investigate the ways in which male students use the smartphone as a significant resource to create opportunities for identity work in the VET classroom. In their use of the smartphone as a happy object, i.e. as a tool to identify

shared interests and funny diversions from the task at hand, the students also engage with identity work that seems to align with the kinds of professional identity of the construction worker that has been previously researched at the workplace and during workplace-based learning. The results show that students, by orienting towards their smartphone and the activities available in that environment. i.e. using different application in their smartphones to connect and create a common jargon, are in fact already dealing with becoming construction workers where the creation of a counter-culture, the establishment of a team, a community and an anti-study culture appear as central elements.

In the fifth article, *Virtual welding: A didactic perspective*, Steinar Karstensen and Arne Roar Lier investigate the simulation of welding in a virtual reality (VR) environment. VR technology adds further elements to simulation in VET and the article aims at shedding light on the ways in which VR-integrated technology can be used as an educational and didactical tool in VET. More specifically, focus lies on the use of 'mixed reality', an environment in which real and virtual worlds merge and where real, tangible objects are mixed with virtual ones. Here, issues of fidelity, realism and photographic quality all play a significant role to provide a realistic experience in VET and especially in activities like welding, where the learning of precise hand and arm movements is in focus. The analysis is grounded on a phenomenological approach and focuses on interviews with teachers and the logs that the teachers were prompted to write during the project. The results highlight issues of transfer, similarity between virtual and real dimensions of the simulation and the kinds of challenges that the implementation of new digital tools entails for the pedagogical practice of teachers and students. The welding simulation machine could not be implemented in its original format in the course, but teachers had to develop the design of the tool in line with the didactical needs and the teachers' professional competence.

The last research article in the issue, *Digitala körsimulatorer i yrkesutbildning: Utmaningar och möjligheter* [Digital driving simulators in vocational education: Challenges and opportunities] by Susanne Gustavsson, Giulia Messina Dahlberg and Ingrid Berglund also deals with the implementation of new simulation tools in VET. The article presents three action research projects carried out in collaboration with four vocational teachers in the natural resource programme, when digital driving simulators were implemented in the educational practice. The vocational teachers identified, based on their own experiences, problem areas, issues and action plans. The action plans were implemented and evaluated in collaboration with the researchers. The projects focused on fidelity, transfer and progression when implementing different kinds of digital driving simulators in the teaching and learning practices. The results highlight the vocational teachers' professional competence to use and 'master' the digital tools to support the students' vocational learning. The article is also an illustration of the ways in which

systematic investigations and school development work can be carried out by vocational teachers in close collaboration with researchers.

The special issue also includes a magazine article, *Five years with vocational teacher education online*, by Steinar Karstensen and Runar Oudmayer. The article deals with the evaluation and development of online technical and vocational teacher education (TVTE). More specifically, it focuses on the pedagogical and didactical considerations that online TVTE entails in terms of its challenges and opportunities and the ways in which it may be compared to a campus programme. The online format of TVTE has meant wider opportunities for students' access to education in terms of flexibility in time and space. It has also meant that teachers developed alternative methods when transitioning from campus to digitally-mediated activities. The article provides interesting insights on, for instance, issues of synchronous vs asynchronous communication and the creation of a community of students completely online.

To conclude, all contributions in the special issue shed light on the kinds of implications that a digitalisation of VET entails for VET teachers and, not least, for VET teacher education. What kinds of competences are relevant in VET when digital tools (of different kinds and with different purposes – from simulators to smartphones) become central in the everyday practices of VET for teachers and students? This special issue, we argue, has contributed to the VET field in two specific ways: *firstly* by investigating how teachers and students use, implement and evaluate online and digital tools in their practice through various theoretical lenses and *secondly*, by adding theoretical depth on the ways in which tools, people and different kinds of knowing are mutually connected. Tools (digital or analogue) cannot be studied in a vacuum. They are tools in that they are entangled in a practice and, when the practice in focus is an educational practice, this gains even more interesting dimensions. In such a practice, we argue, issues of teacher intention and professionalism, curriculum and different competences of teachers and students, all play a significant role in shaping the implementation and use of digital tools to support learning in VET.

Endnotes

[1] Symposium organisers: Giulia Messina Dahlberg, Ingrid Berglund, Susanne Gustavsson, University of Gothenburg, Sweden; Bengt Jonsson, Felix Hermansson, Hans-Ulric Göransson, Jörgen Holmén, Region Västra Götaland natural resource schools, Sweden; Steinar Karstensen, Arne Roar Lier, Oslo Metropolitan University, Tor-Gunnar Karterud, Rune Stensrud, Ove Østerud, Ås videregående skole, Norway.

[2] Team members: Ingrid Berglund, Giulia Messina Dahlberg, Susanne Gustavsson, University of Gothenburg, Sweden; Vibe Aarkrog, Aarhus University, Denmark; Hanne Søgaard, Jørgen Theibel Østergaard, University College Copenhagen, Denmark; Steinar Karstensen, Arne Roar Lier, Oslo Metropolitan University, Norway.

[3] Sweden is the only country in Scandinavia and in Europe to have kept primary schools open during the pandemic.

Nordic Journal of Vocational Education and Training, 2020

Simulation-based training in VET through the lens of a sociomaterial perspective

Song-ee Ahn & Sofia Nyström

Linköping University, Sweden (sofia.nystrom@liu.se)

Abstract

This article aims to review the pedagogical research on simulation training in vocational education and training (VET) and to discuss the emerging teaching practice from a sociomaterial perspective on learning and practice. Literature reviews on research into simulation training with pedagogical interests show that there are three main themes: 1) the effect of technology-enhanced simulation training, 2) the fidelity and authenticity of simulation and learning, and 3) pedagogical consideration and underpinnings. The article draws on a sociomaterial perspective on learning and practice to problematise and discuss the findings of previous research. This theoretical perspective makes it possible to discuss how technology, educational practice and social relations are intertwined and precondition each other.

Through the lens of sociomaterial theory, the article discusses how the introduction of the new technologies brings about changes and expectations of what can be learned, how the teaching practices are enacted and how this affects the relationship between teachers and students.

Keywords: simulation, vocational education and training, teaching practice, sociomaterial perspective

NJVET, Vol. 10, No. 1, 1–17 Peer-reviewed article doi: 10.3384/njvet.2242-458X.201011

Introduction

Practising a vocation and becoming a skilled professional (woman or man) is impossible without mastering a certain type of vocational specific materiality. The materiality can be as mundane as a photocopier and email but also specific and crucial to the vocational practice, such as a hammer and gas for welders. Mastering the crucial material and developing professional judgement regarding how to perform the job are the core foundation of one's vocational competence.

More complex, abstract and knowledge-intensive work tasks and new tools are placing new demands on vocational education and training (VET) (Lindberg, 2003). Some aspects of vocational knowledge can be learned during work-based learning (WBL), but teaching and learning at school also needs to develop in order to ensure high quality education and to educate employable students (Berglund, 2004). Therefore, there is a need for VET in upper secondary school to have and use the latest technology and machines employed in working life. This is costly, and simulators are emphasised as one possible solution to the shortage of equipment (Lucas, Spencer & Claxton, 2012). The development of new technology makes it possible to simulate the complexity of the vocational practice with high fidelity simulators. Fidelity is often defined as 'the degree to which the simulator replicates reality' (Beaubien & Baker, 2004, p. i52) and the term 'high' (or 'low') refers to how well simulators represent a specific aspect of practice. With these high-fidelity simulators, virtual and computerised programs are often combined with a physical environment. An example of a high-fidelity simulator is a forest harvester simulator, equipped with the same control system, keyboard and chair as the authentic machine. By using this simulator, the students can receive training in vocational skills such as driving the machine and producing timber in a variety of wooded areas in a virtual environment. In short, the development of simulators influences what it is possible to simulate and how, creating new pedagogical possibilities and practices within VET.

Different kind of simulators and simulations have been a common teaching and learning method within VET for a long time. Recent development of technology has contributed to both the introduction and use of the high-fidelity simulator as a teaching tool in VET. The issues concerning technology-enhanced simulation training have captured the interest of various researchers. With this article, we aim to review the pedagogical research on technology-enhanced simulation training and discuss the emerging teaching practice from a sociomaterial perspective on learning and practice. The sociomaterial perspective focuses on the relations between human and material arrangements in practice and their effect on practices (Schatzki, 2002). By drawing on practice theory according to Schatzki (2002) it is possible to discuss how technology, educational practices and social relations are intertwined and precondition each other. A focus on the materiality

of the teaching practice of simulation enables the analysis of not only what humans do but also how materiality affects and changes the actions of humans.

The argument behind using simulation as a teaching method

There are different arguments for why simulation can be used as a teaching method. We have identified three different but related arguments for using simulators as a teaching method; the technical development and advancements in working life, the financial aspect, and the safety issue of vocational training. VET needs to be updated with the latest technology and machines used in the vocational practice, so that students can be provided the appropriate opportunities to learn and practise their vocational tasks and knowledge. The latter is a crucial part of training for employment. If the vocational education cannot live up to these demands, it can affect the quality of the education (Lindberg, 2003). However, the rapid pace of technological development and the high cost of new machines and software programs make it almost impossible for vocational schools to keep up to date. Because of the high cost, it is also expensive to obtain enough specimen of the equipment so that all students are able to receive sufficient training. Furthermore, purchasing expensive equipment that is currently used in the work practice is not always suitable for a teaching situation since, if the students do not master the equipment, there is a risk that they could harm themselves or damage the equipment. Therefore, from a financial perspective, it is high risk to allow students to train directly with real machines, even though there is a great need for them to learn. Using a high-fidelity simulator instead of a real machine is highlighted as a possible solution to these problems.

Another argument is more related to performance of different work tasks and the risks that may arise when the student performs these tasks (Magnusson, 2009). Training always includes a risk. An ordinary activity such as driving a car entails a risk for the driver, the pedestrians and the car when the driver is a novice. In a simulated scenario, students can reverse the truck into a fence without damaging the truck or themselves. The accident occurred only in the virtual world, that is, in a computer program, and the student can then restart the program and start practising reversing again. The safety argument is therefore emphasised strongly by the advocates of simulation. In some professions and vocations, such as in health care, the aviation industry and the nuclear power industry, the work practice involves a certain risk and various forms of risk management are included in the professional competence. As a teacher in VET, there is a dilemma associated with students' learning. On the one hand, students should be equipped with the knowledge and skills to manage risks and not cause damage, as well as develop the judgement to handle risk situations. On the other hand, teachers cannot allow the students to train the necessary skills in real situ-

ations. For these risk situations, high fidelity simulation is emphasised as a solution to the dilemma and an appropriate teaching method to train novices in areas where their professional practice may have a decisive influence on people's lives and well-being (Rystedt, 2009).

With these arguments and the development of simulators, simulation training has become a self-evident teaching method. However, it is argued that there has been little critical discussion of how to work with simulation, and therefore, pedagogical considerations, especially in VET, have been ignored (Lucas, Spencer & Claxton, 2012). There is a call for more research on how this teaching method is organised, and research that explores and expands the conceptualisation of simulation-based education (e.g. Berragan, 2011).

Sociomaterial approach to learning and teaching practice

A teaching practice is full of materiality, just as any other practice is. There are mundane objects such as pencils, books, whiteboard and more technical objects such as computers, learning platforms, etc. The materiality is always present in the practice alongside with humans. Many learning theories show interest in the material set-up (things and technologies) but they are interpreted as a means for the human actors' set-up, used for their purposes and a medium for their intentions. However, materiality always produces other unexpected actions and influences practice in unexpected ways, which affect our actions, thinking and even intentions in a practice (Fenwick & Edwards, 2010; Sørensen, 2009). Humans may invent and use an object, but the object in itself also affects a human's actions and mind. Therefore, it is possible to argue for an intertwined relationship between human and materiality, to understand the actions in a practice. Researchers argue for the need to see materiality as a part of the social aspect, as a participant (Fenwick, 2010; Sørensen, 2009), in order to understand the complexity of a practice, in this case the teaching practice.

This shifting view on materiality is related to the 'practice turn' (Fenwick, 2012) in social science. When it comes to the individual's doing, knowing and learning in everyday activities in a specific practice, many researchers (e.g. Nicolini, Gherardi & Yanow, 2003; Schatzki, 2001, 2002) argue that the practice is not a background or a container of human actions, but a site where human actions, knowing and learning are performed through its sociomateriality. Schatzki's (2001) theory on practice has made an important contribution in shifting the focus onto practice. His definition of practice as 'embodied, materially mediated arrays of human activity centrally organized around shared practical understanding' (2001, p. 11) has been useful for the researchers to explore various aspects of the practice as enacted, which includes the materiality as a crucial part of the practice. The theory emphasises the importance of what *is done (organised actions)* in prac-

tice and how it is *arranged.* A practice presupposes a certain arrangement of activities that hang together through language, actions and relations – 'sayings,' 'doings' (Schatzki, 2002), and 'relatings' (Kemmis, 2009). The sayings concern for example the vocational language and different ways of thinking and discussing what a vocational practice is and means. The doings concern the different types of activities and work performed by the individual and the way these doings influence others in the same practice. Also, every practice has its relatings – certain arrangements of people, roles and material set-up (Kemmis & Grootenboer, 2008). The activities that make up a practice are organised and linked by *understandings, rules and normative teleologies* (Schatzki, 2010). A practice consists of organised actions and arranged entities. There are different types of entities: humans, artefacts, organisms and things. The social relations are located not only between humans, but also between different entities and arrangements and further practices. The actions and relations cannot be separated from their materialities in a practice. In order to illustrate the complexity of practice, Kemmis (2009, p. 34) uses the concept of practice architectures 'which are complex bundlings of arrangements of mediating preconditions of practice – ways of saying, doing and relating, and objects and set-ups with which people in the setting interact' (Kemmis, 2009, p. 34).

The discourses on the nature of professional and vocational knowledge and learning, in general, are changing (Hager, Lee & Reich, 2012). The dominant scientific, technical rationalities of professional practice as simply the application of theoretical knowledge, possessed by individuals, are being challenged. We find that the sociomaterial perspective, focusing on practice (Kemmis, 2009; Schatzki, 2002) and its view of knowledge as being embodied and relational, intertwined with materiality, provides useful theoretical concepts to explore vocational learning and teaching practice. For this article, this perspective helps us to see the simulation training in VET as its practice. It relates to the vocational practice, but it is still a part of educational practice. These aspects will be further elaborated on.

Method

This article is based on a research review of pedagogical research on simulation in relation to vocational education and training. The purpose of the review is to obtain an overview of pedagogical research on simulation and the different ways it has been studied, rather than a systematic quantitative literature review (Paré, Trudel, Jaana & Kitsiou, 2015).

The first step was to search for relevant research-based literature on simulation training. The search strategy was to use databases such as ERIC, SCOPUS, Google Scholar and a combination of keywords such as simulation, simulation-based training, vocational education and training, teaching methods and vocational knowledge to locate relevant research published after 2000. Simulation is

an umbrella concept that covers different kind of activities. For this article, we are interested in the research that focuses on the uses of a simulator or simulations with computer-based programs. Therefore, simulation such as role play has not been included as material. The search showed that there is a comprehensive body of research on simulation in general. The second step was to focus on a) the research with pedagogical interests and b) research in the field of vocational education and training. When we delimited literature in this way, we found that the majority of the research literature is from the health care domain and that the amount of research with a pedagogical focus was considerably small. When we delimited the field further, we found that research on the usage of simulation in VET is scarce. There were not enough research projects focusing on VET to conduct a substantive analysis. Therefore, we decided to include the research with pedagogical interest from the health care sector (including higher education as well as professional development for health care professionals), even though the main analysis was based on the research from VET. In the analysis of the previous research, we focused on the findings and the knowledge produced.

Previous research on simulation

Simulation has been used extensively as a pedagogical tool for skills training, particularly when practising tasks associated with high risk, since the simulation exercise can be carried out under safe and controlled conditions, for example in medical, military and pilot training (Cook et al., 2011; Frenk et al., 2010). However, the development of new technologies offers new possibilities for educators in various areas to design pedagogies aimed at different learning outcomes. Simulation has thereby moved beyond the historical use of being a tool for learning discrete skills, and is now used to mimic complex professional practices and to teach cognitive, psychomotor and affective skills, as well as to practise team training and interprofessional collaboration (e.g. Breckwoldt, Gruber & Wittmann, 2014; Motola, Devine, Chung, Sullivan & Issenberg, 2013). The health care sector dominates the field of research on simulation today (e.g. Issenberg, McGaghie, Petrusa, Lee Gordon & Scalese, 2005; Motola et al., 2013; Nyström, Dahlberg, Hult & Abrandt Dahlgren, 2016b; Rooney, Hopwood, Boud & Kelly, 2015; Rooney & Nyström, 2018).

The research on contemporary simulation pedagogies can be thematised into three themes: 1) the effect of technology-enhanced simulation training, 2) the fidelity and authenticity of simulation and learning, and 3) pedagogical considerations and underpinnings. The research in theme two and three is especially relevant for this paper, and therefore we will elaborate more on this below. First, a short conclusion on the research relating to the first theme, *effect of technology-enhanced simulation,* which concerns the impact of simulation. Different meta-analyses of research on high-fidelity simulation (e.g. Cook et al., 2011; Issenberg

et al., 2005) show that simulation training has considerable effects on the outcomes of knowledge, skills and behaviours. Furthermore, these studies state that high-fidelity simulations are educationally effective and, therefore, support the use of technology-enhanced simulations in training.

The second theme, *fidelity and authenticity of simulation and learning*, concerns how 'realistic' simulation is and if and how this aspect is related to learning. The possibility of creating a high level of authentic simulation with a high-fidelity simulator, where that simulation/simulator can stand in for and even replace the real-world experience, has been an intriguing idea. As presented earlier, some studies show positive outcomes of simulation training, and these results reinforce the trust in the high-fidelity technique. However, recent studies also point out that the relation between high-fidelity simulation and its impact on learning is not clear-cut (De Giovanni, Roberts & Norman, 2009; Norman, Dore & Grierson, 2012; Paisley, Baldwin & Peterson-Brown, 2001) and there is research that elaborates on this issue from a pedagogical perspective. For example, Rystedt (2009) and Tosterud (2015) argue that low-fidelity approaches can be preferable, since they focus on limited aspects of what students are expected to learn. This argument questions whether a high level of authenticity is always better for learning. It is pointed out that a high level of fidelity can influence learning negatively, since it tries to copy the complexity of the vocational practice, a complexity that the students are not yet ready to handle, and causes a high level of anxiety among the students (cf. Aarkrog, 2019; Khaled, Gulikers, Biemans & Mulder, 2015).

There is also research suggesting that attributing the realism of a simulation to the physical characteristics of the simulator alone is misleading, since simulators have many unrealistic features and functionalities (Rystedt & Sjöblom, 2012). Therefore, the lack of realism in a simulation exercise is inevitable (Rettedal, 2009) and one can also argue that the fidelity or authenticity of simulation is not a static variable, but something achieved through various materials during the simulation (Aarkrog, 2019; Ahn & Rimpiläinen, 2018).

The last theme, *pedagogical consideration and underpinnings*, shifts the focus onto the teaching practice and learning process as a relationship between learning and technology. While studies focusing on fidelity and learning outcomes place an emphasis on the accountability of a simulator to resemble reality, there are other studies that place the emphasis on the simulator's ability to manipulate the reality and how this ability can be used for the teaching practice. This research stresses that a simulator simplifies the complexity of reality and discusses it as both a positive (i.e. the students can focus on one aspect of vocational practice) and a negative (the complex reality becomes too simplified) aspect for learning and teaching. Further, it is emphasised that the scope to create realities that are not easily accessible for the students, i.e. different weather conditions, is a key pedagogical point of using a simulator. The strength of using the simulator is that

the situation and reality can be adjusted to reach the intended learning goals of the course. For example Hansson (2004, p. 19) emphasises:

> A simulation that is a copy of reality is pedagogically neither desirable nor feasible. On the other hand, simulations that do not resemble reality can show contrasts which make one understand the reality better. [translated by the authors]

Research shows that a simulation 'session' is basically structured according to three widely used routines and general phases: *briefing* (provides information on the technical equipment in use and the scenario that is about to be simulated), *simulation* (when students use the simulator to train their vocational skills), and *debriefing* (students' emotional reactions, actions and interactions in the scenario are brought up as topics for reflection) (Dieckmann, Molin Friis, Lippert & Østergaard, 2009).

Besides the issue of fidelity and authenticity of simulation, studies have also focused on the enactment of simulation and more specifically the teacher's role in simulation. The teacher's role and tasks change during the simulation, since the simulator gives feedback on students' actions and whether they manage to perform the task in the correct way. There is a risk that the teacher's role may be reduced to that of an operator or a passive observer, rather than an expert in the subject (McGaghie, 2010). However, it is also argued that teachers interpret and translate technical innovations into educational practices, and therefore it is crucial to understand teachers' actions and roles, since they influence how students will learn in a simulation (Tosterud, 2015; cf. Jossberger, Brand-Gruwel, van de Wiel & Boshuizen, 2015). For example, Tosterud (2015) shows that students who see the teacher as an expert perceive simulation as a legitimate learning method, and that the teacher's ability to conduct simulation, give feedback, etc. has a decisive impact on the students' learning. Aarkrog's (2019) study adds that teacher's expertise contributes to the student's perception of the level of fidelity of the simulation. It is argued that without teachers' active support and guidance, students can obtain 'wrong' knowledge and the weaker students risk not achieving the learning objectives (e.g. Berglund, 2004; Khaled et al., 2015). Furthermore, it is possible that the students may misunderstand the goal of the simulation, which could cause them not to follow the intended learning path of the exercise (Ahn & Rimpiläinen, 2018). Studies have also shown that students could have problems in seeing and understanding the consequences of their actions when working with simulators (Leiberg, 2005). Therefore, the vocational teachers need to pay attention to and discuss students' actions and mistakes, in order for students to learn (Berglund, 2004; Jossberger et al., 2015).

Reflection after the simulation (or debriefing as it is described in some simulation research) is identified as crucial for learning through simulations (e.g. Motola et al., 2013; Rudolph et al., 2006), since it is a way to bridge the gap between experiencing an event and learning from it (Hansson, 2004). Studies emphasise

the teachers' role in planning and organising reflection, since it will influence the learning process and outcome (Dieckmann et al., 2009; Jossberger et al., 2015; Nyström et al., 2016a). However, various studies also show that teachers do not include reflection as a self-evident part of the training (Husebø, Dieckmann, Rystedt & Friberg, 2013; Jossberger et al., 2015). Therefore, it is necessary to develop an analytical framework for probing questions in order to facilitate deeper reflection on learning (Husebø et al., 2013).

Recent studies (e.g. Ahn, Rimpiläinen, Theodorsson, Fenwick & Abrandt Dahlgren, 2015; Nyström et al., 2016a, 2016b; Rooney et al., 2015) also argue for the inclusion of the material arrangements, e.g. the simulator, since they are not just tools to be used but take an active part of the curricula, and therefore influence the learning outcome. Ahn et al. (2015) showed that the varying sociomaterial arrangements available in the different locations involved in simulation training, i.e. the actual simulation and the room where debriefing takes place, lead to different kinds of knowing and learning. Therefore, Ahn et al. (ibid) argue that by manipulating the available sociomaterial arrangements, the pedagogical outcomes could be affected and changed. Furthermore, Rooney and Nyström (2018) argue that the use of simulators creates a complex pedagogical space, since teaching in these spaces is demanding for educators, as they must have multiple foci if they are to support all the students in their learning.

To conclude, studies have asked for a shift in perspective away from teaching students how to simulate, and towards a more critical approach that scrutinises the learning goals, in order to determine when and in relation to which goals simulation-supported teaching could be an effective method to aid learning (McGaghie, 2010). Moreover, researchers argue that in order to be an effective teaching method, simulation training should be an integrated part of the curriculum, instead of a separate feature (Motola et al., 2013).

Discussion

There is a mature body of research on simulation, mainly from the health care sector and professional education. This research emphasises that simulation training has a positive effect on students' learning. At the same time, simulation training is often viewed as a self-evident teaching method and researchers argue that there has been little critical discussion of how to work with simulation, and therefore, pedagogical considerations, especially in VET, have been ignored (Lucas, Spencer & Claxton, 2012). The research on simulation often focuses either on materiality, e.g. the simulator, or on the involved participants. By doing so, some aspects become foregrounded and others neglected. In this article, we draw upon a sociomaterial perspective on practice to problematise and discuss the presented educational research on simulation training and how the introduction of the new technologies brings about changes and expectations of what can be learned, how

the teaching practices are enacted and how this affects the relationship between teachers and students.

From a sociomaterial perspective, simulation training is viewed as an organised set of actions embedded in a practice, expressed through the relationship between teachers/students and the material set-up. Each practice occurs in a material world in which the arrangements of objects, artefacts and technology (e.g. computer, chairs and a specific steering system) are essential to the formation of a teaching practice and the enactment of different actions (Kemmis, 2009; Schatzki, 2002). Therefore, it is possible to argue that the material set-ups precondition certain individual actions. Thus, individual actions always relate to a certain activity, which is enacted in and adapted to the material world. In simulation training in VET, the actions of teachers and students are entangled with the material set-up of the simulation, e.g. software, screens, instruction books. Therefore, the material set-up, i.e. the arrangement of objects, artefacts and technology, is seen as dynamic and integrated with individual activities in ways that act on and emerge in a practice (Schatzki, 2010). For example, a forestry machine simulator allows the student to practise isolated skills repeatedly, and the teacher can give feedback to the student based on recordings of the student's actions and choices, which would not be possible when using a real forestry machine in the woods. By using the simulator, different activities emerge in the practice of teaching and learning a vocation. A focus on the social and material arrangements as relational can shed light on how and why certain activities become more or less likely to happen in the unfolding practice (Schatzki, 2002). Changes in the material set-up – for instance, the development of new simulator programs – could change the teaching practice and alter the way individuals do their work, as well as which actions need to be performed. The vocational education and training programme, including simulation-based training, can be viewed as practice architectures (Kemmis, 2009). As simulation is always shaped and maintained by the practice architectures, our study describes and analyses research on simulation in its cultural-discursive sayings, the social-material activities, and the relatings between students, teachers and others in the specific educational practice. As presented above, there are arguments why a vocational education and training programme should purchase simulators in order to support students' vocational learning. The arguments that are put forward are technical, financial and work related. The arguments all fall back on the development of working life, with more knowledge-intensive work tasks and new tools, which places new demands on VET (Lindberg, 2003). If the teaching and learning in schools do not step up and offer a high-quality education i.e. with the latest technology and machines currently used in the work practice, the students may not be employable. New machines and technology are expensive and there is always a risk involved in letting novice students train with new equipment. These arguments are based on cultural and discursive sayings with conceptual ideas such as high quality and

employability, along with material and financial conditions for which simulators are posited as a potential solution (Lucas, Spencer & Claxton, 2012). Therefore, one possible interpretation is that the arguments are mediating preconditions of practice, because if the schools do not invest in simulators, they cannot argue that their education is up to date.

One of the key questions that research on simulation training has focused on is the relation between simulation and learning outcomes. Researchers have tried to establish whether this teaching method leads to better learning outcomes compared with other methods, and whether the use of high-fidelity simulators leads to better outcomes than with low-fidelity simulators. Here the research results do not give us a coherent answer. While these questions seem to be relevant and neutral, they are grounded in an objective ontological view that there is one reality out there (in this case, the vocational practices) and that the simulation can stand in for or reproduce this reality (cf. Rooney et al., 2015). This view leads to a misplaced trust in technology and 'realism' as the best teaching method and ignores the fact that simulation training happens in the educational practice. From a sociomaterial perspective, there is a fundamental difference between vocational practice and the educational practice, which in some cases imitates the real vocational practices. It is argued that reality is not something that exists independently of us, but is something that emerges and is enacted through various actions in a certain practice (Schatzki, 2010). In other words, there is no single reality, but multiple realities that are enacted through the sociomateriality in the different practices.

What is enacted and in which arrangement it is enacted differs in the educational practice, compared to the vocational practice. We can easily point out the arranged entities in the educational practice that differ: there are teachers, students, textbooks, course syllabi etc. When a simulator is introduced in this practice, it affects and changes some part of the arrangement. However, it does not bring the whole set of the arranged entities in another practice, the vocational practice, and what that entails – its sayings, doings and relatings – into the educational practice. It cannot replace the educational practice, so it becomes more 'like' a vocational practice. Knowledge embedded in doings, relatings, procedure and materials in a vocational practice cannot be transferred into the educational setting merely by using a high-fidelity simulator.

The assumption that a simulator represents a 'real' aspect of vocational practice simplifies the complexity of vocational practices. Treating the fidelity of a simulator as the main component for the realism of a simulation is misleading too, considering that simulators have many unrealistic features and functionalities. If the use of a simulator focuses on its ability to mimic or imitate the reality out there, the shortcomings of the simulator as a teaching and learning tool are inevitable (cf. Rettedal, 2009). What happens in simulation training is that the students need to learn to discern the unimportant and meaningless differences

between the reality of the simulation and the reality of the vocational practice, and be able to ignore and handle them to attain the intended learning goals (cf. Ahn & Rimpiläinen, 2018). In other words, simulation is a practice and the students need to learn to perform a simulation.

When a simulator and simulation training are used in the educational practice, it happens within these specific practice architectures. What a student is expected to learn and perform always stands in relation to learning goals and educational aims and is therefore a product of the educational practice. Thus, the answer to the question of whether a high-fidelity simulator is a better tool for teaching and learning is ambivalent. In order to answer the question properly, the question must be situated in relation to the specific goals of the course in which the simulation training is located, but also related to the student's level of knowledge and the teacher's knowledge of simulation training, etc.

We have discussed the relatings between the simulator and the student, and how the relation supports learning, and we have presented previous research that emphasises how the relatings between the students and the teacher change when a simulator is introduced into the teaching practice. Based on the previous research, we understand that the simulator can only replace some of the teacher's sayings and actions, since studies stress the importance of having a teacher as an expert presence and the need for students to receive feedback from the teachers, not just the immediate feedback from the simulator, as a crucial part of learning. The simulator can be programmed so it can train students' vocational knowledge and skills and, therefore, give feedback on these aspects. However, it cannot replace the teacher's vocational knowledge and ability to reflect with students on their actions and the consequences a specific action can have for a specific vocational practice.

Conclusion

Based on the review of research on simulation and the sociomaterial analysis, it is possible to argue that the development of new technology and new teaching methods, in this case simulators, is prompting a new teaching practice emerge. In this practice, the teacher and the students are important actors, but the introduction of simulators brings a change to the material set-up in which the learning takes place. Through the lens of a sociomaterial perspective, it is possible to acknowledge not just what we humans do in this specific context, but also how the material context and set-up are intertwined and precondition our actions. This means that the conditions and the way that teaching and learning are organised become different and result in changing relations between teacher and students. As mentioned, this places new demands on the teacher to understand and interpret what is possible (and not possible) within this new practice and foresee the consequences it will have for students' vocational learning.

To conclude, in the last few decades, simulation training has become a common teaching method in VET worldwide (Lucas, Spencer & Claxton, 2012). However, there is a need for a critical and pedagogical discussion on how to work with and plan simulation training to support students' learning and prepare them for their future work. Furthermore, there is a need for more process-oriented analysis of this specific teaching practice in order to contribute to the pedagogical underpinnings of simulation, by providing knowledge on how to use the simulation method to its full potential in preparing students to take on the complexity of their future vocational practice. Such knowledge, for example on how to conduct the reflection (i.e. debriefing) after the simulation to support learning, will be of practical use for vocational teachers in their work on arranging simulation-based training.

Notes on contributors

Song-ee Ahn is an associate professor and senior lecturer at the Department of Behavioural Sciences and Learning, Linköping University, Sweden. Her research interests focus on sociomaterialities and educational practices, such as interprofessional learning, simulation-based medical education and international education.

Sofia Nyström is an associate professor and senior lecturer at the Department of Behavioural Sciences and Learning, Linköping University, Sweden. Her research interests focus on the relation between education and work concerning arrangements for professional and vocational learning, identity formation and simulation-based training using different theoretical perspectives.

References

Aarkrog, V. (2019). 'The mannequin is more lifelike': The significance of fidelity for students´ learning in simulation-based training in the social and healthcare programmes. *Nordic Journal of Vocational Education and Training*, *9*(2), 1–18.

Ahn, S., & Rimpiläinen, S. (2018). Maintaining Sofia – or how to reach the intended learning outcomes during a medical simulation training. *International Journal of Learning Technology, 13*(2), 115–129.

Ahn, S., Rimpiläinen, S., Theodorsson, A., Fenwick, T., & Abrandt Dahlgren, M. (2015). Learning in technology-enhanced medical simulation: Locations and knowings. *Professions & Professionalism*, *5*(3), 1–12.

Beaubien J., & Baker P. (2004). The use of simulation for training teamwork skills in health care: How low can you go? *Quality and Safety in Health Care*, *13*(Suppl 1), i51–i56.

Berglund, I. (2004). *Lärande simulering eller simulerat lärande? En studie av fyra elevers lärande av styrteknik med användning av ett datorbaserat inlärningsprogram på gymnasieskolans elprogram* [Learning by simulation or simulated learning?]. Licentiate thesis. Stockholm: Lärarhögskolan.

Berragan, L. (2011). Simulation: An effective pedagogical approach for nursing? *Nurse Education Today*. *31*(7), 660–663.

Breckwoldt, J., Gruber, H., & Wittmann, A. (2014). Simulation learning. In S. Billett, C. Harteis, & H. Gruber (Eds.), *International handbook of researching professional and practice-based learning* (pp. 673–698). London: Springer

Cook, D.A., Hatala, R., Brydges, R., Zendejas, B., Szostek, J.H., Wang, A.T., Erwin, P.J., & Hamstra, S.J. (2011). Technology-enhanced simulation for health professions education: A systematic review and meta-analysis. *The Journal of American Medical Association, 306*(9), 978–988.

De Giovanni, D., Roberts, T., & Norman, G. (2009). Relative effectiveness of high-versus low-fidelity simulation in learning heart sounds. *Medical education, 43*(7), 661–668.

Dieckmann, P., Molin Friis, S., Lippert, A., & Østergaard, D. (2009). The art and science of debriefing in simulation: Ideal and practice. *Medical Teacher, 31*(7), e287–e294.

Fenwick, T. (2012). Co-production in practice: A sociomaterial analysis. *Professions & Professionalism, 2*(2), 1–16.

Fenwick, T., & Edwards, R. (2010). *Actor-network theory in education*. London: Routledge.

Frenk, J., Chen, L., Bhutta, Z.A., Cohen, J., Crisp, N., Evans, T., & Zurayk, H. (2010). Health professional for a new century: Transforming education to strengthen health systems in an interdependent world. *The Lancet, 376*(9756), 1923–1958.

Hager, P., Lee, A., & Reich, A. (Eds.) (2012). *Practice, learning and change: Practice theory perspectives on professional learning*. Dordrecht: Springer.

Hansson, Y. (2004). *Simuleringar: För lärande och insikt* [Simulation: For learning and insight] (1st ed.). Stockholm: Gothia.

Husebø, D., Dieckmann, P., Rystedt, H., & Friberg, F. (2013). The relationship between facilitators' questions and the level of reflection in the post-simulation debriefing. *Simulation in healthcare*, *8*(3), 135–142.

Issenberg, S.B., McGaghie, W.C., Petrusa, E.R., Lee Gordon, D., & Scalese, R.J. (2005). Features and uses of high-fidelity medical simulations that lead to effective learning: A BEME systematic review. *Medical teacher*, *27*(1), 10–28.

Jossberger, H., Brand-Gruwel, S., van de Wiel, M.W.J., & Boshuizen, H.P.A. (2015). Teacher's perceptions of teaching in workplace simulation in vocational education. *Vocations and learning*, *8*(3), 287–318.

Kemmis, S. (2009). Understanding professional practice: A synoptic framework. In B. Green (Ed.), *Understanding and researching professional practice* (pp. 19–38). Rotterdam: Sense Publishers.

Kemmis, S., & Grootenboer, P. (2008). Situating praxis in practice: Practice architectures and the cultural, social and material conditions for practice. In S. Kemmis, & T.J. Smith. (Eds.), *Enabling praxis: Challenges for education* (pp. 37–62). Rotterdam: Sense Publications.

Khaled, A., Gulikers, J., Biemans, H., & Mulder, M. (2015). How authenticity and self-directedness and student perceptions thereof predict competence development in hands-on simulations. *British Educational Research Journal, 41*(2), 265–286.

Leibring, I. (2015). *Metodrumsundervisning: En kvalitativ studie av simulering inom vård- och omsorgsutbildning* [Clinical skills laboratory teaching: A qualitative study of simulation in nursing and healthcare education]. Licentiate thesis. Karlstad: Karlstads universitet.

Lindberg, V. (2003). *Yrkesutbildning i omvandling: En studie av lärandepraktiker och kunskapstransformationer* [Vocational education in change: A study of learning practices and knowledge transformations]. PhD thesis. Stockholm: Stockholm University.

Lucas, B., Spencer, E., & Claxton, G. (2012). *How to teach vocational education: A theory of vocational pedagogy.* City & Guilds Center for skills development. Retrieved 2. March, 2016, from: https://www.educationinnovations.org/sites/default/files/How-to-teach-vocational-education.pdf

Magnusson, P. (2009). Simulerade rattar: En studie om simulatorn som pedagogiskt verktyg i buss- och lastbilsförarutbildningar [Simulated stearing wheels: A study of simulation as a tool for learning how to drive bus and trucks]. Master thesis. Retrieved 2. March, 2016, from: http://urn.kb.se/resolve?urn=urn:nbn:se:vxu:diva-6214

Motola, I., Devine, L.A., Chung, H.S., Sullivan, J.E., & Issenberg, S.B. (2013). Simulation in healthcare education: A best evidence practical guide. AMEE Guide No. 82. *Medical Teacher*, *35*(10), e1511–e1530.

Nicolini, D., Gherardi, S., & Yanow, D. (2003) Introduction: Toward a practice-based view of knowing and learning in organizations. In D. Nicolini, S. Gherardi, & D. Yanow (Eds.), *Knowing in organizations: A practice-based approach* (pp. 3–31). New York: M.E. Sharpe.

Norman, G., Dore, K., & Grierson, L. (2012). The minimal relationship between simulation fidelity and transfer of learning. *Medical education, 46*(7), 636–647.

Nyström, S., Dahlberg, J., Edelbring, S., Hult, H., & Abrandt Dahlgren, M. (2016a). Debriefing practices in interprofessional simulation with students: A sociomaterial perspective. *BMC Medical education, 16*(148), 1–8.

Nyström, S., Dahlberg, J., Hult, H., & Abrandt Dahlgren, M. (2016b). Enacting simulation: A sociomaterial perspective on students' interprofessional collaboration. *Journal of interprofessional care*, *30*(4), 441–447.

Paisley, A.M., Baldwin, P.J., & Paterson-Brown, S. (2001). Validity of surgical simulation for the assessment of operative skills. *British Journal of Surgery, 88*(11), 1525–1532.

Paré, G., Trudel, M-C., Jaana, M., & Kitsiou, S. (2015). Synthesizing information systems knowledge: A typology of literature reviews. *Information & Management, 52*(2), 183–199.

Rettedal, A. (2009). Illusion and technology in medical simulation: If you cannot build it, make them believe. In P. Dieckmann (Ed.), *Using simulations for education, training and research* (pp. 202–214). Lengerich: Pabst Science Publishers.

Rooney, D., Hopwood, N., Boud, D., & Kelly, M. (2015). The role of simulation in pedagogies of higher education for the health professions: Through a practice-based lens. *Vocations and Learning, 8*(3), 269–285.

Rooney, D., & Nyström, S. (2018). Simulation: A complex pedagogical space. *Australasian Journal of Educational Technology*, *34*(6), 53–64.

Rudolph, J., Simon, R., Dufresne, R., & Raemer, D. (2006). There's no such thing as "non-judgemental" debriefing: A theory and method for debriefing with good judgements. *Simulation in healthcare, 1*(1), 49–55.

Rystedt, H. (2009). Simulering: Att återskapa vårdpraktiker som lärande miljöer [Simulation: To recreate health care practices as a learning environment]. In J. Linderoth (Ed.) *Individ, teknik och lärande* [Individual, technology and learning] (pp. 44–66) Stockholm: Carlssons.

Rystedt, H., & Sjöblom, B. (2012). Realism, authenticity, and learning in healthcare simulations: Rules of relevance and irrelevance as interactive achievements. *Instructional Science*, *40*(5), 785–798.

Schatzki, T.R. (2001). Introduction: Practice theory. In T.R. Schatzki, K. Knorr-Cetina, & E.V. Savigny (Eds.), *The practice turn in contemporary theory* (pp. 10–23). London: Routledge.

Schatzki, T.R. (2002). *The site of the social: A philosophical account of the constitution of social life and change*. University Park: Pennsylvania State University Press.

Schatzki, T. (2010). Materiality and social life. *Nature and Culture, 5*(2), 123–149.

Tosterud, R. (2015). *Simulation used as a learning approach in nursing education: Students' experiences and validation of evaluation questionnaires.* PhD thesis. Karlstad: Karlstad University.

Sørensen, E. (2009). *The materiality of learning: Technology and knowledge in educational practice*. Cambridge: Cambridge University Press.

Nordic Journal of Vocational Education and Training, 2020

Both novice and expert? How apprentices develop vocational competence in workplaces where technology is continuously changing: Examples from the Norwegian media graphics programme

Nina Aakernes

OsloMet – Oslo Metropolitan University, Norway (nina.aakernes@oslomet.no)

Abstract

This article explores how young apprentices develop vocational competence through apprenticeship in workplaces where technology is continuously changing. The article draws on results from a longitudinal study that followed seven apprentices enrolled in the media graphics programme in Norway through their two-year apprenticeships.

The results showed how the apprentices developed vocational competence in the community of practice in the workplaces by taking an active part in the daily production, experimenting with different solutions, reflection, and by advice and discussions with their instructors and co-workers. However, the apprentices also had to deal with work tasks where the solutions were not yet known in the workplace. The article shows how the apprentices combined learning from colleagues with learning from other resources such as software courses and use of the internet. The results showed how the apprentices' competence development can be a resource for the co-workers and can facilitate the development of the enterprise. Furthermore, these results provide new perspectives on competence development in the community of practice. The study showed that the apprenticeship has an innovative potential and is an essential way for young people to develop vocational competence in a world of work where technology is continuously changing.

Keywords: vocational education and training, apprenticeship, workplace learning, technology, media production

NJVET, Vol. 10, No. 1, 18–42 Peer-reviewed article doi: 10.3384/njvet.2242-458X.2010118

Hosted by Linköping University Electronic Press

Introduction

Throughout human history, apprenticeship learning in the workplace has been an essential way of developing vocational competence (Billett, 2013). The apprentices develop competence as they engage in authentic work tasks and interaction in the 'natural' setting of a workplace, and there is no distinction between learning and participating in practice (Billett, 2010; Lave & Wenger, 1991).

In the 21st century, practice-based learning through apprenticeship is acknowledged as essential for young peoples' development of vocational competence (e.g. Billett, 2010; Fuller & Unwin, 2011; Nielsen & Pedersen, 2011). In today's labour market, workers are required to continuously develop their competence in order to meet the rapidly changing requirements in the workplaces (Billett, 2013; Poortman, Illeris & Nieuwenhuis, 2011). Instead of a set of narrowly defined forms of knowledge, there is a need for a comprehensive competence (Moreno Herrera, 2016); thus, workplace learning should provide possibilities for the apprentices to become broad rather than narrow experts (Fuller & Unwin, 2004).

The traditional apprenticeship model was developed under conditions where the technology, and thus the expertise in the workplaces, was more stable. Even though there is renewed interest in workplace learning (Billett, 2013), there has been little research investigating how apprentices develop vocational competence in vocations where technology is continuously changing and when the best way of carrying out specific work tasks is not yet known to the experts in the workplace. This article contributes to the existing literature by investigating how young apprentices enrolled in the media graphics programme in Norway developed vocational competence through their two-year apprenticeships.

This apprenticeship programme is interesting due to the continuously changing technology in the workplaces. Furthermore, no previous studies have investigated how apprentices in this trade develop vocational competence under such circumstances. In this trade, rapid changes in technology mean that there are continuous changes in the software and ways of performing work tasks. Furthermore, there is rapid development both of new devices and software for the production of media material for these devices. Thus, there is a requirement in the workplaces for tradespersons to stay updated about the possibilities that changes in technology provide.

The article draws on the results of a longitudinal study that followed seven apprentices enrolled in the media graphics programme in Norway through their two-year apprenticeships. Six of the apprentices secured a two-year apprenticeship contract after two or three years of school-based education in the vocational education programme for media and communication in upper secondary school, and one after finishing a bachelor programme in graphic design at a university.

The research question for this article is: *How do young apprentices in the media graphics programme develop vocational competence in workplaces where technology is continuously changing?*

To answer this question, the article draws on workplace observations and in-depth interviews with the apprentices, their instructors in these enterprises, and three instructors in the apprenticeship training office during different stages of the apprenticeship period.

In the literature, there is different use of the concepts of skills, knowledge, qualifications, competencies and competence. In this article, I have chosen to use the concept of vocational competence in order to emphasise the multidimensionality and complexity of what is expected of a tradesperson. Even if the concept of competence is used differently, there seems to be agreement that competence is an integrated set of skills, attitudes, and forms of knowledge that becomes visible through successful behaviour in specific situations (Koenen, Dochy & Berghmans, 2015; NOU 2018:2).

The Norwegian apprenticeship programme for media graphics

The standard vocational education and training (VET) model in Norwegian upper secondary education consists of two years of school-based training followed by two years of apprenticeship training at an approved training enterprise. There are nine different and broad programmes in the school-based part of VET. (e.g. programmes in social and health care, electricity work, building construction, etc.). Each programme prepares students for many different, but related vocations. The programmes consist of academic subjects (Norwegian, English, mathematics, etc.) and vocational subjects specific to the programme. The students are also given the opportunity to undergo placement periods in enterprises during the school-based part of VET (Norwegian Directorate for Education and Training, 2016). However, few students from media and communication have had this opportunity (Aakernes, 2018).

Media graphics provides opportunities for apprenticeships in traditional prepress enterprises, advertising agencies, web or digital media firms, and film production companies (Opplæringssenteret for visuell kommunikasjon, 2019). The work tasks can include design and production of advertising materials, brochures, magazines and websites, editing of still or motion pictures, and practical work on film sets (Norwegian Directorate for Education and Training, 2008). The national curriculum outlines the requirements for the two years of enterprise-based training. Important objectives are 'idea generation, composition and design of different media products'; 'development of skills in the use of tools, technology'; and 'promotion of ability to always stay updated and keep developing one's own competence, and the ability to adapt to changes in the occupation' (Norwegian Directorate for Education and Training, 2008, pp. 1–2).

In the Norwegian VET system, the training of apprentices is a shared responsibility between the company where learning takes place, and the apprenticeship training office (Lahn & Nore, 2018). The training office for media graphics is trade-specific and is owned and operated by a community of companies. The task of the office is to recruit apprentices and training enterprises and network with enterprises, schools, and branch organisations, and to follow up apprentices. The apprentices attend several courses in the training office during their training period (Opplæringssenteret for visuell kommunikasjon, 2019). After the apprenticeship period, apprentices take a final practical examination, usually carried out over five working days, to earn the Journeyman's Certificate in the trade (Norwegian Directorate for Education and Training, 2008).

Previous research

Previous research on apprenticeships has established that the most common way of developing vocational competence is by taking part in everyday tasks in the workplace, interacting with more experienced colleagues (e.g. Aarkrog, 2005; Fuller & Unwin, 2003; Lensjø, 2016). The researchers found that the apprentices worked alongside their more experienced colleagues, and especially as newcomers, watched and listened to their colleagues. However, it is through the opportunity for active participation that the apprentices become tradespersons. Even if there might be some brief instructions, Aarkrog found that 'the predominant way of learning is to plunge into performing the tasks' (2005, p. 142).

Guidance and assessment by their co-workers is an integral part of the apprentices' work and competence development (Pedersen & Elmholdt, 2008). From this feedback, the apprentice is guided towards the quality standards and 'the required level of proficiency' (p. 101). A significant type of assessment is to let the apprentice take part in work tasks that demand greater responsibility (Nielsen & Kvale, 2006, p. 130). Most of the previous research on apprenticeships has investigated how apprentices develop vocational competence in workplaces where the apprentice is the novice, and the more experienced colleagues are the experts (Lave & Wenger, 1991). However, to meet the requirements of contemporary workplaces, the apprentices must develop the ability to keep updating their own competence so they can master both known and challenging new situations.

Messmann and Mulder's study of apprenticeship in the German dual system underlined 'the importance of designing complex work environments which challenge apprentices to learn' (2015, p. 592). To be able to deal with challenging situations and tasks, the study points to the importance of work environments that provide the apprentices with autonomy so they can make their own plans and decisions (p. 592). However, the apprentices also needed to receive support and competence-related feedback from their colleagues and superiors.

Nore (2015) found that due to the continuous development of technology and qualification needs, VET students entered into a 'more hybrid learning arena'. They developed vocational competence from schools, workplaces, courses and E-learning and became co-designers of their own VET. The courses offered by specialised course providers can be a way of meeting 'schools' and companies' lack of updated or specialised knowledge and skills' (p. 188).

Fenwick and Nerland (2014, p. 25), point out that in today's society, 'knowledge is generated from a multitude of sources and circulated rapidly across organisational boundaries'. They call this phenomenon 'knowledge on its travels'. It is necessary for practitioners to learn how to relate general instructions found on the internet to their specific work task. Similarly, Elmholdt's (2001) study of a web development company showed extensive use of the internet as a learning resource. Due to the continuously changing technology, there is a need to combine local knowledge sources (i.e. the knowledge of colleagues) and global sources which can be easily accessed via the internet, and to understand how they can be mutually supportive.

Young people are born and grow up in a society where competence in the use of media and ICT are daily necessities. They learn the use of digital technology both in schools and in their broader social life (Erstad & Silseth, 2019). The growing use of digital technology in different contexts results in young people gaining confidence and expertise in the use of these tools (Forkosh Baruch & Erstad, 2018). They are not only consumers of professional productions, as from an early age they learn how to produce and upload their own media material (Bond, 2014). Extensive use of digital technology, both as a hobby and at work, can blur the boundaries between work and leisure time. Elmholdt (2001) shows in his study how one of the employees found out how to use a specific digital technology during his leisure time. He shared his experience in the workplace, and this resulted in an improvement of production.

Fuller and Unwin (2003, 2004) have developed the 'expansive-restrictive framework' to analyse approaches to apprenticeship. An expansive learning environment concerns the opportunity to gain broad experience across the organisation; a gradual transition to full participation; and having a recognised status as a learner. Furthermore, these authors challenge the assumption that an apprenticeship is a 'linear journey from novice to expert' (2004, p. 32). They found that apprentices were sharing their expertise, spending a 'significant amount of time helping colleagues to learn in the workplace' (p. 38). Their expertise was developed both from previous competence development at school and also from their broader life experience. Restrictive learning environments are the opposite of expansive and they imply that the learners will gain mastery over a 'limited range of tasks, skills and knowledge', and are more likely to become 'narrow experts' (Fuller & Unwin, 2004, p. 35).

In summary, previous research has established that apprentices develop vocational competence through active participation in authentic work tasks with their colleagues in workplaces. Due to the continuous changes in qualification needs, the apprentices should be given the opportunity to autonomously make their own plans and decisions. This work autonomy must be combined with guidance and support from their colleagues. The research also points to the need to combine workplace learning with learning in courses and global knowledge sources such as the internet. However, there is a need for further in-depth studies to throw light on apprentices' competence development in workplaces where the technology and qualification requirements are continuously changing, and where the experts might lack the expertise in how to carry out specific work tasks. Furthermore, it is interesting to investigate the extent to which apprenticeship can develop to meet the rapidly changing needs for qualifications in workplaces.

Theoretical framework

Lave and Wenger's (1991) theory of learning explains how the apprentice develops vocational competence by participating in the 'community of practice' in the workplace. Apprentices develop competence without formal teaching through engagement in authentic vocational tasks together with their more experienced co-workers. Lave & Wenger's concept of 'legitimate peripheral participation' refers to how apprentices are given access to the community and the community's expertise. The apprentices start with simple tasks, where mistakes can be tolerated, and move on to more demanding tasks as they develop competence. During their competence development, they move towards 'full participation' in the community.

Lave and Wenger's concept is developed mainly from studies of craft apprenticeship in traditional societies. Thus, some scholars point to limitations in the theory regarding explaining how apprentices develop vocational competence in modern workplaces in advanced industrial societies (for example Fuller, 2007; Fuller, Hodkinson, Hodkinson & Unwin, 2005). Of particular interest for this study is the questioning of the innovative capacities of communities of practice due to the emphasis on transmission of existing practices; oversimplification of relationships between novices and experts; and insufficient recognition of the importance of multiple settings and networks for learning processes. However, the same scholars who point to limitations in Lave & Wenger's model also argue that the model 'continues to provide an important source of theoretical insight for research into learning at work' (Fuller et al., 2005, p. 50). Further development of the model is needed, along with research into how the model can be used to explain the complexity of competence development related to work activities in modern workplaces (Hughes, Jewson & Unwin, 2007). The major strength of the model is the emphasis on competence development through participation in a

vocational community, even though this model alone cannot explain how apprentices develop vocational competence in workplaces where technology is continuously changing.

Building on Lave and Wenger's earlier concept (1991) Wenger presents human activity and competence development as a duality of participation and reification (1998, p. 62). While participation is local and refers to the interaction within a purposive community, reification is global and refers to representation of practice as tools and documents. Also, computer software, web sites and instruction videos are kinds of reification, within which professional knowledge is embedded. Thus, competence development in the workplace must be analysed as a combination of participation in the local practice and the use of global knowledge sources. A large part of the reification involved in work practice in a digital workplace is global; however, this reification must be accommodated to the local practice and specific work tasks (p. 60). The right balance between participation and reification is essential for the development of the local practice, and for an enterprise to be a 'learning community' (p. 214).

The development of technology changes the activity in vocations, and the competence the tradespersons have to develop (Säljö, 2001). For example, the introduction of a new desktop publishing software in an enterprise changes the nature of the activity and the competence requirements. Specific technology is developed by humans for particular purposes and holds the same possibilities and limitations, regardless of who is using it (Leonardi, 2010). When using professional photo editing software like Photoshop, the user can choose a variety of different functions. While some functions are essential for the media graphics artist, others are essential for the photographer or the illustrator. Thus, the technology in use will differ between vocations and local practices, and technology becomes useful through purposeful human interaction (Orlikowski, 2000, 2007).

The study is also inspired by other scholars who regard vocational competence as holistic and multidimensional (Billett, 2001; Dreyfus & Dreyfus, 1988; Schön, 1995). These scholars regard vocational competence as an integration of practical skills, theoretical knowledge, embodied knowledge, tacit dimensions and social competencies such as accountability towards customers.

In order to develop vocational competence, the apprentices must be given the opportunity to engage in varied work tasks which gradually increase in difficulty and responsibility (Dreyfus & Dreyfus, 1988). Competence development also requires opportunities for both performance of routine tasks and using the competence in new situations (Billett, 2001; Dreyfus & Dreyfus, 1988). Expertise indicates that the practitioners should both be able to deal with known tasks and should have developed the competence necessary to meet new, challenging tasks. Furthermore, competence is understood as developed 'through a combination of engagement in work tasks of increasingly accountability, the close

guidance of other workers and experts, and the more indirect ongoing guidance by the settings' (Billett, 1999, p. 155).

It is common to say that a designer has 'an eye for it' or has a 'sense of aesthetics'. Her experience of whether the design is functional is more to do with what Ingold (2013) calls 'sensory awareness' than about whether she has used the principles for design in a prescribed way. An important part of the development of design competence is the development of this 'sensory awareness'. 'To have an eye for it' means that the professional sees in a special way and has developed 'skilled vision' (Grasseni, 2007). A community of practice or a professional community share aesthetic sensibilities and ways of seeing, and an important part of becoming a member of the professional community is to develop this community's specific skilled vision (p. 216). According to Grasseni, skilled vision is a result of 'education of attention, which requires repeated training and discernment' (p. 217).

Due to digitalisation, there are no strict boundaries between working with design and production in media enterprises. Thus, the apprentice can be given the opportunity to try out different solutions for design while she tries to find the different tools and panels in the software. 'The ongoing guidance by the settings' (Billett, 1999, p. 155) can happen when the apprentice tries out different solutions and sees what happens (Ingold, 2013, p. 7). Schön says that the 'situation talks back' and the practitioner engages in 'a conversation with the situation' as she 'reflects in action' on different solutions for the design (1995, p. 79). In this process, the apprentice can also reflect with the instructor or other colleagues through 'reflective conversations' (Schön, 1995).

The theories presented above throw light on how apprentices can develop vocational competence through active participation in authentic and varied work tasks of gradually increasing difficulty, and by being given room for reflection. The theories, however, do not sufficiently explain the consequences of continuously changing technology for the development of vocational competence. Earlier mentioned concepts such as hybrid and expansive learning environments, reification and digital confidence may contribute to this explanation.

Methods

To acquire an in-depth understanding of the research question, a qualitative design approach was used (Creswell, 2013). Seven apprentices in the media graphics programme were followed through their two-year apprenticeships. The sampling of media enterprises was purposeful (Patton, 2015), to ensure that the selected workplaces covered the apprentices' different training possibilities. Thus, the seven workplaces covered film production, traditional pre-press, advertising agencies and production both for print and digital platforms. To get a comprehensive understanding of the research question, the study included

apprentices, the instructors in the apprentices' workplaces, and instructors in the apprenticeship training office. The study follows the Norwegian guidelines regarding matters such as consent, confidentiality, information provided to participants, and the use of data (Norwegian Centre for Research Data, 2019).

Due to the study's longitudinal design, data were collected several times during the two-year apprenticeships, and the data collection methods were workplace observations (Creswell, 2013) and semi-structured interviews (Brinkmann & Kvale, 2015).

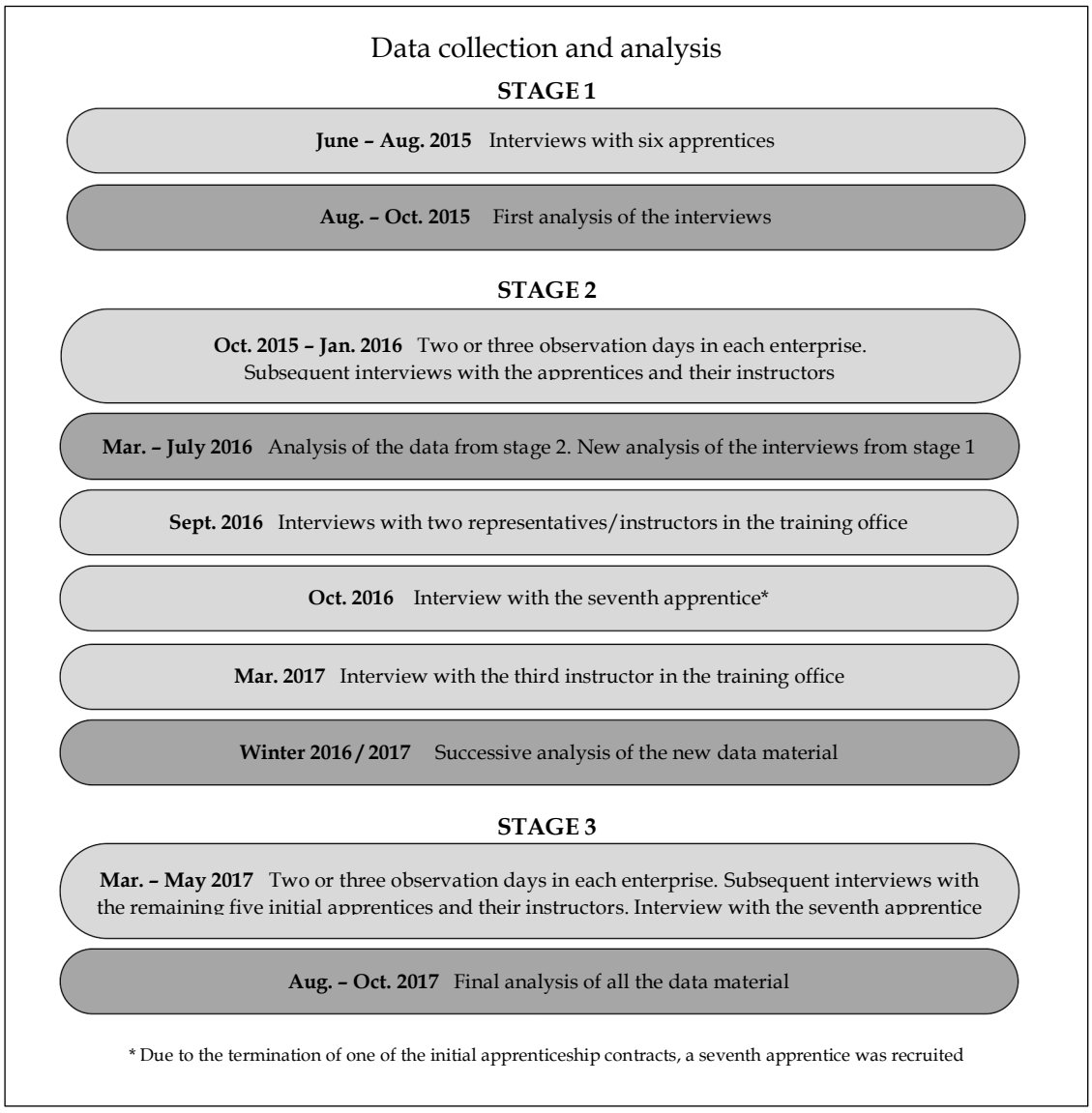


Figure 1. Overview of the process of collecting and analysing the data.

All the data collection was carried out by the author, and the interviews were recorded digitally and then fully transcribed. The combination of the methods made it possible both, through my own presence, to gain insight into the work and learning arrangements, and through in-depth interviews, to gain insight into the experiences and opinions of the different participants. The alternation between interviews and observations enhanced the possibility for continuous adjustment of the investigation's focus based on preliminary analysis of the results from one of the methods. Furthermore, triangulation of both methods and data was essential to enhance the study's validity (Merriam & Tisdell, 2016).

To cause as few disturbances as possible during the observation days, I chose the 'observer as participant' stance as an observer (Creswell, 2013, p. 167). However, I conducted conversations with the apprentices, instructors and other employees and asked questions about the work tasks when it was possible without disturbing their work. The theoretical framework and previous research informed the focus of the observations. Of specific interest was: the apprentices' role in the community in the workplace; variation in work tasks; reflection and development of skilled vision; autonomy, feedback and guidance; whether the environment was expansive or restrictive; and the use of global resources such as the internet and tutorials. I used an observational protocol during the observation days and included both descriptive and reflective notes (Creswell, 2013, p. 167).

Semi-structured interview guides were designed for all the interviews (Brinkmann & Kvale, 2015), and previous research in the field and the theoretical framework of the study were used as a framework for the interview guides. In addition to the themes from the observations, themes of specific interest were: competence requirements in the vocation; the local competence vs. the competence requirements; progression during the training period; the courses in the training office; the apprentices' digital competence.

The first cycle of data coding was carried out in accordance with the open coding principles (Merriam & Tisdell, 2016) by use of the software HyperRESEARCH. Emergent analysis of the data from the previous stage before conducting the next stage of data collection made it possible to follow up on things that seemed important on the observation days, and include preliminary results in the new interview guides. During analysis of the new data, the initial codes were changed to be more analytic and deductive, and the codes were organised into categories (Gibbs, 2018).

During the analysis, it became apparent that an essential part of the apprentices' competence development occurred through their participation in authentic vocational tasks in the enterprises. Furthermore, the participants emphasised design and use of technology as the two most significant aspects of vocational competence. Thus, these three main categories were identified: 1) Development of holistic vocational competence through active engagement in authentic

vocational tasks; 2) Development of stable competence in design; 3) Development of competence in the use of continuously changing technology.

The following sub-categories are used in the presentation of the results in the second main category: design competence as the basis for the vocation; development of skilled vision through reflection, feedback and discussions. The results in the third main category are presented in these sub-categories: use of the internet and apprentices' digital expertise; change in technology and development of enterprises; courses in the apprenticeship training office; change of the production; expansive vs. restrictive approaches towards apprenticeship. While defining the sub-categories, I used a combination of 'top down' (by using sub-categories from previous research and the theoretical framework of the study), and 'bottom up' (by developing analytic sub-categories from the data) approaches (LeCompte & Schensul, 2012). To ensure participant anonymity, the pronoun 'she' is used for all the participants.

Development of holistic vocational competence through active engagement in authentic vocational tasks

The results showed a strong understanding in the workplaces that apprentices' participation in the production work from the start of their apprenticeship period was essential for their development of vocational competence. Instructor 4 said: 'They take part in a production milieu where they work with real productions from day one.' Apprentice 7 spoke about how she developed vocational competence from taking part in the work:

> This is the way I learn best; to be given a production task. Then I try to perform it the way I think it should be and ask somebody if I have some questions. I have found out that I learn quite fast this way, faster than if somebody tells me about something, because then I will not remember it the same way as when I have done it myself.

There were no strict boundaries between the apprentices' work with design and production. They tried out different solutions for the design during the production work and developed competence in the use of technology and various types of software by taking part in the production. Instructor 4 said: 'At the beginning, most of the tasks are simple and the primary focus is on quality assurance.' Apprentice 7 said: 'I like to test out the different tools and possibilities in the software, and actually learn mostly by myself.' Apprentice 4 said: 'I can learn through trial and error because there is always an undo button.' When the apprentices could not discover how to carry out a specific function, they asked their colleagues. Apprentice 1 said: 'I might ask about the best way to perform non-destructive editing of a picture, or how large a file should be.'

It was from their own active engagement with the performance of the work tasks that the apprentices experienced development of vocational competence. Sometimes they received a brief instruction, but the main impression from the observation days was that the apprentices started by experimenting on their own, and consulted their colleagues if they found it necessary.

The results showed that there was usually a significant progression in the complexity of the apprentices' design work and that they were given the opportunity to work with various productions. Instructor 4 said: 'In fact, the apprentices are, except for the production manager and me, the persons that work with the most different productions.' Apprentice 7 confirmed that it was the same in her workplace: 'I feel that my learning really is given priority. Sometimes I am the one who gets a creative job rather than somebody else that might want it.'

In the daily work in the enterprises, design competence and competence in the use of technology were interwoven parts of a holistic vocational competence. However, during the analysis, these aspects of competence appeared to be significantly different. While principles for graphic design are quite stable, technology is continuously changing. Due to this distinction, the analysis also showed differences in how the apprentices developed these competences.

Development of stable competence in design

Design competence as the basis for the vocation

The instructors emphasised the importance of the development of design competence. Instructor 2 called this competence 'the basis for the vocation'. She continued: 'Good design is based on the existence of a framework, and principles and concepts for good design do not change […] you have to work according to the traditions as you follow the trends'. Even if graphic design changes and develops according to different trends, the basic principles for design were considered stable. As Instructor 4 said: 'principles for composition will never change'. It was also acknowledged that it takes a long time to become proficient. Instructor 2 said: 'A part of learning design is connected to psychology, to understand how different people respond to colour or typography […] and you really have to work a while to understand this relationship.'

Development of skilled vision through reflection, feedback and discussions

I saw many examples of how the apprentices tried out different solutions for the design during the production work. Apprentice 1 was tasked with making an advertisement for sports equipment. She used her vision and feeling for design while continually making adjustments and trying different solutions concerning both the placement and sizes of the various elements. Later she explained how she reflected during the process:

> It is about putting it all together in a way that results in less space between the different clothes and shoes and so forth. At the same time there should be some space that makes it look like there is a certain flow […] I have to think about how big the socks should be compared to a sweater and a pair of trousers. You see, the trousers are long while the sweater is more quadratic in form, and I have to find a solution that makes it all fit together.

The participants in the study used different expressions to describe design competence. Instructor 1 called it 'see it with your eye', while others spoke about 'understanding' or 'feeling'. During the process of trying out different solutions for design, the apprentices could ask some of their colleagues for advice or for their opinions. They also asked for others' opinions when they had made a finished draft. The apprentices said that listening to their colleagues' different opinions about design was a part of their competence development. Apprentice 4 said:

> I have experienced that when I ask a colleague for her opinion, then the others hear what we say, and then suddenly we have a kind of briefing for the whole group. And this is rather good, I think, because the one you asked has her opinion, and then somebody else says: No, I think it will be better this way. Then I understand that there are different opinions regardless of how long you have worked in the trade, and that design is not about right or wrong.

Competence development in design is not concerned with what is right or wrong but with developing a feeling or understanding of why specific solutions might be more suitable than others. The apprentices experienced that feedback from colleagues contributed to their development of a better understanding of design. Apprentice 1 said: 'It might concern the sizes of the different elements, and then it doesn't take much before I understand why small adjustments should be made'. Apprentice 2 said:

> I find that I learn more from this feedback that is professionally reasoned than I do from the feedback from the customers. They usually do not see things the same way, and may just say: I do not like it this way.

Summary

To sum up, the results showed that the apprentices developed design competence by taking part in the everyday production tasks in the community of practice in their workplaces. There was a high vocational competence in design in the workplaces; a competence commonly understood as developed through many years of work in the trade. The apprentices performed independent design tasks and developed competence as they tried out different solutions, using feedback from colleagues, and discussions about design as ways of sharing ideas and developing understanding for design.

Development of competence in the use of continuously changing technology

While design competence was understood as the basis for the vocation, competence in the use of technology was understood as necessary for the actual performance of the design. Instructor 2 said: 'It should not be lack of competence in how to use technology that limits the possibility to be creative.'

Use of the internet and apprentices' digital expertise

Due to continuous changes in technology, the apprentices sometimes encountered tasks that nobody in the workplace knew how to carry out. Both the apprentices and the instructors pointed to the internet as an important resource for finding solutions. Apprentice 4 said: 'It is rather easy to make searches on the internet when you have a specific problem. Then you might find a YouTube video showing how you perform the task.' Apprentice 2 said that an essential part of the competence development was to understand which websites were professional and trustworthy.

> There are of course the sites from the software providers, where there are forums for discussions and questions are answered by professionals. Then there is YouTube, and after you have done some searching, you know what seems trustworthy, and what seems not so professional.

Several of the instructors pointed to the apprentices' digital expertise as a competence they benefitted from in the enterprises. Instructor 6 said: 'Young people already have a lot of digital competence; they have grown up with PCs, with computer games, they have a totally different understanding. They are what I would call unafraid.' Being unafraid is understood for example as not being afraid of trying out possible solutions for solving tasks when they work with various types of software. Apprentice 3 experienced that there was a difference between her and her elder colleagues concerning digital competence: 'There are some things I can do that they cannot because they have not grown up with technology the same way that I have.' Some of the apprentices drew on software competence they had developed on their own by using the software as a hobby. Apprentice 6 explained how she had learned to use specific software for 3D modelling this way: 'Actually, I am self-taught. I have learned by watching YouTube videos. I had the opportunity to use it in some of my school assignments, but it was not a part of the education, and nobody has taught me about the software.'

Change in technology and development of enterprises

The instructors considered the changes in technology as the driving force for the changes in competence requirements in the enterprises. However, it was regarded as a challenge to find the time necessary to develop the required

competence. Instructor 1 said: 'There are new updates in the software that provide the opportunity to work more efficiently, but we might not know about them'. Apprentice 7 pointed to the internet as a source for joint competence development in the workplace by explaining how colleagues tried to find the solution together: 'Sometimes nobody knows the answer, and then we conduct searches on Google or YouTube, and then we often find the answer quickly.' This answer was then shared and discussed among the colleagues.

In some of the workplaces, there were regular in-house vocational development courses as a way of improving specific expertise and staying updated. Instructor 6 said that these in-house courses were a way of sharing expertise in the workplace. 'Some are real racers in InDesign regarding how to work efficiently, and we try to benefit from their expertise by using them as teachers on the courses. The apprentices always take part in these courses.'

Courses in the apprenticeship training office

During their apprenticeship period, the apprentices attended several courses in the apprenticeship training office as part of their formalised training. Instructor 9 in the apprenticeship training office said that they planned the courses in accordance with their experiences of the requirements in the enterprises. She said: 'We set up the courses to match what they are first exposed to in the enterprises, so we start with InDesign and typography, and we build on that.' She also explained that they aimed to ensure that the courses matched the curriculum for the apprenticeship period, but also that they covered

> … things such as digital advertising, social media, and so forth, things that will not be assessed when they sit for the journeyman's examination. We think that they should know what is going on in the trade to become proficient tradespersons.

When Instructor 10 talked about how she organised the course activities, she emphasised that the apprentices should develop competence in how to use the software in different situations and for various tasks, rather than follow specific instructions for a set task.: 'I seldom show them something that they will repeat. I show them how things can be done because I want them to understand the functionality of the software. Afterwards they must use the same functions for a different work task.'

Especially due to the rapid changes in the software, the instructors in the workplaces pointed to apprentices attending these courses as a resource for the entire enterprise. Instructor 2 said: 'When they come back from the courses, they usually have something new to contribute. We always tend to have a little briefing about what they have learned. Do we already know it, or is there something they can teach us?' Apprentice 2 said that she enjoyed teaching her instructor.

> It is a long time since she attended courses in software, and when we sit together working, I say: You know that there is a short command for this function, or that

> you can carry out this operation differently? And she is very grateful and is really open to getting such input. And that is fun, to be able to teach your teacher something!

The results also showed how apprentices could take on the role of instructors for their co-workers.

Change of the production

In the last stage of the study, it became apparent that in two of the workplaces changes were made in the product and services due to the apprentices' competence development. In one workplace, there was a change from working with printed material to 'more involvement in the development of websites and web advertising, and the advantage is that we do not need to buy this service from elsewhere anymore' (Instructor 2). Apprentice 2 spoke about the changes this way:

> There is more web production now, and the reason is that we have taken the initiative, and said we were willing to try it out. We have found out how to carry out the production, and we have agreed to take on this kind of work.

The 'we' in this context refers to her, the instructor and one co-worker. It seemed, however, that Apprentice 2 underplayed her role in these changes because Instructor 2 said:

> The reason we now produce more for the web is that the apprentice is interested in learning new production methods. She has had to learn this on her own, either by attending courses in the apprenticeship training office or by finding her way here in the workplace. We would like her to use the time necessary to learn the methods, and then we can learn from her.

According to Instructor 2, the apprentice was seen as a resource in the development of production, and also for the competence development of the community in the department. In the other workplace, the apprentice was given the responsibility for digital 3D modelling of designs for exhibition stands.

> She was one of the first apprentices to be more focused on digital than on paper-based design, and she had made 3D design earlier. She had the software on her personal computer, and we decided that we should try it out. We gave her the opportunity to make a 3D model for a small exhibition stand. And then she got it right away, and the model turned out to be really good, and it has snowballed from there. (Instructor 6)

Until it was discovered that the apprentice had this competence, the 3D modelling services were bought from another company, since no one in the enterprise had the necessary software competency. Instructor 6 continued:

> We have recently purchased new 3D software that the apprentice is testing out. There is a need for more of us to learn this software, and this is something we actually have requested for some time now, […] but it has been challenging to find the time to be able to sit down and learn the software.

This quote also points to the contradiction that was experienced in the workplaces between production requirements and the opportunities for the employees to update their competence.

Expansive vs restrictive approaches to apprenticeship

In most of the workplaces in the study, the apprentices were given the opportunity to develop competence in multiple settings, and their competence development was given priority. An example is apprentice 6, who was given the opportunity to work with 3D modelling due to the need for the enterprise to have qualified staff. However, Instructor 6 also emphasised that this opportunity was important for the apprentice's competence development.

> For her, it is important that she is allowed to continue on this track, that we do not stop her, even if she is within a department that mainly produces material for print. […] because competence in digital production is, and will be, very important.

Furthermore, their digital competence was acknowledged, and considered as a resource for updating the way of working with the software in the enterprises. However, in one of the workplaces, Apprentice 1 did not experience the same open-mindedness regarding change to the way of working.

> There are certain details regarding, for example, the use of templates, and I have said, maybe we can do this another way, or I have learned another way in a course. But they do not want to do it that way; they want to do it the way we do it here.

In another workplace, the main part of the apprentice's job was to operate the digital printing machine, something not in accordance with the competence aims in the curriculum for the apprenticeship training period. Apprentice 5 said that she felt she was taken advantage of because the wages she had as an apprentice were lower than the other workers'. Furthermore, she experienced that she was not given the opportunity to take part in work tasks where she had the opportunity to develop the competence required to sit for the journeyman's examination. The solution to this situation was that the apprentice decided she wanted to terminate the apprenticeship contract. These two examples showed how restrictive approaches to apprenticeship are incongruent both with the apprentices' competence development and also with the development of the enterprise.

Summary

To sum up, the results showed that due to the continuous changes in technology, the apprentices also developed vocational competence from other sources than the community of practice in the workplaces. From the courses given by the apprenticeship training office they developed competence in efficient use of various types of software. Furthermore, they also used learning resources found on the internet, mainly when the way of dealing with the work task was not yet known

in the workplace. In some of the workplaces, the competence development of the apprentices became a resource for the other colleagues and for development of the enterprise.

Discussion

The results show that theories of apprenticeship learning in craft societies are still useful for explaining some aspects of competence development in modern workplaces. Participation in authentic vocational tasks in the enterprises was essential for the development of competence in design and the use of technology as a whole (Lave & Wenger, 1991). Even if the technology is continuously changing, this part of vocational competence also has some basic aspects that are learned through taking part in the community of practice in the workplaces.

In a vocation with rapid changes in competence requirements, competence in design is emphasised as a core competence. Even if graphic design changes according to trends in society, principles for typography, colour contrast and composition do not change. Moreover, changes in design trends happen far more slowly than changes in technology.

In order to develop design competence, the apprentices had to develop 'skilled vision' by training their aesthetic sensibility (Grasseni, 2007). They developed this competence by experimenting with different solutions for the design, by reflection (Schön, 1995), and by receiving guidance from their colleagues (Pedersen & Elmholdt, 2008). They were guided by co-workers with long experience in the trade and found that they learned from tradespersons that shared a specific way of seeing (Grasseni, 2007), and not from customers that did not see and talk about design in the same way. The results point to quite a linear journey from novice to expert in how the apprentices developed vocational design competence (Dreyfus & Dreyfus, 1988).

However, the study also shows the limitations in Lave and Wenger's theory regarding how to explain the whole picture of competence development in contemporary workplaces. Due to the continuously changing technology, the apprentices sometimes had to deal with work tasks for which the solutions were not known in the workplace. Schön's theory (1995), which was used to describe how the apprentices reflected on design solutions when the way of using the technology was known, does not explain what is going on when the apprentices face the unknown.

The primary information source in such cases was the internet, and the use of computers as the primary tool in the trade gave easy access to this source of information (Elmholdt, 2001). However, the apprentices had to relate the information they found, for example in an instruction video on the internet, to the specific work task they were dealing with (Fenwick & Nerland, 2014). Thus, the apprentices' development of vocational competence was situated and related to

challenges in concrete situations. In such cases, the apprentices' digital competence and previous experience in the use of technology were essential (Forkosh Baruch & Erstad, 2018). Furthermore, it was important that they were given the opportunity to autonomously make plans and decisions regarding their work, and also experienced support from their colleagues (Messmann & Mulder, 2015). However, the results do not fully explain how the apprentices developed the necessary critical approach towards the different web resources available.

Due to the apprentices' attendance on courses in the apprenticeship training office and their previous experience with the use of technology at school and for leisure, they were sometimes the experts in the workplaces regarding how to use the technology (Fuller & Unwin, 2004). The apprentices took on the role of teachers in the workplace, a role that is traditionally associated with the experienced participants in the community of practice (Lave & Wenger, 1991). The results showed a new relationship between the apprentice and the more experienced colleagues, and that the young apprentices were respected for their expertise. This new relationship challenges the role of the novice and the expert in the workplace. Furthermore, the results showed that the apprentices do not proceed on a linear journey from novice to expert in all the aspects of vocational competence (Fuller & Unwin, 2004). Moreover, it seems that these apprentices, due to the continuously changing technology, received complex work tasks and became 'full participants' earlier than both the Dreyfus model (1988) and Lave and Wenger (1991) describe.

The results suggest that reification and participation are complementary, and show the necessity for a proportional relationship between them to compensate for their respective shortcomings (Wenger, 1998). The workplace where there was resistance towards a change of the use of software based on the apprentice's suggestions, is an example of how participation in established, but not always updated practices prevailed. As a result, the co-workers in the enterprise missed an opportunity to change the practice and thus become a 'learning community' (p. 214).

In other workplaces, the apprentice's competence development and the colleagues' acknowledgement of their expertise, resulted in changes in practice, and competence development for the community (Wenger, 1998). These workplaces show similarities to 'expansive approaches' to apprenticeship (Fuller & Unwin, 2003). The apprentices were acknowledged as learners and became co-designers of their own VET (Fuller & Unwin, 2003; Nore, 2015). They were given the opportunity to develop vocational competence by a combination of participation in the everyday tasks in the workplaces, participation in courses, and by use of sources on the internet. The apprentices brought in new, updated competence in how to use the software, and thus also became co-constructors of the competence in the community of practice.

The results also point to engagement among the tradespersons in the enterprises regarding updating their own competence through cooperation and in-house courses. These results show that workplaces go beyond the traditional communities of practice where there is no distinction between learning and participating (Lave & Wenger, 1991). These workplaces bear a resemblance to 'learning communities' (Wenger, 1998) and show how participation in the local practice is insufficient for updating vocational competence.

Lave and Wenger's theory can be criticised for underplaying power relations and contradictions between production requirements and considerations about the apprentices' opportunities for competence development (e.g. Fuller, 2007, p. 20). In the use of the term 'community', the understanding of harmony and common interests among the different groups in a workplace is implicit. This study is also vulnerable to the same criticism. Even if there is an example of termination of an apprenticeship contract, the conditions in the workplaces appear harmonious with few conflicts. One possible reason is that I did not have enough focus on power relationships and contradictions during observations and interviews. Another reason is likely to be the instructors' attitude towards apprenticeship. Most of the instructors spoke highly about apprenticeship as a way for young people to develop the vocational competence required in the future job market. Furthermore, they regarded the enterprises taking on apprentices both as crucial for the development of the trade and as fulfilling a social responsibility. These factors can explain the results of the study; most of the enterprises offered an 'expansive approach' to apprenticeship (Fuller & Unwin, 2003).

Conclusion

This study has shown examples of how young people, through apprenticeship, can develop the vocational competence necessary to meet the challenging competence requirements in contemporary workplaces. The study attempted to answer the following research question: How do young apprentices in the media graphics programme in Norway develop vocational competence in workplaces where technology is continuously changing? The results showed that the apprentices developed vocational competence in multiple settings and from different sources. Engagement in authentic vocational tasks in the workplaces was still essential for their competence development. However, due to the continuously changing technology, this engagement was insufficient for the development of the required vocational competence. Thus, the apprentices combined participation in the community of practice in the workplace (Lave & Wenger, 1991), participating in courses in the apprenticeship training office, and use of sources on the internet (Nore, 2015).

The courses in the apprenticeship training office were essential for the media graphics apprentices' competence development. The training office provided

systematic education that reinforced the apprentices' ability to meet the continuously changing technology in the workplaces. The combination of production work in the enterprises and regular courses seems to be a good model for facilitating apprentices' competence development. The results showed that the training offices could be a crucial factor in the Norwegian VET system, by linking formalised school-based education and workplace learning. Further investigations of the training offices in different trades could represent an essential contribution to knowledge about possibilities for developing VET systems according to contemporary requirements.

Furthermore, the study has shown that the apprentices can take part in and be important for the construction of competence in workplaces. Thus, it is essential to acknowledge the apprentices' expertise and their possible role in the development of the workplace. The study points to the innovative potential of apprenticeship if an 'expansive approach' is adopted in the workplace (Fuller & Unwin, 2003). Thus, apprenticeship can continue to be an essential way for young people to develop vocational competence in a world of work where technology is continuously changing. This study has shown the complexity of vocational competence development in one specific trade in the Norwegian VET system. In order to continually develop VET to meet the changing competence requirements in modern workplaces, there is a need for further in-depth studies that investigate different trades and VET systems.

Note on contributor

Nina Aakernes is a PhD candidate at the Department of Vocational Teacher Education at OsloMet – Oslo Metropolitan University, Norway. Her research interests focus on vocational learning in school and through apprenticeship, and curriculum development in vocational education.

References

Aakernes, N. (2018). From school to work: Coherence between learning in school and learning in workplaces for apprentices in the Media graphics programme in Norway. *Nordic Journal of Vocational Education and Training, 8*(1), 76–97.

Aarkrog, V. (2005). Learning in the workplace and the significance of school-based education: A study of learning in a Danish vocational education and training programme. *International Journal of Lifelong Education, 24*(2), 137–147.

Billett, S. (1999). Guided learning at work. In D. Boud, & J. Garrick (Eds.), *Understanding learning at work* (pp. 151–164). London: Routledge.

Billett, S. (2001). *Learning in the workplace: Strategies for effective practice*. Crows Nest, Australia: Allen & Unwin.

Billett, S. (2010). Learning through practice. In S. Billett (Ed.), *Learning through practice: Models, traditions, orientations and approaches* (pp. 1–20). Dordrecht: Springer.

Billett, S. (2013). Learning through practice: Beyond informal and towards a framework for learning through practice. In K. Ananiadou (Ed.), *Revisiting global trends in TVET: Reflections on theory and practice* (pp. 123–163). Bonn: UNESCO-UNEVOC International Centre for Technical and Vocational Education and Training. Retrieved 20. February, 2019, from https://unevoc.unesco.org/fileadmin/up/2013_epub_revisiting_global_trends_in_tvet_book.pdf

Bond, E. (2014). *Childhood, mobile technologies and everyday experiences: Changing technologies = changing childhoods?* London: Palgrave Macmillan.

Brinkmann, S., & Kvale, S. (2015). *InterViews: Learning the craft of qualitative research interviewing* (3 ed.). Thousand Oaks, Calif: Sage.

Creswell, J.W. (2013). *Qualitative inquiry & research design: Choosing among five approaches* (3 ed.). Los Angeles: Sage.

Dreyfus, H.L. & Dreyfus, S.E. (1988). *Mind over machine: The power of human intuition and expertise in the era of the computer*. New York: Free Press.

Elmholdt, C. (2001). *Læring som social praksis på arbejdsplassen* [Learning as social practice in the workplace] (Doctoral dissertation). Aarhus: Aarhus Universitet.

Erstad, O., & Silseth, K. (2019). Futuremaking and digital engagement: From everyday interests to educational trajectories. *Mind, Culture, and Activity, 26*(4), 309–322.

Fenwick, T., & Nerland, M. (2014). Sociomaterial professional knowing, work arrangements and responsibility: New times, new concepts? In T. Fenwick, & M. Nerland (Eds.), *Reconceptualising professional learning: Sociomaterial knowledges, practices and responsibilities* (pp. 1–8). London: Routledge.

Forkosh Baruch, A., & Erstad, O. (2018). Upbringing in a digital world: Opportunities and possibilities. *Learning mathematics, science and the arts in the context of digital technologies, 23*(3), 377–390.

Fuller, A. (2007). Critiquing theories of learning and communities of practice. In J. Hughes, N. Jewson, & L. Unwin (Eds.), *Communities of practice: Critical perspectives* (pp. 17–29). London: Routledge.

Fuller, A., Hodkinson, H., Hodkinson, P., & Unwin, L. (2005). Learning as peripheral participation in communities of practice: A reassessment of key concepts in workplace learning. *British Educational Research Journal, 31*(1), 49–68.

Fuller, A., & Unwin, L. (2003). Learning as apprentices in the contemporary UK workplace: Creating and managing expansive and restrictive participation. *Journal of Education and Work, 16*(4), 407–426.

Fuller, A., & Unwin, L. (2004). Young people as teachers and learners in the workplace: Challenging the novice–expert dichotomy. *International Journal of Training & Development, 8*(1), 32–42.

Fuller, A., & Unwin, L. (2011). Apprenticeship as an evolving model of learning. *Journal of Vocational Education & Training, 63*(3), 261–266.

Gibbs, G. (2018). *Analyzing qualitative data* (2 ed.). London: SAGE.

Grasseni, C. (2007). Communities of practice and forms of life: Towards a rehabilitation of vision? In M. Harris (Ed.), *Ways of knowing: Anthropological approaches to crafting experience and knowledge* (pp. 209–221). New York: Berghahn.

Hughes, J., Jewson, N., & Unwin, L. (2007). Conclusion: Further developments and unresolved issues. In J. Hughes, N. Jewson, & L. Unwin (Eds.), *Communities of practice: Critical perspectives* (pp. 171–177). London: Routledge.

Ingold, T. (2013). *Making: Anthropology, archaeology, art and architecture*. London: Routledge.

Koenen, A-K., Dochy, F., & Berghmans, I. (2015). A phenomenographic analysis of the implementation of competence-based education in higher education. *Teaching and Teacher Education, 50*, 1–12.

Lahn, L.C., & Nore, H. (2018). ePortfolios as hybrid learning arenas in vocational education and training. In S. Choy, G-B. Wärvik, & V. Lindberg (Eds.), *Integration of vocational education and training experiences: Purposes, practices and principles* (pp. 207–226). Singapore: Springer.

Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge: Cambridge University Press.

LeCompte, M.D., & Schensul, J.J. (2012). *Analysis and interpretation of ethnographic data: A mixed methods approach* (2 ed.). Lanham: AltaMira Press.

Lensjø, M. (2016). *Læring og opplæring i rørleggerfaget: En etnografisk studie av fag- og yrkesopplæring i opplæringskontor og på byggeplass* [Learning and training in plumbing: An ethnographic study of vocational education in apprenticeship training agency and on construction site] (Doctoral dissertation). Roskilde: Roskilde Universitet.

Leonardi, P.M. (2010). Digital materiality? How artifacts without matter, matter. *First Monday, 15*(6).

Merriam, S.B., & Tisdell, E.J. (2016). *Qualitative research: A guide to design and implementation* (4 ed.). San Francisco: Jossey-Bass.

Messmann, G., & Mulder, R.H. (2015). Conditions for apprentices' learning activities at work. *Journal of Vocational Education and Training, 67*(4), 578–596.

Moreno Herrera, L. (2016). Yrkesutbildningsutmaningar i nya tider: Vilken väg ska vi ta? [Vocational education and training in new times: What is the best way forward?]. *Nordic Journal of Vocational Education and Training, 6*(2), 66–83.

Nielsen, K., & Kvale, S. (2006). The workplace: A landscape of learning. In E. Antonacopoulou (Ed.), *Learning, working and living: Mapping the terrain of working life learning* (pp. 119–135). Basingstoke: Palgrave Macmillan.

Nielsen, K., & Pedersen, L.T. (2011). Apprenticeship rehabilitated in a postmodern world? *Journal of Vocational Education & Training, 63*(4), 563–573.

Nore, H. (2015). Re-contextualizing vocational didactics in Norwegian vocational education and training. *International Journal for Research in Vocational Education and Training, 2*(3), 182–194.

Norwegian Centre for Research Data. (2019). *Information and consent*. Retrieved 25. February, 2019, from http://www.nsd.uib.no/personvernombud/en/help/information_consent/

Norwegian Directorate for Education and Training. (2008). Curriculum for Media Graphics VG3 / in-service training at a training establishment (MGR3-01). Retrieved 17. January, 2018, from https://www.udir.no/kl06/MGR3-01?lplang=http://data.udir.no/kl06/eng

Norwegian Directorate for Education and Training. (2016). Norwegian vocational education and training (VET). Retrieved 3. August, 2016, from https://www.udir.no/in-english/norwegian-vocational-education-and-training/

NOU 2018:2. (2018). *Fremtidige kompetansebehov I: Kunnskapsgrunnlaget* [Future competence needs I: Platform of knoweldge]. Retrieved 5. January, 2019, from https://www.regjeringen.no/no/dokumenter/nou-2018-2/id2588070/

Opplæringssenteret for visuell kommunikasjon. Retrieved 4. October, 2019, from https://opplaringssenteret.no/os/

Orlikowski, W.J. (2000). Using technology and constituting structures: A practice lens for studying technology in organizations. *Organization Science, 11*(4), 404–428.

Orlikowski, W.J. (2007). Sociomaterial practices: Exploring technology at work. *Organization Studies, 28*(9), 1435–1448.

Patton, M.Q. (2015). *Qualitative research & evaluation methods: Integrating theory and practice* (4 ed.). Los Angeles: Sage.

Pedersen, L.T., & Elmholdt, C.W. (2008). Assessment in practice: An inspiration from apprenticeship. *Scandinavian Journal of Educational Research, 52(1)*, 97–116.

Poortman, C.L., Illeris, K., & Nieuwenhuis, L. (2011). Apprenticeship: From learning theory to practice. *Journal of Vocational Education & Training, 63*(3), 267–287.

Schön, D.A. (1995). *The reflective practitioner: How professionals think in action*. Aldershot: Arena.

Säljö, R. (2001). *Læring i praksis: Et sosiokulturelt perspektiv*. Oslo: Cappelen akademisk.

Wenger, E. (1998). *Communities of practice: Learning, meaning, and identity*. Cambridge: Cambridge University Press.

Nordic Journal of Vocational Education and Training, 2020

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

Ann-Britt Enochsson, Nina Kilbrink, Annelie Andersén & Annica Ådefors

Karlstad University, Sweden (ann-britt.enochsson@kau.se)

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

NJVET, Vol. 10, No. 1, 43–64 Peer-reviewed article doi: 10.3384/njvet.2242-458X.2010143

Hosted by Linköping University Electronic Press

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.

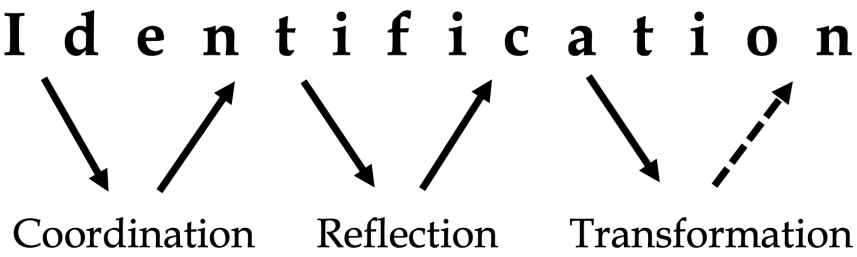


Figure 1. Iterative model of the learning mechanisms showing a development along a timeline.

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 *legitimating 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 legitimating 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.

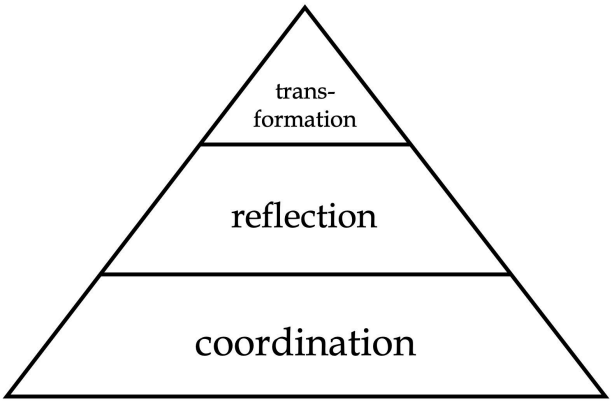


Figure 2. Hierarchical model of the learning mechanisms showing how the learning mechanisms build on one another.

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, 3003; 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.

Acknowledgement

This study was funded by Faculty Board of Teacher Education at Karlstad University.

Notes on contributors

Ann-Britt Enochsson, Professor in Educational work at Karlstad University. Enochsson has a long record of research on digital technology in educational settings in general, and also specifically on communication with technology, where the latest publication was in *Education and Information Technologies*. Regarding vocational education and technology, she has recently had an article accepted together with Kilbrink and Söderlind in *Zeitschrift für Berufs- und Wirtschaftspädagogik*, and she also has a number of conference presentations in the area.

Nina Kilbrink, Associate Professor in Educational work at Karlstad University. Kilbrink had her PhD 2013 on a thesis concerning the connection between school and workplace learning in technical vocational education (Lära för framtiden: Transfer i teknisk yrkesutbildning). Her research interests concern for example vocational learning; ICT in education; school workplace relationships, professional learning, learning studies and narrative research. She has recently been publishing in for example *Journal of Education and Work, Journal of Vocational Education & Training* and *Scandinavian Journal of Educational Research.*

Annelie Andersén, Assistant Professor in Educational work at Karlstad University. Her research focuses on culture and (social) identity in education and at work, as well as teachers' role in learning in vocational and higher education. Her most recent work has been accepted in *Employee Relations* and *Nordic Journal of Vocational Education and Training*.

Annica Ådefors, Lecturer in Educational work at Karlstad University. Ådefors has been working as a qualified vocational teacher since 2009 and has worked as a lecturer in vocational teacher education at Karlstad University since 2014. She has also co-authored conference papers for *NordYrk 2018 Conference* in Oslo and for *EARLI SIG Conference 2018* in Geneva.

References

Aarkrog, V. (2005). Learning in the workplace and the significance of school-based education: A study of learning in a Danish vocational education and training programme. *International Journal of Lifelong Education, 24*(2), 137–147.

Akkerman, S., & Bakker, A. (2011). Boundary crossing and boundary objects. *Review of Educational Research 81*(2), 132–169.

Akkerman, S., & Bakker, A. (2012). Crossing boundaries between school and work during apprenticeships. *Vocations and Learning, 5*(2), 153–173.

Al-Ali, S., & Middleton, H. (2004) Technology transfer: The interaction of vocational education and industry, the college of technological studies, Kuwait. *Australian Vocational Education Review, 11*(2), 19–28.

Andersson, P. (2019*). Att utbilda nästa generation i yrket: En kunskapsöversikt om och för yrkeslärare* [Training the next generation of the vocation: A knowledge review about and for VET teachers] (Forskning för skolan). Stockholm: The Swedish National Agency of Education.

Asghari, H. (2014). *Från uppväxt till lärargärning: En livsberättelsestudie med åtta yrkeslärare på industritekniska programmet* [From growing up to the teacher act: A life story study with eight vocational teachers in the industrial-technology programme] (Karlstad University Studies 2014:53). Doctoral dissertation. Karlstad, SE: Karlstad University.

Baartman, L.K.J., & de Bruijn, E. (2011). Integrating knowledge, skills and attitudes: Conceptualizing learning processes towards vocational competence. *Educational Research Review, 6,* 125–134.

Baartman, L., Gravemeijer, K., & de Bruijn, E. (2013). Nurses' and technicians' communication and learning at the boundary. In H. Middleton, & L. Baartman (Eds.), *Transfer, transitions and transformations of learning* (pp. 49–68). Rotterdam, NL: Sense Publishers.

Baartman, L., Kilbrink, N., & de Bruijn, E. (2018). VET students' integration of knowledge engaged with in school-based and workplace-based learning environments in the Netherlands. *Journal of Education and Work, 31*(2), 204–217.

Berg Christoffersson, G. (2015). *Digital dialog som redskap för utveckling av yrkeskunnande: En studie vid APL på gymnasieskolans vård- och omsorgsprogram* [Digital dialogue as a tool for development of vocational knowing: A study during workplace based learning in a health and social care program in upper secondary school]. Licentiate thesis. Stockholm, SE: Stockholm University.

Berglund, I., & Henning Loeb, I. (2013). Renaissance or a backward step? Disparities and tensions in two new Swedish pathways in VET. *International Journal of Training Research*, *11*(2), 135–149.

Berner B. (2010) Crossing boundaries and maintaining differences between school and industry: Forms of boundary-work in Swedish vocational education. *Journal of Education and Work 23*(1), 27–42.

Bjurulf, V. (2012). "You'll just have to practice until you find your own way to do it!": A narrative study about how teaching is carried out in technical vocational education. *NorDiNa, 8*(1), 17–25.

Bound, H. (2011). Vocational education and training teacher professional development: Tensions and context. *Studies in Continuing Education, 33*(2), 107–119.

Bransford, J.D., & Schwartz, D.L. (1999). Rethinking transfer: A simple proposal with multiple implications. *Review of Research in Education, 24*(1), 61–100.

Cattaneo, A., & Aprea, C. (2018). Visual technologies to bridge the gap between school and workplace in vocational education. In D. Ifenthaler (Ed.), *Digital workplace learning: Bridging formal and informal learning with digital technologies* (pp. 251–270). Cham, CH: Springer.

Cattaneo, A., & Barabasch, A. (2017). Technologies in VET: Bridging learning between school and workplace – the "Erfahrraum Model". *bwp@* Berufs- und Wirtschaftspädagogik [online], 33, 1–17.

Choy, S., & Sappa, V. (2016). Australian stakeholders' conceptions of connecting vocational learning at TAFE and workplaces. *International Journal of Training Research, 14*(2), 88–103.

Clandinin, D.J., & Connelly, F.M. (2000). *Narrative inquiry: Experience and story in qualitative research*. San Francisco, CA: Jossey-Bass Publishers.

Cohen, L., Manion, L., & Morrison, K. (2000). *Research methods in education* (5th ed.). London, GB: Routledge.

Enochsson, A-B., & Rizza, C. (2009). *ICT in initial teacher training: Research review.* EDU Working Paper No 38. Paris, FR: OECD.

Eraut, M. (2004). Transfer of knowledge between education and workplace settings. In H. Rainbird, A. Fuller, & A. Munro (Eds.), *Workplace learning in context* (pp. 201–221). London, GB: Routledge.

Fives, H., & Gill, M.G. (2015). *International handbook of research on teachers' beliefs*. London, GB: Routledge.

Freeman, M. (2010). *Hindsight: The promise and peril of looking backward*. New York, NY: Oxford University Press.

Gulikers, J.T., Baartman, L.K., & Biemans, H.J. (2010). Facilitating evaluations in innovative, competence-based assessments: Creating understanding and involving multiple stakeholders. *Evaluation and Program Planning, 33*(2), 120–127.

Haelermans, C. (2017). *Digital tools in education: On usage, effects and the role of the teacher.* Stockholm, SE: SNS Förlag.

Hattie, J. (2012). *Visible learning for teachers.* New York, NY: Routledge.

Kilbrink, N. (2013). *Lära för framtiden: Transfer i teknisk yrkesutbildning* [Learning for the future: Transfer in technical vocational education] (Karlstad University studies, No. 2013:4). Doctoral dissertation. Karlstad, SE: Karlstad University.

Kilbrink, N., Bjurulf, V., Baartman, L., & de Bruijn, E. (2018). Transfer of learning in Swedish technical vocational education: Student experiences in the energy

and industry programmes. *Journal of Vocational Education & Training, 70*(3), 455–475.

Kilbrink, N., Bjurulf, V., Olin-Scheller, C., & Tengberg, M. (2014). Experiences of educational content in Swedish technical vocational education: Examples from the energy and industry programmes. *International Journal of Training Research, 12*(2), 122–131.

Kilbrink, N., Enochsson, A-B., & Söderlind, L. (in press). Digital technology as boundary objects: Teachers' experiences in Swedish vocational education. *Zeitschrift für Berufs- und Wirtschaftspädagogik*.

Kvale, S., & Brinkmann, S. (2009). *Den kvalitativa forskningsintervjun* [InterViews]. (S. Thorell, Trans., 2nd ed.). Lund, SE: Studentlitteratur.

Markowitsch, J., Luomi-Messerer, K., Becker, M., & Spöttl, G. (2008). Putting Dreyfus into action: The European credit transfer system. *European Industrial Training 32*(2/3), 171–186.

Motta, E., Cattaneo, A., & Gurtner, J-L. (2014). Mobile devices to bridge the gap in VET: Ease of use and usefulness as indicators for their acceptance. *Journal of Education and Training Studies, 2*(1), 165–179.

Nore, H. (2015). Re-contextualizing vocational didactics in Norwegian vocational education and training**.** *International Journal for Research in Vocational Education and Training, 2*(3), 182–194.

Polkinghorne, D. (1995). Narrative configuration in qualitative analysis. *International Journal of Qualitative Studies in Education*, *8*(1), 5–23.

Sappa, V., Choy, S., & Aprea, S. (2016). Stakeholders' conceptions of connecting learning at different sites in two national VET systems. *Journal of Vocational Education & Training, 68*(3), 283–301.

Schaap, H., Baartman, L., & de Bruijn, E. (2012). Students' learning processes during school-based learning and workplace learning in vocational education: A review. *Vocations and Learning, 5*(2), 99–117.

Schwendimann, B.A., de Wever, B., Hämäläinen, R., & Cattaneo, A.A.P. (2018). The state-of-the-art of collaborative technologies for initial vocational education: A systematic literature review. *International Journal for Research in Vocational Education and Training*, 5(1), 19–41.

Schwendimann, B., Cattaneo, A., Dehler Zufferey, J., Gurtner, J., Bétrancourt, M., & Dillenbourg, P. (2015). The 'Erfahrraum': A pedagogical model for designing educational technologies in dual vocational systems. *Journal of Vocational Education & Training, 67*(3), 367–396.

SFS 2010:2039. *Gymnasieförordning* [Upper secondary school ordinance]. Stockholm, SE: Ministry of Education.

Swedish National Agency of Education. (2016). *Det arbetsplatsförlagda lärandet på gymnasieskolans yrkesprogram: Nationell kartläggning och analys av apl-verksamheten utifrån yrkeslärarnas perspektiv* [Workplace based learning in upper secondary vocational education: A national survey based on a vocational teacher

perspective] (Rapport 437/2016). Stockholm: The Swedish National Agency of Education.

Swedish Schools Inspectorate [SI]. (2011). *Arbetsplatsförlagd utbildning i praktiken: En kvalitetsgranskning av gymnasieskolans yrkesförberedande utbildningar* [Workplace based learning in practice: A quality evaluation of upper secondary pre-vocational training] (Rapport 2011:2). Stockholm: The Swedish Schools Inspectorate.

Swedish Schools Inspectorate [SI]. (2013). *Fördjupad tillsyn på yrkesprogram* [In-depth evaluation in upper secondary vocational education]. Stockholm: The Swedish Schools Inspectorate.

Swedish Schools Inspectorate [SI]. (2014). *Undervisning på yrkesprogram* [Teaching in upper secondary vocational education] (Rapport 2014:5). Stockholm: The Swedish Schools Inspectorate.

Swedish Schools Inspectorate [SI]. (2016). *Samverkan för bättre arbetslivsanknytning: En kvalitetsgranskningsrapport om restaurang- och livsmedelsprogrammet och hantverksprogrammet* [Collaboration for better connection to working life: A quality evaluation report from the restaurant and food programme and the handicraft programme]. Stockholm: The Swedish Schools Inspectorate.

Swedish Schools Inspectorate [SI]. (2017). *Helhet i utbildningen på gymnasiets yrkesprogram* [A complete educational experience in upper secondary vocational education]. Stockholm: The Swedish Schools Inspectorate.

Tanggaard, L. (2007). Learning at trade vocational school and learning at work: Boundary crossing in apprentices' everyday life. *Journal of Education and Work, 20*(5), 453–466.

Tuomi-Gröhn, T., & Engeström, Y. (Eds.) (2003). *Between school and work: New perspectives on transfer and boundary-crossing*. Oxford, GB: Pergamon.

Tynjälä, P. (2009). Connectivity and transformation in work-related learning: Theoretical foundations. In M. Stenström, & P. Tynjälä (Eds.), *Towards integration of work and learning* (pp. 11–37). Dordrecht, NL: Springer.

Yin, R.K. (2014). *Case study research: Design and methods* (5th ed.). Thousand Oaks, CA: Sage.

Zitter, I., Hoeve, A., & de Bruijn, E. (2016). A design perspective on the school-work boundary: A hybrid curriculum model. *Vocations and Learning, 9*(1), 111–131.

Nordic Journal of Vocational Education and Training, 2020

Becoming a construction worker in the connected classroom: Opposing school work with smartphones as happy objects

Stig-Börje Asplund & Janne Kontio

Karlstad University, Sweden (stig-borje.asplund@kau.se)

Abstract

This article aims to fill a very specific and acute gap; in addition to the few studies on youth and digitalisation, smartphones and other mobile tools, it is very clear that the field of research concerning these issues in regards to vocational education and training is close to non-existent. By examining male Building and Construction programme students' collective use of smartphones in interaction during classes, this study contributes to increased knowledge about some of the challenges and possibilities that arise with the digitalisation of vocational education and training. The study uses new and innovative methods regarding how students' digital activities in the classroom could be captured and studied, and approaches video recorded data through the lens of Sara Ahmed's ideas of happy objects (2010), and the concept of community of practice (Wenger, 1998). The analyses show how the identity constructing processes that take shape when the students orient towards the smartphone as a happy object intersect with the students' future vocational identity as building and constructing workers, as well as explicating an anti-school culture.

Keywords: smartphone, vocational education, identity construction, masculinity

NJVET, Vol. 10, No. 1, 65–94 Peer-reviewed article doi: 10.3384/njvet.2242-458X.2010165

Hosted by Linköping University Electronic Press

Introduction

Participating in different activities in the everyday work, as well as the learning strategies that vocational students develop is important in their process in adapting occupation-specific norms and values, and for creating a vocational identity. Studies on vocational identity show that vocational students can adopt different strategies in their work in constructing a vocational identity. Within the studies of identity construction in male-dominated vocational education and training, the focus has largely been on problematic aspects of boys' and young males' identity construction (Rosvall, 2015). These studies have often been in line with Willis' (1977) classic study on a group of young English working-class males, where the development of a macho jargon and a counter culture towards school, teachers and (female) ambitious peers are predominant attributes in the male identity construction. From different theoretical perspectives, and with different methodological approaches, studies have to a large extent confirmed these attributes in boys' and young males' vocational identity construction, in and outside school (cf. Åberg & Hedlin, 2015; Berglund, 2009; Ferm, Persson Thunqvist, Svensson & Gustavsson, 2018).

In parallel with this, there has been a digital development in society at large, that in many ways has led to essential changes to the teaching and learning practices that take place in contemporary classrooms. Significant investments have been made by schools to introduce digital tools like laptops and tablets, with expectations that they will become an essential prerequisite for school development. However, the issue of smartphones in the classroom has shown to be significantly more controversial and has in the debate, primarily been seen as a cause of disturbance (Ott, 2017). In research, studies on smartphone presence and use in classrooms have, to a large extent, focused on the relations between banns on smartphones and students' school performance (Beland & Murphy, 2015) as well as smartphone usage and its impact on student learning (Asplund, Olin-Scheller & Tanner, 2018; Kuznekoff & Titsworth, 2013; Wei, Wang & Klausner, 2012). However, knowledge about the role of the smartphones in the classroom and the way in which they interact with teaching and other activities such as students' identity constructing processes, is still relatively limited, especially in regards to vocational education. One reason to this might be that it is difficult to capture not only the fact that the phones are used, but also when they are used, and what student's do when they use them (see Pascoe, 2012). One of the purposes of this study is to fill a very specific and acute gap; in addition to the few studies on youth and digitalisation, smartphones and other mobile tools, it is very clear that the field of research concerning these issues in regards to vocational education and training is close to non-existent (however, see Chua & Jamil, 2012; Shava, Chinyamurindi & Somdyala, 2016).

This article has a special focus on a Swedish male-dominated study programme in upper secondary school – the Building and Construction programme – and the use of smartphones in these classrooms. The results derive from a larger video-ethnographic project with the aim to explore the role of smartphone usage in upper secondary classrooms in Sweden.[1] In this study we have used new and innovative methods regarding how students' digital activities in the classroom could be captured and studied (see method section below). During two semesters we have followed the teaching in a male-dominated Building and Construction class at an upper-secondary school in a Swedish medium-sized city.

A recurring trait in the classroom interaction were the collective features in the smartphone usage of the students in the Building and Construction class. During classes, the students displayed what they did on their phones for several of their classmates at the same time, and we also witnessed numerous situations where the students used each other's smartphones. In this article, we will explore what these collective features in the Building and Construction boys' smartphone usage come about, and what their interactional purposes are. More precisely, the purpose is to study what identity-constructing processes the male students are engaged in when they involve their classmates in their smartphone use and how these processes relate to their shaping of a professional identity.

Becoming a construction worker

Colley, James, Tedder and Diment (2003) develop the concept of 'vocational habitus' to explain a set of dispositions required in the vocational culture in their analysis and interpretation of vocational becoming in three vocational learning sites. The vocational habitus is relational and dynamic, and it operates in disciplinary ways to dictate one's feelings, actions, attitudes and values, as well as how one should look, in order to 'become right for the job' (p. 488).

In the mentioned study, Colley et al. (2003) depict how engineering students encounter an engineering education that entails a culture characterised by specific notions of masculinity and instrumental attitudes towards study. In their encounter with the engineering education, the students develop certain notions of dispositions that are of importance in establishing a legitimate position within the field. In line with this, many recent studies on male students in Swedish vocational education (cf. Högberg, 2009; Korp, 2006, 2011) also point out different aspects of the distancing towards study, especially towards academic subjects such as language studies and mathematics. What these studies all have in common, besides following the work of Willis (1977), is the reaffirming of an 'anti-school' or 'counter-school' culture in which 'real men' do not do school work, and where 'having a laff' and/or using rough, provocative language are seen as strategies to display resistance (cf. Hill, 2001, 2007; Högberg, 2009, 2011; Moret, Dümmler & Dahinden, 2017; Nyström, 2012; Rosvall, 2011).

Many recent studies also argue that the construction of a male professional identity often demands a proficiency in a specific masculine jargon with elements of teasing, jokes and foul language use in a tough atmosphere in school as well as in work place-based learning (see Asplund, 2010; Berglund, 2009; Kontio, 2016; Lennartsson, 2007; Rosvall, 2011). Åberg and Hedlin (2015), for example, show how being able to display humour, orient toward the collective, physically strong and skilled carpenter, and to embrace a certain homophobia, reinforces students' orientation to their future occupation. At the same time, students who fail in maintaining these relationships are at risk of being marginalised (ibid.). This is also something that seem to apply on workplace-based learning in VET. Ferm et al. (2018) show how students in the industrial programme with experience from workplace-based learning in industrial work perceived that being accepted as a team member at the workplace had to do with one's attitudes towards informal jargon and sexistic jokes. Being able to handle this rough, masculine culture – to join in – were perceived as prerequisite strategies for establishing a favourable position in the working team, thus facilitating their transition into the work community.

A recurring trait in the studies made on professional identity construction in VET is the element of collectiveness. The process of learning to be a professional is by and large about adapting to a team of workers, to fit in. Berglund (2009) shows how these collective elements and the processes of creating a group affiliation are so strong in comparison that they overshadow actual professional knowing and learning. Becoming a part of a group are forces considered to be more important for these male students than conquering a more concrete professional knowledge or professional skills. In her study, Berglund (2009) shows that the students' enculturation into competent team workers includes that the students learn how to display comradeship and loyalty as well as to accept subordinating individual achievements to the collective results and achievements of the work team.

The fact that the creation of a community becomes such an important part of the education and its participants has also historical explanations; it has within the different occupations and vocational educations been important within a group, an affiliation to be able to rely on each other. Work often requires cooperation and is associated with a number of hazards (Andersson, Gunnarsson, Rosén & Moström Åberg, 2014), thus responsibility can be seen as valuable attitudes and as a way of moving closer to becoming a full member of the work group (Reegård, 2015; Taylor, 2009). Becoming a part of a work group, and being able to cooperate with others at the work place (and in school) are also features that the curriculum for the Building and Construction programme in several instances highlights as important features when one is to become a construction worker (Skolverket, 2011).

It is in the light of this that we try to make sense of the male students at the Building and Construction programme and their collective use of their smartphones. What are they actually doing with their phones, what does this 'new' medium create as it takes up a large proportion of the students' attention, and in what ways can this be understood in relations to the students' vocational identity?

Theoretical and methodological approaches

Community of practice

In the last decades, the concept *communities of practice* (Lave & Wenger, 1991; Wenger, 1998) has become more prominent in studies analysing how student and professional identities are accomplished in everyday classroom interactions (Åhlund, 2015). Compared to a workplace, the vocational classroom is a slightly different community of practice, where students are balancing between being a vocational student who is at the same time taking steps into becoming a proper member of a vocational community of practice. In this article, we have applied the concept of communities of practice in order to analyse how these local identities are accomplished through collective smartphone use in everyday vocational classroom interactions.

A community of practice has been described as a collective of people who come together around mutual engagement in some common endeavour, in our case it is a number of students engaged in learning building and construction as a future profession. Relations, interactions and norms, emerge in the course of the students' joint activity around that endeavour. Eckert (1998) states that a community of practice is defined by its membership and by the practice in which that membership is produced, thus the individual building and construction student constructs his or her identity through participation in a number of different communities of practices, and in many different forms of participation in each of those communities.

Billett (2001) points out that in addition to the disciplinary knowledge that is central to school institutions, vocational education students also have to engage with complex forms of work-based knowledge that include conceptual, procedural and dispositional dimensions. This affects not only knowledge acquisition, but also the ways in which students position themselves in the social practices they engage in. Lave and Wenger (1991), alongside other anthropologists have, for instance, for a long time stressed the idea that vocational learning 'implies becoming a different person with respect to the possibilities enabled by these systems of relations' (p. 52). Consequently, identity issues are key components to study when looking closer at transitions from school to work and therefor deemed worthy of a serious research focus.

The community of practice turns out to be an important space of this process of vocational identity construction. Communities of practice in classrooms emerge in response to common interest or position and play an important role in forming their members' participation in, and orientation to, the world around them. In this study we will analyse interaction where collective use of smartphones in vocational education classrooms and practical workshops play a role in creating these communities, and how the interaction in turn is related to the students' future vocational identity as building and construction workers.

Happy objects

The activities that are set into play in and through the students' collective use of the smartphones comprise processes of constructions of power of relations. Emotions are crucial here in relation to the construction of power relation in school concerning gender, class, sexuality, ethnicity, place etc. (Ahmed, 2004, 2010; Connell, 2005) which means that they are important to consider when analysing the constructing students' identity work. In this work, we find Ahmed's notion of *happy objects* (2010) useful when examining how the students involve their peers in and through their use of smartphones during classes.

According to Ahmed (2004, 2010), emotions are relational; they involve 'relations of towardness or awayness' in relation to objects (2004, p. 8), and as soon as this relation between the emotion and an object is established, it is given its individual and social meaning. In her book *The promise of happiness* (2010), Ahmed scaffolds theoretical tools from the fields of feminist and queer theories and she highlights the affective state of happiness, arguing that 'good things' are a product of the repetition of our pleasure. After we have experienced pleasure of a thing, we deem the thing as 'being good' (2010, p. 37), and we orient ourselves toward this 'happy object' to find happiness.

This expectation of pleasure from happy objects, or even from objects that are close to the original happy object, is not merely an individual orientation. According to Ahmed, objects become sites of personal as well as social tension, thus objects become spaces around which social groups orient themselves. When a group experiences pleasure from a 'happy object', they are aligned and facing the same way, and the object incites further pleasure and increases its affective significance. The more such links to different objects that are established, the stronger the solidity. The social dimension also means that the ones who do not experience pleasure from being close to objects that are already considered as being good by others, become alienated or excluded (see also Åberg & Hedlin, 2015; Åberg & Olin-Scheller, 2017).

In Ahmed's work, objects are not only material things, but also everything and anything that might bring us happiness. In that sense, also objects in the sense of values, practices, lifestyles and endeavours can become happy objects. The promise of happiness can, from Ahmed's point of view (2010), be seen as a moral

imperative that conceals inequalities and justifies the oppression of 'others' in order to 'restore' the natural goodness of particular ways of being in the world. As such, Ahmed presents a cultural critique that highlights and questions the marginalisation of particular identities that are seen to cause unhappiness (using the examples of 'affect aliens' such as 'feminist killjoys', 'unhappy queers', and 'the melancholic migrant') and that threatens the normative social order. Ahmed's approach to happiness thus provides a model for paying attention to and analysing how the different positioning of certain individuals and social groups (by the affirmation of appropriate 'happy objects') make certain norms and ideals become affective and more valuable than others, and how this facilitates specific gender, class and ethnic formations, among others.

The purpose of combining the concepts of community of practice with Ahmed's theorising on happy objects is to relate ways of doing a collectiveness to ways in which the participants co-construct their everyday worlds and in particular their own social identities and those of others in relation to the objects surrounding them. This is not simply a question of discovering how objects correlate with social structure or activity, but of how social meaning is constructed in the course of local social practice and conventionalised on the basis of shared experience and understanding (McConnell-Ginet, 1989). Approaching the boys' use of the smartphones in the classroom through a micro-perspective on interaction makes it possible for us not only to describe and show how the boys orient themselves towards the smartphone as a happy object, and what constitutes the smartphone as a happy object, but also how this is negotiated and what happens when particular norms and distinctions are challenged.

Method and data

In our study, we have applied a conversation analytic methodology (henceforth CA) in order to analyse and describe the identity constructing processes that take shape when the boys use the smartphone in the interactions (Schegloff, 2007; Sidnell & Stivers, 2014) during classes. In line with CA's radical participant's perspective, the organisations of talk-in-interaction are seen as ongoing sense-making practices of participants' social interaction. How the participants demonstrate their understanding of the situations there and then, and how they orient to the situation is in the centre of our analysis. This means that we examine which actions are made relevant at a specific moment in the interaction, and how they are made relevant from the participants' points of view, and the method involves the use of the participants' demonstrated understandings of each other's actions, and thereby provide material for analytic explication (e.g. Lee, 2010; Schegloff, 2007).

In our analyses, we understand both verbal and non-verbal language as resources that people use to produce and reproduce social reality; thus, not only sequential organisation of talk but also other semiotic resources such as gaze,

gestures, body movements, and physical objects such as laptops and smartphones are seen as constitutive of the activities being analysed (Goodwin, 2000). When approaching the data like this, the video recordings are transcribed in great detail according to specific conventions (e.g. Hutchby & Wooffitt, 2008).

The students included in this article come from one mid-Sweden upper-secondary school class in year 2 (of 3) of a vocational education programme, i.e. the Building and Construction programme. The students are aged 17–18, and the class consists of 25 students whereof 23 are boys. All students were informed about the aim and implementation of the study and were asked to participate either in recordings from the teaching lessons or by also allowing the researchers to record their use of smartphones and computers. The students' activities have been documented continuously over a period of one school year, through video recordings with two different perspectives; we have followed and recorded the student's physical interaction with peers, teachers, and with artefacts, in different teaching contexts in school with one portable camera, and as a second data source, we have used wi-fi technology to mirror and record the student's smartphone screen on a researcher's computer. These two data sources have then been synchronised and compiled into a video that shows the perspectives simultaneously.[2]

The field work in the Building and Construction programme has generated a total of 17 hours of video recordings of both practical teaching situations in the school's carpenter workshop, as well as theoretical teaching situations in the vocational education classroom. Although volunteering to be a part of the study, it is possible that the students could have felt intimidated by being followed by a researcher with a portable camera, and by letting their smartphones being mirrored and recorded on a computer. However, the choice of the technical solution where we mirror the screens of the smartphones gives us only access to what the students allow us to see. The mirror software is student controlled and the students were informed that they could shut down the mirroring if/when they wanted to do something on their phones that they would not like to share with the researchers.

As mentioned above, we noticed early on in our analyses of the material that there were a lot of collaborative activities surrounding the use of the students' smartphones. We also noted that all of these activities were student initiated, and in none of the examples were the use of smartphones a teaching-oriented activity. Rather, and as we will show below in our analyses, the smartphones were used for different social intentions, such as Snapchat, Instagram and other social and game related smartphone applications. After having categorised multiple clips in relation to the collective smartphone use, the analytic decisions made by the authors were presented, discussed and examined in several data sessions, as is common within interaction studies (Stevanovic & Weiste, 2017). These data sessions

involved up to five other researchers until we agreed upon choosing a couple of examples for a closer, in-depth analysis.

Thus, in this article we will take a closer look at some of these collaborative activities that are set into play when the students use the smartphone in the classroom by analysing three examples from our material. These examples are but only a few examples of the entire material, but they still make an adequate representation of these collaborative activities that the students participate in when they use the smartphone in class. The examples are also chosen on the grounds that they illustrate the variation of the smartphone use in the classroom.

The examples have been transcribed in detail inspired by the conventions of CA, where we have a special focus on the role of the smartphone in the sequentially ordered interaction, and on the identity constructing practices that are made relevant by the students in the interaction. The representations of the interactions are in this article presented in the form of detailed transcriptions of spoken data (see appendix for transcription conventions), as well as in pictures from still images of visual phenomena.

Results

During our field work, we have studied classes where the teaching of theoretical concepts has been in focus, as well as the classes where practical work has been done inside and outside different school workshops and classrooms. As we have been able to depict in previous studies within the project (e.g. Olin-Scheller, Tanner, Asplund, Kontio & Wikström, under review; Sahlström, Tanner & Valasmo, 2019; Tanner et al., 2017), the students mostly used the smartphones in the naturally occurring pauses, the so-called in-between spaces, that happen for instance when students move between classrooms, or when they are done with one assignment and wait for some new teacher-initiated activity. But we also noted some occasions where the students used the phone during a teacher's instruction, during movie-viewings, and in situations when students were expected to work on their assignments, either by themselves or in groups.

The selected examples that we have chosen to analyse in this article are chosen on the common basis that they all revolve around situations where the smartphones are used when the students are expected to work on teacher-initiated assignments, and that these smartphone uses in one way or another involves more than one student. Thus, in the following we will focus on the identity-constructing processes that take shape when the male students in the Building and Construction programme involve each other in their smartphone use, and how these processes relate to the shaping of a professional identity.

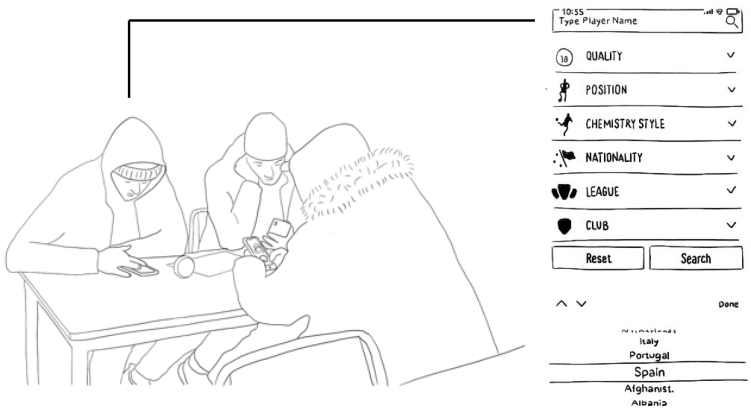
Contesting and validating the use of a happy object in peer group interaction

A recurring theme in the data collected from the teaching and learning at the Building and Construction programme was that of sustainable building. Our first extract from the data depicts a sequence that occurs in a longer session where the students are assigned to work in groups to construct a fictitious city where sustainability should be foregrounded. The subject matter and the assignment were introduced by the teacher and the instructions to the assignment were also available for the students on their digital school platform. Following the instructions, the students were assigned to work on their own by watching a film on YouTube related to the subject matter.

The student that we focused on during that particular day, Simon[3], was initially working in a group of seven peers. When the class was reassembled, four of the group members were still in class, three of them had deviated. The remaining members of the group regard the assignment as solved and finished, the teacher however, asks the students to clarify and colorise their sketch of their sustainable city. Quite immediately, Aron, one of the group members, takes on the task and sits down by a table beside his fellow group members. Aron is left alone with the work of colorising while his peers; Simon, Erik and Liam, focus their attention on their smartphones. The sequence below starts with Simon encouraging Erik to open a smartphone application, Futbin, that is linked to a popular football video game. Simon then shares with his friends that he is about to look up some players when it suddenly comes to everyone's attention that Liam, who is not an avid gamer, has two packs of player cards to open in his smartphone application:

Example 1: ***It's fucking electro man***

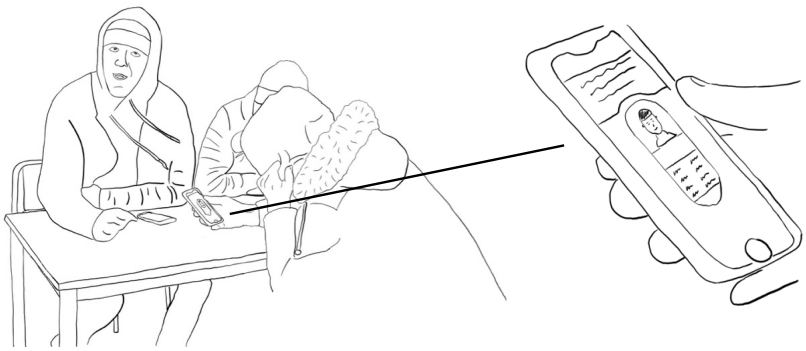
1 Simon: Ecki (.) ta upp futbin då
Ecki (.) open up futbin then
2 Erik: varför det?
why?
3 Simon: jag ska kolla va dom här spelarna kostar# (.) nåra
I'll look at the price# (.) of some of these players some



4 spanska jävlar
spanish fuckers
5 Erik: det är ju packe (x)
that's a pack (x)
6 Simon: Liam öppna pa:↑ck då↓ (.) två styckna
Liam open the pa↑ck then↓ (.) two of them
7 Liam: °(knip) käften°
°shut up°
8 Simon: mä (.) du spelar ju ändå inte
but (.) you don't play any way
9 Liam: nej jag ska bara ha dom där (x) (.) fan va roligt
no I will just have those (x) (.) damn that's fun
10 Simon: dä ä ju ro[l-
It's fun
11 Erik: [vi öppnar rare electrum player det är fan alla rare
we open rare electrum player it's all fucking rare
12 (.) tolv kort tolv rare
(.) twelve cards twelve rare
13 Liam: va sa du?
what did you say?
14 Simon: tretti du har två styckna
thirty you have two of them
15 Liam: du har två styckna?
you have two of them?
16 Simon: ja
yes
17 Erik: ja
yes
18 Liam: HE::J[HEJAOOÅÅOO ((gungar med kroppen)) metelehabalekem>
HE::J[HEJAOOÅÅOO ((rocks his body)) metelehabalekem>
19 Simon: [he:j ((bankar snusdosa i bänk i takt med Liams sång))
he:j ((dunks a snuffbox on desk in pace with Liams' song))
20 Liam: >ehäbe
>ehäbe
21 Simon: det gör du Liam du spelar ju inte ens Fifa
you do that Liam you don't even play Fifa
22 Erik: fan [var lite kul nån gång å inte
dammit [be a little fun sometime and don't
23 Liam: (*spelar ju fan inte ens*)
damn you don't even play
24 Simon: å så får du inte ens kolla på packet heller
and you don't get to look at the pack either
25 Liam: joho (.) jag ska kolla på det så jävla hårt också (.)
oh yes (.) I will look at it so fucking hard too (.)
26 Sto↑re promo↓ electro
Sto↑re promo↓ electro
27 Erik: det där är det det där är bra det
that is that that is good it is
28 Liam: det ä fucking# electro man (.) it's electro::
It's fucking# electro man (.) it's electro::

29

30 ele[ctro:# ((sjunger)) electr[o:
ele[ctro:# ((sings)) electr[o:
31 Simon: [ÄAHAA ((kastar sig bakåt))
[OAHAA ((throws himself backwards))



32 Erik: (x)menes (.) fick du nån spansk rare?
(x)menes (.) did you get any Spanish rare?
33 Liam: Aleksis Vidal
Aleksis Vidal
34 Erik: ja han kostar
yeah he costs

In line 8 Liam is positioned by his peers as someone who does not play (FIFA on a video game console), but he responds to this by saying that 'I will have them, damn that's funny', thus constructing an affective stance. Adjacent to this exchange, Erik requests that they all should open 'rare electrum players', as he also excitedly makes the others aware of the fact that 'they are all fucking rare'. In line 13 Liam says 'What did you say?', which probably is directed towards Erik's previous turn, but instead Simon tells Liam that 'you have two', a remark that Liam repeats – in the form of a question – in the following turn. The question is affirmed by Simon and directly after Liam starts singing some kind of cheering chant at the same time as he is swaying his body to and fro. The chant turns into a rigmarole with possible Arabic prosody, and as Liam is singing, Simon accompanies him by singing and beating his snuffbox on the table in line with Liam's chant.

After being positioned again as someone who does not play FIFA properly (line 21), as someone who does not get to 'look at the pack either' (line 24), and being encouraged to 'be a little fun sometime' (line 22), Liam makes it clear for everyone (line 25) that he is indeed going to 'look at a couple of fucking [packs]'. Simon's contesting of Liam's permission or worthiness to open the pack, through a kind of reverse psychology, intensifies the participants' interest in the outcome of the packs. This part of the interaction can be seen as a struggle for worthiness within a local hierarchy of managing happy objects, often noticed in previous research on play and gaming interaction (see Evaldsson & Corsaro, 1998; Sparrman & Aronsson, 2003). This struggle, competition and negotiation of respect among the peers done by Simon, Erik and Liam can be viewed in the light of the work of Robles, DiDomenico and Raclaw (2018) as a way of constructing oneself as an ordinary user of digital applications. By responding to the allegations of not being a proper gamer, Liam is constructing an identity that aligns with the expectations on smartphone use and games in this community of practice.

Meanwhile, Simon and Erik monitor Liam's smartphone activities, activities that Liam invites the others to take part of by making the smartphone display visible for his class mates. In line 27 Erik says 'that is good it is'. Liam upgrades this validating assessment by adding a game specific categorization; 'It's fucking electro man', and even repeats 'electro' a couple of times in a sort of sing-song, rhythmic, swaying manner which evolves into a chant or a song, perhaps one might find this to be linked to the very matter at hand; cheering chants and songs play an important part in being a football fan at a football game.

In the midst of the chanting, however, Simon leans over towards Liam's smartphone and touches the screen and immediately responds to what he sees by throwing his upper body backwards, and with a smile upon his face he makes a jubilant, celebratory response cry (Aarsand & Aronsson, 2009); 'OAHAA' (line 31), although a bit muffled, mind you, we are still in the classroom and extremely

loud response cries to gaming on the smartphone are not in line with expected student behaviour.

In line 32 Erik then asks Liam whether or not he got 'any rare', which Liam seems to have gotten as he quickly responds with the name of a well-known Spanish football player: 'Aleksis Vidal'. Erik confirms that the player is indeed to be regarded as rare, and he amplifies this by adding that the player is expensive.

In Example 1 we note that Simon, with the support from Erik, encourages Liam to log in to the FIFA 18 Companion application, in order to open a few packs. Liam then keeps his peers informed about how he orients towards the game. Simultaneously, there is some banter going on between Simon and Liam, where Simon on two occasions positions Liam as someone who does not play FIFA properly. Meanwhile, Liam, while opening his packs, responds to the banter, he disagrees with the categorisation as not proper gamer by orienting towards the surprise element of the opening of the random packs of football players as 'damn that's fun' (line 9) and on two occasions burst into singsong chants (lines 18, 20, 28 and 30) – which in turn charges a mood of excitement in the group. Noted not least, in the way in which Simon sings along and pounds his snuffbox on the table.

In Example 1 above we can see how the students are building alliances with each other; through which they are building a community spirit. To become a member of this community, it is vital that one can present oneself as an unsensitive person who can defend oneself verbally and to display humour, as a defence weapon, if one is 'attacked' for not being a 'real' FIFA player (on the video game console) as Liam is in the example, in order not to get marginalised. These strategies have in previous research been emphasised as crucial for vocational students in order to be included and accepted in the community of practice (see Ferm et al., 2018; Willis, 1977), and previous research also shows that prominent features in the construction of a professional identity in the Building and Constructing programme are attached to teamwork, comradeship, and loyalty (cf. Åberg & Hedlin, 2015; Berglund, 2009; Hedlin & Åberg, 2013; Lennartsson, 2007). These are also features that are heavily stressed in the policy documents' overall aims related to the Building and Construction programme, in which there is an emphasis on collaboration and the goals of becoming a team player, a part of a professional culture of working in a community with colleagues (Skolverket, 2011).

Thus, the building of a community is, very much, a continuously and ongoing project that the construction boys have to engage in (see Åberg & Hedlin, 2015; Asplund, 2010; Colley, et al. 2003; Kontio, 2016) in order to be a team player, and in the example we can see how the students use the smartphone, the FIFA18 Companion application and the Futbin application as a vessel for inclusion in a shared multimodal participation. So, in order to 'become the right person for the

job' (Colley et al., 2003), one can also say that one has to 'become the right person for the team'.

The excitement in the example above, driven in the interaction by the surprise element induced in the smartphone game, can also be understood in terms of happy objects (Ahmed, 2004, 2010). Excitement is relational; it involves 'relations of towardness' in relation to happy object, as seen in the ways in which the students turn their attention bodily towards the shared smartphone display, and the way in which Simon bodily reacts by jerking his entire body backwards in happiness, exclaiming the joy and excitement over Liam's opening of the packs.

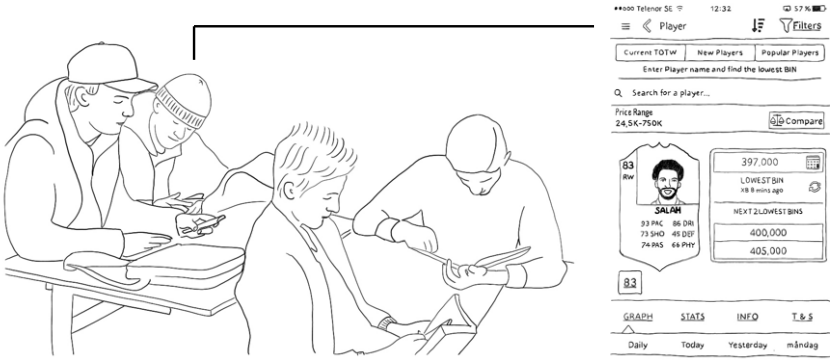
The entire sequence of actions surrounding the opening of the packs in Liam's phone is a joint fellowship endeavour that is reinforced by the dialogue between Simon and Liam, with the support from Erik. To take part in the joint interest and negotiation of worthiness and respect in the smartphone interaction is crucial to team building and the process of becoming a part of the community of practice. This excitement can be seen as a joint orientation towards happiness, an expectation of getting good, rare players, that might have implications for gaming outside of the walls of the here and now, on the video game consoles at home.[4] We can note a reciprocal direction, where games have found a way of stepping in and occupying a place in classroom interactions, as well as having impacts on gaming outside of the very room the students sit in. This obviously affects the students, their interactions and perhaps even in ways that we cannot tell from only looking at classroom interaction.

Male jargon in collective smartphone use

In this particular school studied, they have recently started a reading project, which involves having 20 minutes of silent reading every day in school. In the extract below we follow the students as they are supposed to read for 20 minutes. The teacher introduces and manages the assignment, but the reading project does not seem to win any legitimacy among the students of the class, as seen in their actions. A quick scan of the classroom sees that almost all of the students occupy themselves in their laptops or smartphones, many of them hide their phones behind their opened books, reading perhaps other things on their digital displays than what the school's reading project impels. This assignment opens up an opportunity for Simon to yet again engage in the FIFA 18 companion smartphone application – and yet again he turns towards Liam, whom he encourages to use the same application and do certain actions linked to different packs of random players.

Example 2: ***Is she retarded?***

1 Simon: Liam gör Liga Santander (.) det är då får man bra
Liam do Liga Santander (.) that's when you get some good
2 Erik: gör den me:d barca å athletico
do the one wi:th barca and athletico
3 Simon: är det den# man får tjugofem(ton)pack i?
is that the one# you get twenty-five(fifteen)pack in?



4 Erik: nja du får e: sällsynt guldpaket# (>x<)
nah you get a: rare gold pack# (>x<)
5 Simon: ja fick (.) °vänta vart fan är den då°
I got (.) °hold on where the hell is it°
6 Erik: vänta va?# ((tar upp sin mobil)) titta vem som skicka till
wait what?# ((picks his phone up)) look who sent to

7 mig (3.0)/((visar upp mobilen för Simon och sedan Liam))#
me (3.0)/((displays his phone to Simon and then Liam))#

8 Simon: Li:sa#
Li:sa#

9 Erik: Ellen Jonsson
Ellen Jonsson
10 **(7.0)/((all four look at Erik's smartphone))**
11 Liam öj är hon CP?# skriv ”°ska du ha en kuk din hora°”
ey is she retarded?# write ”°do you want some dick you slut°”

12 Simon: ut ur
out of
13 **(6.0)/((Liam looks at Erik and Simon with a confused look. The teacher approaches the group and listens. The boys smile.))**
14 Aron: vad hände?
what happened?
15 Liam: den där my story du la ut [(.)] skrev du (.) ”ur>
that story you posted (.) did you write (.) out>

```
16 Aron:                              [a: ]
                                     yeah:
17 Liam:    >garderoben" å så skrev hon "ut ur"
            >the closet and then she wrote out of
18          (6.0)/((they look up towards the teacher who looks at them))
19 Teach:   prova å läs nu
            try reading now
```

Yet again, the students orient towards their smartphones, and the excitement related to the happy object of finding out together, right here and now, what lies behind the corner (open up now, so that we can see what players you get!). This is a joint social activity and it is done in accordance with the intensity of the lesson and school assignments at hand. The assignment is to read a book, but the students decide to do something different instead; for the students the lesson, the reading project, is given meaning through gaming and socialising through their phones, not through reading the books or texts impelled by the school.

The students jointly create an affinity space within the classroom in and through their smartphone use. However, Erik introduces a new topic on line 6, as he gets a message from a girl, displaying his smartphone and saying: 'look who sent to me'. Erik's turn raises the others' attention, and they are drawn towards Erik and his smartphone. Liam's response on line 10 is in line with previous research on masculinity, a jargon where certain specific hegemonic masculinity norms construct and position females as subordinate and as sex objects (Mac An Ghail, 1994; Pascoe, 2007), a jargon which also is very much connected to the process of becoming a team member in vocational education (Åberg & Hedlin, 2015; Ferm et al., 2018.

What the example shows is also that this sexist jargon is something that emerges without warning, and in one way it is also an expression of a normalised culture often connected to male professional identity in vocational education (cf. Åberg & Hedlin, 2015; Rosvall, 2011), and to be skilled in sexist and humorous language in interaction has been noted as fundamental in participating in similar male communities of practice in Swedish upper secondary schools (Kontio, 2016; Rosvall, 2011). This sexist jargon can also be described as work in which the boys, together and socially, construct and maintain homosocial relations. They orient themselves towards each other as males and happy objects (and against the female 'snapchat-sender'), thus reconstructing the gender order that Connell and Pearse (2002) highlight in which men dominate females. As quickly as the sexist comment emerges, just as quickly it leaves the space for a discussion where the boys together try to figure out the origin of the comment the girl has sent to Erik on snapchat. The example also shows how the teacher, as he approaches the group, marks – both through his bodily presence and by encouraging them to 'try' reading – that he has discovered that the boys seem to devote themselves to

projects other than those impelled by the teacher, and the school sanctioned reading project.

When the teacher then approaches the group, the sexist comment has already been dropped, which means that the teacher has no chance of forming an idea of the project that the boys have been involved in, other than taking part of the boys' fragmented talk about something that has been texted on Aron's 'my story'. What we can see here is therefore also an expression of what Asplund et al. (2018) show in a previous study on smartphones and schools; namely that students' smartphone use brings new challenges to teachers in gaining access to the processes that are set into play when students use their smartphones in the classroom during class.

While the boys are oriented towards the smartphone, they also mark a rejection of the teaching they encounter in the classroom. The school-sanctioned reading that the boys are asked to devote their time and attention to is nothing that engages them. Instead, they seek contact with each other by focusing their attention and their commitment to the smartphone; first by using the FIFA app and then towards the snapchat conversation Erik shows up for his classmates. As earlier studies on working-class boys and masculinities have shown, the creation of a counterculture in relation to school, is a way for these boys to strengthen their community and sense of belonging (Högberg, 2011; Willis, 1977), and research on male students in the Building and Construction programme also highlights that using male jargon and foul language in order to blend in with the group constitute core elements of occupational socialisation (cf. Åberg & Hedlin, 2015; Berglund, 2009; Högberg, 2009; Lennartsson, 2007).

Thus, once again we have an example of a situation where the construction of a community, a group affiliation, precedes the actual school work, and again this construction of a community of practice takes place through the boys' orientation towards the smartphone as a happy object. The smartphone is oriented towards something that, unlike the current reading project, can create joy, excitement and community, and thus becomes a tool for the boys through which they construct a professional identity where elements of the interactional co-construction of a team, male chauvinist jargon and an anti-study culture appears as central forces.

Disaligning with expected smartphone behaviour

We return again to the lesson where the students are working on sketches for a sustainable city. After having seen the assigned video on YouTube on their own (many of the students chose to view the video on their smartphone), the group reassembled around a table in the construction workshop. Simon had taken it upon himself to plot down the thoughts and ideas of the group on a large piece of paper. It is mainly two out of the seven students that take authority over what ideas get to be written down on the paper; Simon and Eric, who also happen to sit closest to the one laptop that they gather around. The laptop displays the

instructions for the assignment at hand, and Simon and Erik often turn their attention towards it. The rest of the group turn their attention and actions, gazes and their bodily stances towards Simon and Erik as they complete the task of writing down their ideas. It is at times a pretty intense discussion going on in the group as to what ideas should be written down, Eric and Simon's ideas however, dominate and are given priority. One of the students, Aron, tries initially to contribute with his own ideas and thoughts.

Example 3: ***No turn it off I can't stand that crap***

1 Aron: alltså >vet du vad vi gör?< vi gör en vi↑lla (.) du vet vi
you know what we gonna do? We make a house (.) you know we
2 (sopar en r k) (.) så får vi med det (.) å brevid villan
(sweep an r k) (.) than we have that (.) and next to the house
3 vi ett företag du vet som Tesla en elbilar å se↑n: (.) [å:
we a company you know like Tesla an electric cars and then (.) [and
4 Erik: [nej
[no
5 stäng av jag ork[ar inte med den där skiten
turn it off I can't st[and that crap
6 Simon: [A:ro:n#
[A:ro:n#

7 Aron: de ä för jag behöver tänka mannen (.) ska ni↑ tänka (.) då
it's because I need to think man (.) if you↑ need to think (.)
8 kommer det å bli (drrt) ((pruttljud)) alltså
then it will be (drrt) ((fart sound)) you know
9 **((the students next to Aron look at him and smile))**

In lines 1–3, Aron presents a suggestion of how the group could develop its sketch, but gets interrupted by Erik in lines 4-5 who quite annoyed tells him to shut down the music that Aron plays on the smartphone's speaker because he cannot 'stand that crap'.

In the middle of Erik's turn, Simon follows Erik when he turns to Aron in line 6 and calls out his name in a rather accusatory manner. Through this action he displays support for Erik, and thus also reinforces Erik's rejecting comment.

What Aron then does is that he tries to save his face (Goffman, 1967) by initially explaining why he chooses to play music on his mobile phone ('I need to think man') and then goes to counterattack by criticising Simon and Erik for their inability to think.

The fart sound that Aron adds at the end of his turn may well be regarded as an attempt to ridicule his critics, and given some of his classmates' reactions (they laugh), the counterattack can be considered as successful. Aron's suggestion about what could be added to the sketch that the group work on however, does not gain any support, instead the discussion takes another direction, after which Aron also puts his earphones in his ears and continues to listen to music.

This is an example of how the smartphone sometimes is made into a disturbing object in classroom interaction by the students themselves. Here the contents, or the functions of the smartphone are no happy objects. Despite Aron's displayed ability to handle the verbal attacks from Erik and Simon, which is one of the core abilities in order to blend in with the group in many male-dominated vocational education programmes (Asplund, 2010; Berglund, 2009; Högberg, 2011; Kontio, 2016; Korp, 2011) it is obvious that his mobile use excludes him from the group; he simply does not use it in the way that wins legitimacy, and it violates the agreed upon norm. Not playing by the rules concerning how the smartphone is expected to be used by his peers when working together on the assignment, the smartphone use in this excerpt (in contrast to previous examples above) results in exclusion for Aron from the group assignment, the peer interaction, and also from the (working) team. According to Ahmed, an object that recalls as being happy does not always stay in place (Ahmed, 2010, p. 23), and what we can see in the example above is an expression of this. It is a continuous work of maintaining an object as a happy object, and this is also connected to local construction of a community of practice (see also Åhlund & Aronsson, 2015). One has to use the smartphone according to the norms and conventions that are constructed and reconstructed by the students in the interaction here and now in order to be a full member of the (working) team.

Discussion

In this study, we have made microanalyses of the social dynamics between male students in the Building and Construction programme in vocational classrooms. We can note, by looking into the very minute details in interaction, from turn to turn, how features of identity constructions previously found in research on work places and during workplace-based learning (Ferm et al., 2018) is indeed produced already in the classrooms of vocational education. Through the methods used in this study, we have been able to point out how these identity constructions are being made here and now, and the role the smartphone plays in these processes; highlighting traits found by previous research on male students

in vocational education, such as the use of male jargon, foul language and a counterculture in relation to school assignment (cf. Åberg & Hedlin, 2015; Berglund, 2009; Högberg, 2009; Lennartsson, 2007; Willis, 1977).

The teaching that the vocational students meet in schools, as well as in workplace-based learning, is to a large extent characterised by the apprenticeship's historical traditions where teamwork, loyalty to work colleagues, and orthodox masculinity ideals are valued higher than the professional knowledge, and by extension producing an anti-school attitude among the students. These are processes and traits that we have had fairly good insight to through the research done in the field (see e.g. Berglund, 2009; Ferm et al., 2018; Kontio, 2016). In this respect, our study is no exception. By contrast, through our approach and by directing our analytical focus on building and construction students' smartphone use in the connected classroom, we have been able to show how the smartphone is made into a resource by which the students stage these processes in their construction of a professional identity.

In their exploration of the ways that objects feature in the situated, embodied, and spatial circumstances of everyday social interaction and activity, Nevile, Haddington, Heinemann and Rauniomaa (2014) distinguish two overarching themes; 'objects as situated resources' and 'objects as practical accomplishments'. As resources, objects are used by people to interact with others and contribute to developing processes and trajectories of social interaction. As practical accomplishments, objects are oriented to as emerging in and through trajectories of social interaction. Based on this distinction, the processes that take place in the first two examples in this article are processes where the smartphone is used as a situated resource, in that they show how the boys interact with the smartphone, and use the smartphone, to interact with each other. When Simon orients to the smartphone (example 1 and 2) he manages the interactional demand of not only getting Liam's attention (and then the other participants) but also getting him involved in the FIFA 18 Companion smartphone application.

However, in both these examples we can also identify processes where the boys orient to the smartphone as emerging in and through social interaction. According to Nevile et al. (2014), in such processes, participants 'handle and shape objects to create shared realisations of what objects are, or can or should be, and so how they might be perceived, understood, and treated' (p. 14), and in our analysis we have shown how the boys, together and socially, orient towards the smartphone and the FIFA 18 Companion app, their features and affordances, as happy objects (Ahmed, 2010). The smartphone as a practical accomplishment is also highlighted in our last example (example 3). Here, Aron's use of his smartphone is perceived as something that violates the group's established norm for when and how a smartphone can or should be used, and the smartphone's significance and value as something disturbing (and not as a happy object) thus emerges in and through the social interaction.

In the article we have shown how the smartphone is used by the boys as a resource for establishing contact with each other here and now, and through the applications and social media provided by the smartphone, the boys find common areas of interest which they can explore together. These are interests that the teaching in school, by default, cannot compete with. Through the students' collective orientation towards the smartphone as a happy object, the boys construct a community in which inclusion in the group takes place provided that the smartphone is used correctly, that they share the interests that it is oriented towards and that one can handle the tough jargon that is constructed in interaction. What we can see in the examples is thus how the collective use of the smartphone offers more, and new opportunities for building and construction students to create a local community of practice (Wenger, 1998), and how the identity-constructing processes that take shape when the boys orient themselves towards the smartphone as a happy object are related to the student's future vocational identity as building and construction workers as well as explicating an anti-school attitude. In order to become a full member of this community of practice, i.e. this working team, one has to accept the tough masculinity norms, use a raw and sexist male chauvinist jargon, and openly display a negative or, at the very least, a distancing attitude towards the academic teaching at hand.

However, the smartphone does not only offer more and new opportunities for the students in their identity work, but it also helps to strengthen the community that the boys establish in the interaction, while also making it difficult for others to become full members of it. It is not only the smartphone itself that is made into a happy object, but also the applications – FIFA 18 Companion, Futbin, and Snapchat – are oriented towards as happy objects; these are apps around which the boys can engage in for them more fun and exciting projects than the teaching that is currently conducted and in which they are expected to participate. The collective elements of the boys' smartphone use, and the explicit will to engage their classmates in collective smartphone use also make the solidarity, the community itself – i.e. the establishment of a community of practice (Wenger, 1998) – made into a happy object to which the boys attach affects to. Shared joy becomes double joy, and in that sense, we are faced with situations when the boys, through their collective smartphone use, make several happy objects relevant at the same time in the interaction.

With Ahmed's work (2010) in mind, we can also see this as processes that constantly strengthen the strong links between the boys; the more such connections to different objects (which can be both physical and social) that are established and which are focussed in the same direction, the stronger the solidity becomes, Ahmed says. Thus, the collective use of the smartphone, more often than not openly vis-à-vis the teaching and intended learning outcomes, sets in motion processes through which the boys work hard with the aim to fit in, to become a part of a group, which research shows is a core element in the development of a

professional identity among (male) vocational education students (Berglund, 2009; Ferm et al., 2018). But, as Ahmed also reminds us, these social dimensions also mean that this strong solidity makes it harder for others that do not enjoy pleasure or joy from being close to the objects that are considered to be good by others, to shatter it. Thus, those students who are not comfortable with this specific vocational work culture that are established through the use of the smartphone risk becoming alienated and excluded from gaining access to the community of practice.

As noted by Åberg and Hedlin (2015, p. 536), such processes produce social inertia 'making it hard for the Building and Construction programme to become more accessible to people who inhabit bodies other than the comfortable ones' (see also Holth, 2014). In the light of the many connections between different objects that are made possible and actualised by the smartphone usage, the access to the Building and Construction programme for those people who do not want to, or cannot live up to and embody the norms and distinctions that are constructed and reconstructed through the use of smartphone during classes, appear even harder.

It is important to emphasise here, that the video recordings provide for micro-level analyses of the students' smartphone use, which give insights to actions that we, as observational researchers, were not able to detect whilst being in the classrooms. The students find strategies for smartphone use that neither we nor the teachers could see with our eyes; phones being hidden behind books and bags, phones being picked up when moving between classrooms etc. The methods chosen here have been crucial in order to detect and properly analyse these hidden micro actions.

Highlighting the use of the smartphone in the Building and Construction programme through the lens of Ahmed's ideas of happy objects (2010) and the concept of community of practice (Wenger, 1998) can deepen our understanding of how these specific norms are negotiated and constructed in vocational education classrooms, and how students bring their own digital devices to school, and use them as resources in their construction of a professional vocational identity. By studying how this is done in the interaction, there and then, and what happens when particular norms and distinctions are challenged, we can also identify potential possibilities to break these stereotypical norms and patterns, given that we gain increased knowledge of the collective use of smartphones in traditional male-dominated vocational programmes.

Endnotes

[1] *Connected classrooms*, financed by the Swedish Research Council, (Dnr: 2015-01044, https://www.kau.se/csl/forskning/forskningsprojekt/uppkopplade-klassrum).

[2] The examples presented and analysed in the following sections are selected from a larger video-ethnographic study on smartphones in upper secondary classrooms, focusing on students' use of different social media, applications, search engines and links, and the role these play in relation to the literacy practices of the classroom. The complete material consists of approximately 70 hours of recordings of teaching activities including 1–4 focus students in each class in a total of 9 upper secondary school classes.
[3] All of the names in this study are made up.
[4] This also relates to the pop cultural phenomenon that is opening packs and posting your reactions in a video on YouTube. Videos that have millions of views and followers. See for instance: https://www.youtube.com/watch?v=6w43e7eeHeU

Note on contributors

Stig-Börje Asplund is Associate professor at the Department of Educational Studies at Karlstad University in Sweden. He holds a PhD in Educational Work, and his current research interests include classroom interaction, processes of identity construction, vocational education, and boys' and young men's literacy practices in and outside school.

Janne Kontio is Doctor of Philosophy (PhD) in education, currently working as a researcher and lecturer at the department of Education at Stockholm University and as a post doc at Karlstad University, Sweden (Connected classrooms. New literacy practices among upper secondary students in the age of smartphones, funded by The Swedish Research Council). He conducts empirical research in the field of education, with a special interest in the research areas of multilingualism, gender and embodiment as situated interactional practices.

References

Aarsand, P.A., & Aronsson, K. (2009). Response cries and other gaming moves: Building intersubjectivity in gaming. *Journal of Pragmatics*, *41*(8), 1557–1575.

Åberg, M., & Hedlin, M. (2015). Happy objects – happy men? Affect and materiality in vocational training. *Gender and Education*, *27*(5), 523–538.

Åberg, M., & Olin-Scheller, C. (2018). Wolf cries: On power, emotions and critical literacy in first-language teaching in Sweden. *Gender and Education*, *30*(7), 882–898.

Åhlund, A. (2015). *Swedish as multiparty work: Tailoring talk in a second language classroom*. (Diss.) Stockholm: Stockholm University.

Ahmed, S. (2004). *The Cultural politics of emotion*. Edinburgh: Edinburgh University Press.

Ahmed, S. (2010). *The promise of happiness*. London: Duke University Press.

Andersson, I-G., Gunnarsson, K., Rosèn, G., & Moström Åberg, M. (2014). Knowledge and experiences of risks among pupils in vocational education. *Safety and Health at Work, 5*(3), 140–146.

Asplund, S-B. (2010). *Läsning som identitetsskapande handling: Gemenskapande och utbrytningsförsök i fordonspojkars litteratursamtal* [Reading as identity construction: Practices and processes of building a sense of community in literary discussions among male Vehicle Engineering students]. (Diss.) Karlstad: Karlstad University.

Asplund, S-B., Olin-Scheller, C., & Tanner, M. (2018). Under the teacher's radar: Literacy practices in task-related smartphone use in the connected classroom. *L1-Educational Studies in Language and Literature, 18*(Open Issue), 1–26.

Beland, L-P., & Murphy, R. (2015). Ill communication: Technology, distraction & student performance. *Centre for Economic Performance* (EP) (No. 1350). Discussion Paper.

Berglund, I. (2009). *Byggarbetsplatsen som skola – eller skolan som byggarbetsplats? En studie av byggnadsarbetares yrkesutbildning* [The site of construction as a school – or school as a site of construction]. (Diss.) Stockholm: Stockholm University.

Billett, S. (2001). *Learning in the workplace: Strategies for effective practice*. Crows Nest: Allen and Unwin.

Chua, J.H. & Jamil, H. (2012). Factors influencing the technological pedagogical content knowledge (TPACK) among TVET instructors in Malaysian TVET institution. *Procedia – Social and Behavioral Sciences*, *69*, 1539–1547.

Colley, H., James, D., Tedder, M., & Diment, K. (2003). Learning as becoming in vocational education and training: Class, gender and the role of vocational habitus. *Journal of Vocational Education and Training*, *55*(4), 471–498.

Connell, R.W. (2005). *Masculinities*. Cambridge: Polity Press.

Connell, R.W., & Pearse, R. (2002). *Gender (Polity short introductions)*. Malden, MA: Polity Press.

Eckert, P. (1998). Gender, social engagement, and linguistic style. In I.L. Pedersen, & J. Scheuer (Eds.), *Sprog, koen – og kommunikation*. Rapport fra 3. Nordiske Konference om Sproeg og Koen. Koebenhavn. 11.–13. Oktober 1997. Copenhagen: C.A. Reitzels Forlag.

Evaldsson, A-C., & Corsaro, W.A. (1998). Play and games in the peer cultures of preschool and preadolescent children: An interpretative approach. *Childhood*, *5*(4), 377–402.

Ferm, L., Persson Thunqvist, D., Svensson, L., & Gustavsson, M. (2018). Students' strategies for learning identities as industrial workers in a Swedish upper secondary school VET programme. *Journal of Vocational Education & Training*, *70*(1), 66–84.

Goffman, E. (1967). On face work. In E. Goffman (Ed.), *Interaction ritual: Essays on face-to-face behavior* (pp. 5–33). New York: Doubleday Anchor.

Goodwin, C. (2000). Action and embodiment within situated human interaction. *Journal of Pragmatics*, *32*(10), 1489–1522.

Hedlin, M., & Åberg, M. (2013). *"Vara med i gänget?" Yrkessocialisation och genus i två gymnasieprogram* ['Being one of the gang?' Vocational socialisation and gender in two upper secondary programmes]. Uppsala: IFAU.

Hill, M. (2001). Om vikten av att få sig ett skratt: Ett elevperspektiv [On the importance of having a laugh: A student perspective]. In *Villkor och vägar för grundläggande yrkesutbildning: Några forskarperspektiv* [Conditions and pathways for basic vocational education: Some research perspectives] (pp. 15–31). Stockholm: Skolverket.

Hill, M. (2007). Coola killar pluggar inte [Cool guys don't study]. In J. Olofsson (Ed.), *Utbildningsvägen: Vart leder den? Om ungdomar, yrkesutbildning och försörjning* [The educational pathway: Where does it lead? About young people, vocational education and support] (pp. 158–172). Stockholm: SNS förlag.

Holth, L. (2014). Passionate men and rational women: Gender contradictions in engineering. *NORMA: International Journal for Masculinity Studies*, *9*(2), 97–110.

Hutchby, I., & Wooffitt, R. (2008). *Conversation analysis* (2. ed.). Cambridge: Polity.

Högberg, R. (2009). *Motstånd och konformitet: Om manliga yrkeselevers liv och identitetsskapande i relation till kärnämnena* [Resistance and conformity: On the life and identity making of male vocational students in relation to the core subjects]. (Diss). Linköping : Linköpings universitet.

Högberg, R. (2011). Cheating as subversive and strategic resistance: Vocational students' resistance and conformity towards academic subjects in a Swedish upper secondary school, *Ethnography and Education*, *6*(3), 341–355.

Kontio, J. (2016). *Auto mechanics in English: Language use and classroom identity work*. (Diss.) Uppsala: Uppsala universitet.

Korp, H. (2006). *Lika chanser i gymnasiet? En studie om betyg, nationella prov och social reproduktion* [Same opportunities in upper secondary school? A study of grades, national tests and social reproduction]. (Diss.) Malmö: Lärarutbildningen, Malmö högskola.

Korp, H. (2011). What counts as being smart around here? The performance of smartness and masculinity in vocational upper secondary education. *Education, Citizenship and Social Justice*, *6*(1), 21–37.

Kuznekoff, J-H., & Titsworth, S. (2013). The impact of mobile phone usage on student learning. *Communication Education*, *62*(3), 233–252.

Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation.* Cambridge University press.

Lee, Y-A. (2010). Learning in the contingency of talk-in-interaction. *Text and Talk, 30*(4), 403–422.

Lennartsson, R. (2007). "Snus under läppen och en massa snuskprat": Maskulinitetsskapande på byggprogrammet [Snuff under the lip and a lot of dirty talk: The construction of masculinity in the Building and Construction programme]. In G. Arvastson, & B. Ehn, *Kulturnavigering i skolan* [Culture navigation in school] (pp. 40–51). Malmö: Gleerups utbildning.

Mac An Ghaill, M. (1994). The making of men: Masculinities, sexualities and schooling. Buckingham/Philadelphia: Open University Press.

Mcconnell-Ginet, S. (1989). The sexual (re)production of meaning: A discourse-based theory. In F. Frank, & P.A. Treichler (Eds.), *Language, gender and professional writing: Theoretical approaches and guidelines for nonsexist usage* (pp. 35–50). New York: MLA Publications.

Moret, J., Dümmler, K., & Dahinden, J. (2017). The car, the hammer and the cables under the tables: Intersecting masculinities and social class in a Swiss vocational school. *European Journal of Sociology*, *58*(2), 265–293.

Nevile, M., Haddington, P., Heinemann, T., & Rauniomaa, M. (Eds.) (2014). *Interacting with objects: Language, materiality, and social activity.* Amsterdam: John Benjamins Publishing Company.

Nyström, A. (2012). *Att synas och lära utan att synas lära: En studie om underprestation och privilegierade unga mäns identitetsförhandlingar i gymnasieskolan* [To be seen and to learn, without being seen to learn: A study of under-achievement and identity-negotiation among privileged young men in upper-secondary school]. (Diss.) Uppsala: Uppsala universitet.

Olin-Scheller, C., Tanner, M., Asplund, S-B., Kontio, J., & Wikström, P. (under review).

Ott, T. (2017). *Mobile phones in school: From disturbing objects to infrastructure for learning*. (Diss.) Gothenburg: University of Gothenburg.

Pascoe, C.J. (2007). *Dude, you're a fag: Masculinity and sexuality in high school*. Berkeley: University of California Press.

Pascoe, C.J. (2012). Studying young people's new media use: Methodological shifts and educational innovations. *Theory into Practice, 51*(2), 76–82.

Reegård, K. (2015). Sales assistants in the making: Learning through responsibility. *Vocations and Learning*, *8*(2), 117–133.

Robles, J.S., DiDomenico, S.M., & Raclaw, J. (2018). Doing being an ordinary communication technology and social media user. *Language & Communication*, *60*, 150–167.

Rosvall, P-Å. (2011). Pedagogic practice and influence in a Vehicle Program class. In E. Öhrn, L. Lundahl, & D. Beach (Eds.), *Young people's influence and democratic education: Ethnographic studies in upper secondary schools* (pp. 92–111). London: Tufnell Press.

Rosvall, P-Å. (2015). 'Lad' research, the reproduction of stereotypes: Ethnographic dilemmas when researching boys from working-class background. *Ethnography and Education*, *10*(2), 215–229.

Sahlström, F., Tanner, M., & Valasmo, V. (2019). Connected youth, connected classrooms: Smartphone use and student and teacher participation during plenary teaching. *Learning, culture and social interaction, 21,* 311–331.

Schegloff, E.A. (2007). *Sequence organization in interaction*. Cambridge: Cambridge University Press.

Shava, H., Chinyamurindi, W., & Somdyala, A. (2016). An investigation into the usage of mobile phones among technical and vocational educational and training students in South Africa. *SA Journal of Information Management*, *18*(1), 1–8.

Sidnell, J., & Stivers, T. (Eds.) (2014). *The handbook of conversation analysis*. Oxford: Wiley-Blackwell.

Skolverket (2011). *Läroplan, examensmål och gymnasiegemensamma ämnen för gymnasieskola 2011 (Gy11)* [Curriculum for the upper secondary school]. Stockholm: Skolverket.

Sparrman, A., & Aronsson, K. (2003). Pog game practices, learning and ideology: Local markets and identity work. In G. Walford (Ed.), *Investigating educational policy through ethnography* (*Studies in Educational Ethnography, Vol. 8)* (pp. 153–168). Bingley: Emerald Group Publishing Limited.

Stevanovic, T.M., & Weiste, E.H. (2017). Conversation-analytic data session as a pedagogical institution. *Learning, Culture and Social Interaction*, *15*, 1–17.

Tanner, M., Olin-Scheller, C., Buskqvist, U., & Åkerlund, D. (2017). Ett pappers-löst klassrum? Utmaningar för det uppkopplade klassrummets literacypraktiker. [A paperless classroom? Challenges for literacy practices in the connected classroom]. In C. Olin-Scheller, M. Tanner, M. Tengberg, & B. Ljung-Egeland (Eds.), *Textkulturer* [Text cultures] (pp. 175–194). Karlstad, Sweden: Karlstads universitet.

Taylor, A. (2009). Mapping the field of VET partnership. *Vocations and Learning, 2*(2), 127–151.

Wei, F-Y.F., Wang, Y.K., & Klausner, M. (2012). Rethinking college students' self-regulation and sustained attention: Does text messaging during class influence cognitive learning? *Communication Education, 61*(3), 185–204.

Wenger, E. (1998). *Communities of practice: Learning, meaning, and identity*. Cambridge: Cambridge University Press.

Willis, P. (1977). *Learning to labour: How working class kids get working class jobs*. New York, NY: Columbia University Press.

APPENDIX: TRANSCRIPT NOTATIONS

[	overlapping utterances, whether at the start of an utterance or later
]	indicates a point at which two overlapping utterances both end, where one ends while the other continues, or simultaneous moments in overlap which continue
(2.0)	length in seconds of a pause
(.)	a short untimed pause (less than 0,2 seconds)
(( ))	contextual description and accounts
(x)	an uncertain hearing of what the speaker said
Word	stressed syllable or word
°world°	degree signs indicate that talk is markedly quiet
>word<	left/right carats indicate that the talk between them is compressed
:	a prolonged stretch
=	continued speech
-	hyphen after a word indicates a cut-off or self-interruption
↑↓	arrows mark rising or falling intonation
#	indicates the exact moment at which the screen shot has been recorded

Nordic Journal of Vocational Education and Training, 2020

Virtual welding: A didactic perspective

Steinar Karstensen & Arne Roar Lier

OsloMet – Oslo Metropolitan University, Norway

(steinar.karstensen@oslomet.no)

Abstract

This research was conducted as part of a Technical and Vocational Education and Training (TVET) programme in Technical and Industrial Production and is a collaboration between Aas upper secondary school in Akershus and the Department of Vocational Teacher Education at Oslo Metropolitan University (OsloMet). Starting in autumn 2017, simulated welding has been the first step in the use of simulation teaching in order to produce qualified professionals. In TVET education, Virtual Reality technology is a new training tool for welding, and little is known about the pedagogical approaches and didactic challenges.

This article is based on interviews that were conducted with teachers and their immediate supervisors to gain insight into their prior knowledge, the approaches they intended to use, and their initial experiences of the introduction of simulation-based teaching. The research consists primarily of qualitative analyses, based on a phenomenological approach. The focus for the article is the possibilities and limitations of a virtual welding machine, as well as how it might be introduced as an educational and didactic tool in upper secondary school.

The article provides useful knowledge for those who will be using some form of simulation in teaching in general and for simulated welding in particular. This applies to both current TVET teachers and those undergoing Technical and Vocational Teacher Education.

Keywords: simulated welding, technical vocational education and training (TVET), augmented reality (AR), virtual reality (VR), mixed reality, simulation

NJVET, Vol. 10, No. 1, 95–107 Peer-reviewed article doi: 10.3384/njvet.2242-458X.2010195

Introduction

In this article, we examine the simulation of welding in a Virtual Reality (VR) machine (what we term VRW – virtual reality welding). VRW encourages exploration and experimentation in learning welding procedures. It allows the user to actively evaluate progress in real time, adjust techniques accordingly and to start over and abandon poor welds without concern for wasted consumable materials.

Research in this field is characterised by a focus on efficiency in education (Stone, Watts & Zhong, 2011a). This focus is shared by suppliers of VRW machines. They emphasise that a VRW environment can train welders faster and more efficiently, attract and engage learners by making it more enjoyable enhance and supplement welding training, and save money on base materials, electricity, consumables and waste (Stone et al., 2011a; Stone, Watts, Zhong & Wei, 2011b).

The research is based on empirical evidence regarding decision-making and choice of equipment, placement of the VRW and further developments. We follow how the technical and vocational education and training (TVET) teachers responsible for welding training approach planning and implementation, and how they assess training outcomes. The analysis is based on a phenomenological approach, chosen to illuminate and identify specific phenomena via their perception by the actors in situation (Lester, 1999; Postholm & Moen, 2009). The primary question concerns the possibilities and limitations of a virtual welding machine, as well as how it might be introduced as an educational and didactic tool in upper secondary school. We look at these issues through the following underlying questions: (1) What are the teacher's reasons and pre-understandings for adopting the virtual welding machine; (2) what are the didactic justifications for how the welding machine is adopted; (3) what is the relationship with the holistic learning approach; and finally, (4) what kind of training is needed to take advantage of the virtual welding machine.

First, we will give a brief introduction to what simulation is, aimed specifically at the use of VRW as a didactic tool in welding training. The article does not deal with welding and welding training, but simulation as a virtual aid used in the training. In this context, it is also important to distinguish between simulated welding through the VRW machine, often referred to as virtual welding, in relation to welding in the real world, or authentic welding, referred to as real welding, although this can also be a practical exercise task undertaken in school.

Previous studies comparing VRW with real welding (Stone et al., 2011a; Stone et al., 2011b) show evidence of the following: VR-integrated training results in superior training outcomes compared to traditional methods (as VR has a higher transfer percentage and a far superior operation completion time than participants in the real welding group), and a VR system leads to increased levels of team interaction and learning.

There was no difference between the VRW and control groups, in the participants' desires to perform well and to learn from their experience. These results however indicate that participants in the VR group were more willing to communicate and learn from each other. The VR machine provided a conduit by which participants were not only more likely to communicate, but were more likely to value communication and use it to improve their skills. VR Groups were also more likely to seek feedback from the VR system due to the fact that they felt that information given by the system was 'delivered in a more timely manner' than that which could be gained from a shared instructor.

VR integrated technology is significantly less expensive than training using traditional methods. A cost analysis clearly confirms this (Stone et al., 2011a). In additional to material costs, VR machine training makes it possible to practice welds without having to invest time in set-up and material gathering processes. VR training also allows the user to start over and abandon poor welds without concern over wasted consumable materials. These attributes embolden users and encourage exploration of new welding procedures and techniques without the fear of accruing excessive expenses (Stone et al., 2011a; Stone et al., 2011b).

Simulation

Simulation is the imitation of the operation of a real-world process or system. Simulations can allow learners to practice skills or undertake embodied learning tasks, which is particularly appropriate when the tasks involved are expensive, dangerous or risky to undertake in the real world (Dalgarno & Lee, 2010). In welding there are high levels of sound, sparks and light which can seem daunting. It is also expensive to train repeatedly to weld correctly.

In this project, we examine the use of a welding simulator that uses both sensors and Mixed Reality (MR). MR is the merging of real and virtual worlds to produce new environments and visualisations in which physical and digital objects co-exist and interact in real time. Mixed reality takes place not solely in the physical or virtual world but entails a combination of reality and Virtual Reality (VR), encompassing both Augmented Reality (AR) and Augmented Virtuality. Whereas VR is a computer technology that uses VR headsets to generate realistic images, sounds and other sensations that simulate a user's physical presence in a virtual or imaginary environment, AR has elements that are 'augmented' by computer-generated or extracted real-world sensory input. Although many forms of simulation deal with MR, it is often referred to as VR, as is the case in this article. (Carl, 2018; Farshid, Paschen, Eriksson & Kietzmann, 2018).

Simulating reality requires that participants experience a certain amount of realism in the design of the settling, interaction or artefacts in relation to the usage context, so that potential situations can be understood and dealt with more

quickly when they occur in the field of practice following simulation activity (Spetalen & Sannerud, 2013, p. 11).

Dalgarno and Lie (2010) explore the distinguishing characteristics of virtual learning environments for VR based on research published within the past two decades. This research is not directly related to VRW machines but *is* based on general use of 3D environments. We believe this also applies to VRW. Dalgarno and Lie have identified a set of features that include aspects of both representativeness and interactivity. When it comes to representational fidelity, the most important features are: a realistic display of the environment, a smooth display of view changes and object motion, consistency of object behaviour, user representation and spatial audio. Regarding interactivity, they point out different aspects of importance: kinaesthetic and tactile force feedback, embodied actions (including view control, navigation and object manipulation), embodied verbal and non-verbal communication, control of environment attributes and behaviour, and both construction of objects and scripting of object behaviours.

The two most vital visual aspects of the representational fidelity are a realistic display of the environment, and a smooth display of view changes and object motion. Displaying the objects using realistic perspectives and occlusion, as well as realistic textures and lighting, allows for realism that can approach photographic quality. However, even when the images do not approach photographic quality, with sufficient frame rates, the image changes that reflect the viewer's motion or motion of objects can appear smooth enough to provide a realistic experience. In relation to learner interaction, one aspect that is unique to VR is the ability to undertake embodied actions, including view control, navigation and object manipulation (Dalgarno & Lee, 2010). Furthermore, simulation must lead to a skills transfer and the application of something that one has learned or experienced in one situation over to another situation. Spetalen and Sannerud (2013) note that several factors in the transfer context affect whether simulation is suitable as a transfer strategy. This applies in particular to contextuality, overlapping tasks, an emphasis on the border between simulation contexts and usage contexts, and the extent to which the context of use invokes the use of experiences gained in the simulation context. The extent to which simulation experience is desired, enabled and allowed to be used, has a significant impact on how practice is transferred from simulation activities to final usage context.

Kinaesthetic memory refers to the extent to which the human body can recall its movements and postures. With kinaesthetic development from simulation activities, the experienced action space increases. Consequently, the implementation of simulated practice in the usage context also increases. Minor deviations in participants' experiences as relevant practice in the simulator context can be of great importance for the transfer of practice to the context of use. This may indicate that although the simulation activities are true to nature, relevant practice is

not transferred unproblematically from a simulation context to a usage context (Spetalen & Sannerud, 2013).

In welding training, it is fundamental to exercise and train hand and arm movements. Specifically, this means that the quality of a welding string depends on the movement of the welder in terms of the angle between the welding electrode and the workpiece, the speed of the welding electrode and the distance between the electrode and the welding bath. The welding bath is where the welding electrode is melted and binds together, for example, two steel parts. In order to perform approved welds a welding simulator is therefore designed to train users in gesture control (Johansen, 2013).

As it is important to ensure quality in welding, a person can accomplish specific physical movements through the use of sensory-motor learning and the development of kinaesthetic memory. According to previous research and feedback/observations gathered from experts, muscles that are of significant importance to welding performance include the *deltoid, trapezius, extensor digitorum* and *flexor carpi ulnaris*. Interviews with 16 professional welders and welding engineers revealed that they believed that sensory-motor learning was a very important component of successful welding. The activation and interactions of the muscles serve to define expert welder control, ability and stability during the commission of a weld (Stone, McLaurin, Zhong & Watts, 2013). With regard to physical development, (Keir & MacDonell, 2004) have demonstrated that the activation and interactions of muscles serve to distinguish between expert and novice control, ability and stability throughout the duration of a task.

The results of a study of VR-integrated training showed cognitive development comparable to traditional weld training. In addition, the kinaesthetic memory development in students using VR-integrated weld training was demonstrated to be different to that found in students using traditional weld training, specifically for downhand welding. This difference in kinaesthetic development was a contributing factor in the superior performance outcomes produced by participants in the VR integrated group (Stone et al., 2011b).

VRW machines

Over the past few years, there have been several types of welding simulators available that have used different simple techniques. More recently however, the combined use of VR and AR makes it possible to train welders without wasting consumables during the learning process. New VR systems can provide visual feedback to the user, indicating proper welding parameters such as travel speed, work angle and arc length (Stone et al., 2011b).

There are several suppliers of VRW machines. Fronius was chosen for this project. Fronius (2019) as a supplier notes that in welding, several consumables (metal, wire, gas, etc.) are normally required, which are expensive due to the

quantities involved, and that usage of these could easily be reduced in the early stages of learning. They further explain that novice welders could learn basic manual skills using an ergonomically shaped torch, typical workpieces and adjustable parameters, acquiring basic welding knowledge in a play-centred, hands-on manner. Fronius also point out that VR helps to foster group dynamics, as the various tasks can be discussed, practised and solved by trainees working together as a group. They explain that trainees are guided by colour signals true to the optimum welding speed, tip-to work distance and tilt angle they should use for the torch or electrode holder. Trainees will experience direct instant correction during the process. After training, they move on to simulation mode, where they start practising without guiding – with no help from signals. A pedagogically sophisticated points system means that comparable training results can be achieved again and again. Assessment is then made easier by an automatically generated ranking list. Another factor that promotes learning is the playback function. Every single welding operation is recorded and can be played back whenever needed, allowing the welding operation to be analysed accurately (Fronius, 2019).

Methodology

The context of the research is TVET in Technical and Industrial Production (TIP) at Aas upper secondary school in Akershus (Aas). TIP trains students involved in approximately 90 trades. The first year at TIP entails a wide professional approach and tries to be relevant to all the trades in the education programme. TIP training during the first year of upper secondary school contributes to a broad, technical subject platform, as required in many industries, enabling the more flexible use of labour in these industries. The training helps prevent accidents and injuries by focusing on health, safety and the environment. Joint program subjects emphasise the quality assurance of products, processes and services and familiarises students with the requirements of the workplace. Through training, students develop practical skills, gain professional insight, learn to reflect, and carry out critical assessments. Students learn to interact with others and to work independently in accordance with procedures and drawings, including registration and documentation. Students undergo basic, easy training in all parts of a production process, from planning, production and maintenance to documentation and quality assurance (LK06, 2006).

The stakeholders are Aas as the executive party in this context as well as the chosen supplier, Fronius in this case. The last one is Oslo Metropolitan University (OsloMet), which is both a Technical and Vocational Teacher Education institution in TVET subjects, and a research institution involved in this study.

We had conversations with two teachers and department heads once a month both in in the pre-phase from January to June 2017 and in the testing/

implementation phase September 2017 to June 2018. All the meetings were recorded and transcribed. The content of these meetings was thematic, based on three issues: (1) Our feedback and question on reflections from the previous meeting (We have not analysed and categorized the transcribed material every month, but we have looked for changes and developments from meeting to meeting). (2) What experiences the informants have had within the last period. (3) What is planned for the next period.

In addition to the meetings, we used a research log. The TVET teachers were encouraged to write up all their activities in the project. The log read continuously to gain a greater insight into the overall picture of the development work as the teachers experienced it (Hartviksen & Kversøy, 2008).

The data are based on these conversations, transcriptions and logs. The analysis is based on a phenomenological approach, in order to identify specific phenomena through how they are perceived by the actors in a situation (Lester, 1999; Postholm & Moen, 2009). In phenomenology, researchers are concerned with the study of experience from the perspective of the individual, 'bracketing' taken-for-granted assumptions and usual ways of perceiving. This becomes a tool for understanding subjective experience, gaining insight into people's motivations and actions, and moving away from assumptions and conventional wisdom. At the same time, it is important to see that epistemological and phenomenological approaches are based on a paradigm of personal knowledge and subjectivity, and thus emphasize the importance of personal perspective and interpretation (Lester, 1999, p. 1).

Phenomenological research can be robust in indicating the presence of factors and their effects in individual cases, but one must be careful not to generalize. The major challenge with phenomenological research is that it generates a large amount of interview notes. The analysis can quickly become messy when the information obtained is complex and difficult to place in neat categories. At the same time there may be many ways to tie the various statements to each other (Lester, 1999, p. 3).

Our research question and underlying question are described in the beginning of the article. It is difficult to draw conclusions in this type of research because it will suggest a finality and assurance that is not defensible. The discussions of the findings can however form the basis for reflection and further work, provided it is made clear what is being done (Lester, 1999).

Before starting the research project, we had only limited insight into VR welding as a technology and learning arena. As we gained insight into the topic of VR welding, the respondents found it interesting to be challenged on the questions we asked. A statement from the respondents substantiates this, 'We become more aware of what we think and do after talking to you.' As researchers, we tried to influence as little as possible with our own concerns, but rather by the participants' own insights. This interaction between respondents and researchers is

methodically interesting. In a way, researchers are woven into a community where mutual understanding of the research topic is developed together with the participants.

Results

Before the implementation, the following points were highlighted as advantages, disadvantages and areas of interest, or a combination of these: (1) the placement of the equipment and layout of the VR room, (2) the fact that there is no heat, noise or odour in VRW, (3) there are material savings with VRW, (4) an endless amount of practice is possible with VRW compared to true welding, (5) should VRW come before or after real welding? (6) proper guidance of the welding gun as a basic requirement, and (7) two welds may look the same where an x-ray is needed to see the difference between right and wrong.

As described earlier under simulation and transfer, the similarity between the virtual and the real is important. This was discussed and the decision was made to make a separate glass section in an adjoining room to the workshop due to environmental considerations and the cost of the machine. The glass cage has clear VRW symbols on it, so it is marked as a separate area. Workwear, gloves and safety shoes were purchased as normal HSE equipment used in workshops. A welding mask was also purchased since the one provided with the VRW did not function satisfactorily. VRW training is currently carried out without a real welding mask, but with VR glasses. Here research participants felt there was room for improvement.

The plan was for the teachers to start VRW at the start of the school year in August 2017, but they ended up starting after the autumn holiday. This was due to a busy schedule at the start of the school year and unforeseen events. After starting in November, the teachers' logs indicate that everything worked as intended, see later in this article. Although some minor challenges arose at start-up, the teachers dealt with these effectively. The pupils quickly learned from their teachers and were able to perform VRW procedures on their own.

In the conversations we had with the teachers after they had had some experience with the VRW in situ, they expressed that pupils using the VRW machine were far ahead (in terms of the number of exercises) than with the actual real-world welding exercise and that there was a greater student capacity with the VRW machine (the teachers experienced that three students could practice together without compromising capacity).

In the beginning the teachers experienced minor problems but as they become more familiar with the technology, they become adept at solving them. Some teachers mentioned that they initially had operating problems with starting the VRW machine. The simple solution that solved the problem was to re-insert all cables. This is time-consuming and this extra time comes at the expense of

training time. But this also only happened at the beginning of the start-up and is no longer a problem. The teachers were also curious about whether pupils who showed great aptitude for real welding would demonstrate the same quality in VRW. This prompted the teachers to test a pupil who had welded correctly in the welding boxes. He received almost the highest possible points in VRW on the first try. As mentioned in the method section, we encouraged teachers to write logs so that we could gain insight into everyday use of the VRW machine. Here are a number of excerpts from the logs that we believe show some of the 'little things' that provide insight into the daily experiences:

- [It is] a little annoying to determine where your hand is and what you see in the glasses. The picture in brilliance and reality do not match;
- It is easy to remove the glove and the difference is like night and day;
- The butt weld is not that bad, but the fillet weld is not easy when the guides in the glasses are not visible;
- In the VRW, the students show each other how to do things even when they are competing to achieve the highest score (The score indicates that they have completed the requirement and can progress to the next level) They work better together since they share a VRW. The other students sit in their own welding booth and practice by themselves;
- The pupils compared VRW with their own gaming machines at home and were not impressed by the picture and movement of the VR glasses. But they still find VRW interesting to work with;
- With regard to speed, distance comes before the angle. First with the assistant (teacher), then without, after which the different parameters are adjusted. They struggle with the angles without an assistant. Students get a bit frustrated, so it is advisable to change the score in the assessment system in the VR machine. Lower the requirement for the welding angles, since this is less important in reality.

As some of the excerpts from the logs shows, after that the teachers and students had used the VRW for a while, they could tell us how the systems worked as well as their weaknesses. The teachers explained that in VRW the welding bath where the welding electrode is melted is visually displayed in the VR glasses. At the same time, guides in green, yellow and red are displayed. If the student has all the values within green guides, the quality of the welding is correct. The parameters can be adjusted in the machine. In addition, an assessment system with scores has been added, which says something about goal achievement in the welding exercises. These point systems are derived from gaming technology but can be abstract in terms of both giving concrete feedback to the learner about the accomplishment of the welding skills or a pedagogically informed points system,

as the supplier of the WRW machine call it (Fronius, 2019). It turns out that this score is highly demanding for certain welds. Based on the small amount of experience already gained, the teachers wanted to correct the reference in the VR programme because the angle of the welding rod in VRW has too little tolerance in relation to ordinary welding. Currently, the scores are based on the teachers' discretion and are equivalent to what is required in relation to real welding exercises.

Discussion

Changing practice and introducing new learning tools is hard work and requires a considerable amount of will, interest and focus. A collaboration was established between the school, researchers and the supplier that helped focus on VRW and drive the project forward.

Much of the previous research described earlier in this article is American research on laboratory trials. It may be of interest to include this knowledge in the operational aspects of an existing training programme. Economically speaking, VR welding may prove beneficial compared to normal real-life welding training. The teachers involved in the VR welding project calculated that a fillet weld in reality has a unit price of around six euros. Experienced teachers know that students need to practice five to ten times to learn a fillet weld. A corresponding VR fillet weld will cost about 0.10 euros, leading to a didactic question. Is it possible that VR welding can be arranged so that this training can replace traditional welding training?

As a learning tool, the simulator has its limitations. The simulation from the VRW machine provided can be changed. Although it has been difficult, the teachers have undertaken changes to adapt it to the Norwegian model for welding training. What we know about these adaptations is that they involve comprehensive work and that it is necessary to know the VRW machine thoroughly in order to be able to make changes.

Initially, the teachers had an understanding that the simulator training could take place in groups. The teachers also took as a starting point, the simulated sequences that followed with the VR machine which proved to be of little use. These sequences had higher degree of difficulty in relation to the pupils' learning conditions and needs. The welding simulator operates with scores that say something about the skills that students have and must have. A student with little or no welding experience can start at 700–800 points. When they begin to gain some understanding of the flow of the weld, they are at around 1500 points. In order to have sufficient competence or training to weld in reality, students must be between 2500 and 2600 points. Students who can weld before they start TIP have achieved scores of up to 2800 points which means they do not gain anything through training in welding on the simulator.

Conclusion

Our main question in this article concerns the possibilities and limitations of a virtual welding machine, as well as how it might be introduced as an educational and didactic tool in upper secondary school. The welding simulator in its original design barely produces the desired learning effects. Based on the experiences teachers had with the welding simulator, they reworked the software to make it suitable for students at VG 1 TIP. After the reprogramming, it has a learning effect on students who have little experience with welding and / or poor motor skills.

The teachers learned that the VRW is not a learning tool for groups, but is more suitable for individual learning. The simulator is self-instructional and provides students with professional feedback on skill progression. The systematic development work done by the teachers in relation to content and progression has contributed to the welding simulator becoming a didactic teaching tool. The teachers describe the welding simulator as a 'teaching assistant'.

In general, the simulated teaching appears to require significant adaptation in order for it to have a didactic approach. Our analysis shows that the welding simulator would have had no value in learning without the systematic testing the teachers have done, adapting the software and its use.

In TVET, simulation is a known approach to learning. Professional didactics 'is about professional competence entailing something more and more than "application" of general theories and theory-based procedures' (Hiim & Hippe, 2001, p. 39). When VR technology (in our context, VR welding training), is considered as an 'application', it moves away to an even greater extent from the specific 'professional competence'. What kind of professional didactics can be developed in relation to VR learning, or can we describe virtual didactics as a new type of didactics? The simulation that we address here is the first step in gaining an understanding of whether it may be of professional interest to continue working on this topic.

Notes on contributors

Steinar Karstensen is an Associate Professor at the Department of Vocational Teacher Education at OsloMet – Oslo Metropolitan University, Norway. His area of interest is technology in work and learning. The field of technology and learning focuses on the development of technological competence, digitalisation, automation, robotisation, simulation and relations between technology and learning in different professions, and what implications this has for vocational education in secondary school and for vocational teacher education. He is also the leader of a research group with the same area of interest.

Arne Roar Lier is an Associate Professor at the Department of Vocational Teacher Education at OsloMet – Oslo Metropolitan University, Norway. His area of interest is linked to learning and work in a broad sense within technological disciplines. In vocational training there is the use of technology in the training with focus on VR/AR and robotisation and what this does with the education related to school and work. His research focus is related to bachelor, master and continuing education at the Department of Vocational Teacher Education at OsloMet. He holds a PhD degree from Roskilde University in Denmark entitled *From work to learning*.

References

Carl, D.R. (2018). The shifting realities of performance improvement: VR, AR, MR. *Performance Improvement, 57*(4), 6–9.

Dalgarno, B., & Lee, M.J.W. (2010). What are the learning affordances of 3-D virtual environments? *British Journal of Educational Technology, 41*(1), 10–32.

Farshid, M., Paschen, J., Eriksson, T., & Kietzmann, J. (2018). Go boldly! Explore augmented reality (AR), virtual reality (VR), and mixed reality (MR) for business. *Business Horizons, 61*(5), 657–663.

Fronius. (2019). *Virtual welding.* Retrieved December, 2019, from https://www.fronius.com/en/welding-technology/world-of-welding/virtual-welding

Hiim, H., & Hippe, E. (2001). *Å utdanne profesjonelle yrkesutøvere*. Oslo: Gyldendal akademisk.

Johansen, H. (2013). Styrkeberegning i sveiseforbindelser statisk. *Kompendium/ Høgskolen i Gjøvik, 2012 nr. 3*. Retrieved from http://www.ansatt.hig.no/henningj/materialteknologi/Skriftserien/SB_Sveiseforbindelser- Statisk_2012_nr.3.pdf

Keir, P.J., & MacDonell, C.W. (2004). Muscle activity during patient transfers: A preliminary study on the influence of lift assists and experience. *Ergonomics, 47*(3), 296–306.

Lester, S. (1999). An introduction to phenomenological research. *Stan Lester Developments*, 1–4.

Postholm, M.B., & Moen, T. (2009). *Forsknings- og utviklingsarbeid i skolen: Metodebok for lærere, studenter og forskere*. Oslo: Universitetsforlaget.

Spetalen, H., & Sannerud, R. (2013). Erfaringer med bruk av simulering som transferstrategi. *Nordic Journal of Vocational Education and Training, 3*(1), 1–17.

Stone, R.T., McLaurin, E., Zhong, P., & Watts, K.P. (2013). Full virtual reality vs. integrated virtual reality training in welding. *Welding Journal, 92*(6), 167–174.

Stone, R.T., Watts, K.P., & Zhong, P. (2011a). Virtual reality integrated welder training. *Welding Journal, 90*(7), 136–141.

Stone, R.T., Watts, K.P., Zhong, P., & Wei, C-S. (2011b). Physical and cognitive effects of virtual reality integrated training. *Human Factors: The Journal of the Human Factors and Ergonomics Society, 53*(5), 558–572.

Nordic Journal of Vocational Education and Training, 2020

Digitala körsimulatorer i yrkesutbildning: Utmaningar och möjligheter

(Digital driving simulators in vocational education: Challenges and opportunities)

Susanne Gustavsson, Giulia Messina Dahlberg & Ingrid Berglund

Göteborgs universitet, Sverige (susanne.gustavsson@ped.gu.se)

Abstract

This article discusses the didactical challenges and opportunities of driving simulator-supported teaching and learning, mediated through digital technology in vocational educational and training through the example of driving simulators. We highlight relevant research on simulator-supported teaching and the need for practice-based, empirically driven research. The study is part of a larger project that focuses on the implementation of simulator environments in three secondary schools in the natural resource programme. The data consists of three action research projects in two of these schools where vocational teachers, together with researchers, plan and implement teaching with driving simulators as a new technology in their practice. The article is an example of how action research can contribute to critical evaluation and development of teachers' professional work during the implementation of new technology. Results from these projects are analysed using the TPACK framework. The vocational teacher has a central position to 'master' the digital tool. Issues about fidelity, transfer and progression are discussed in terms of concepts that are challenged when new technology is introduced. Here, the vocational teacher's professional and content knowledge as well as the teacher's didactic and technical competence are central for the development of new strategies when the conditions for teaching change fundamentally.

Keywords: vocational education and training, driving simulator, simulator-supported teaching, learning, action research

NJVET, Vol. 10, No. 1, 108–136 Peer-reviewed article doi: 10.3384/njvet.2242-458X.20101108

Hosted by Linköping University Electronic Press

Inledning

Körsimulatorer är ett exempel på digitala verktyg som används i yrkesutbildning. Med simulator i yrkesutbildning avses här en resurs som fiktivt gestaltar användning av ett redskap, en yrkesrelaterad uppgift eller en situation på ett säkert och kontrollerbart sätt (Hirsch, Bellavance, Tahari & Faubert, 2015; de Winter, van Leuween & Happee, 2012). Simulatorn som digitalt läromedel i undervisningen förväntas skapa förutsättningar för elevens lärprocess och utveckling av yrkeskunnande via olika typer av övningar samt återkoppling av resultat. Undervisningen kan individualiseras till exempel genom upprepning eller anpassning av övningar. Simulatorer kan dessutom skapa individuella lösningar för elever i behov av särskilt stöd (Cox, Brown, Ross, Moncrief, Schmitt, Gaffney & Reeve, 2017). Det finns således flera användningsområden och argument för simulatorer i yrkesutbildning, men det saknas i hög grad kunskap om simulatorns betydelse för elevens lärande. Samtidigt behövs kunskap om lärares didaktiska strategier och val när det gäller organisering och genomförande av simulatorstödd undervisning. Implementering av olika typer av digital teknik i skolan har ofta inneburit en tämligen okritisk inställning till hur dessa kan användas och integreras i undervisning (t.ex. Palak & Walls, 2014). Trots att mer än 20 år har passerat sedan första IT-satsningen i svensk skola, ses digitala verktyg än idag som ”lösningen” till många problem, från effektivisering av undervisning, till ökad anpassning samt som verktyg för dokumentation. Digital teknik och ”skolans digitalisering” fortsätter att retoriskt presenteras i dikotomiska och onyanserade termer: antingen är läraren och eleven en vän av teknik eller så är de inte det. Många satsningar som görs i skolan och som ger positiva effekter på elevernas förutsättningar är fortfarande ett resultat av enskilda eldsjälars arbete. Ibland kan satsningar vara ett resultat av skolledningens vision och samarbete med privata och vinstdrivande edtechföretag, som numer utgör och leder den övervägande större delen av de pedagogiska satsningar som görs i skolan när det gäller implementering av digital teknik (i denna studie körsimulatorer) i undervisning.

Föreliggande artikel belyser dessa spänningar som vi menar behöver undersökas från ett perspektiv som problematiserar antagandet att digital teknik möjliggör mer anpassade och flexibla undervisningsformer per se, utan att närmare granska relationen mellan ämnesinnehållet, användare (både lärare och eleven) och digital teknik, samt hur den senare omformar en social praktik. Etnografisk forskning som bygger på longitudinella observationer (där dokumentation med rörliga bilder och annan visuell teknik är en förutsättning) och där analysen fokuserar på det som görs i en praktik, snarare än talet om en praktik, behövs för att kunna belysa hur digital teknik används, samt vilka hinder och möjligheter den erbjuder i en specifik praktik. Detta fokus eller intresse bygger på en förståelse av lärande och utveckling som situerade i en social praktik där användare och sociokulturella artefakter samspelar.

Syfte och frågeställningar

Studiens syfte är att undersöka samt kritiskt granska utmaningar och möjligheter vid simulatorstödd undervisning i gymnasial yrkesutbildning med fokus på undervisning och på elevers lärprocess. Mer specifikt, vad kännetecknar undervisning med körsimulatorer när kunskapsinnehåll, undervisningsformer samt digital teknik behöver samverka och vilken betydelse får det för undervisningen? Vilka konsekvenser får det för lärarens val av stödstrukturer i undervisningen? Vilken roll spelar simulatorer i undervisningen för att stödja elevens utveckling av yrkeskunnande och övergången till användning av autentiska maskiner?

Bakgrund

Forskning om simulatorstödd undervisning har, både nationellt och internationellt, fokuserat på simulering inom luftfart, sjöfart och sjukvård, främst inom högre utbildning (Dahlstrom, Dekker, Van Winsen & Nyce, 2009; Korteling, Helsdingen & Sluimer, 2017; Petzold, Weiss, Krems & Bannert, 2013). Körsimulering har främst studerats som ett instrument för att bedöma och undvika en del potentiellt farliga beteenden i trafiken, då mest med koppling till unga förare (Hirsch m.fl., 2015), samt för att bedöma simuleringens autenticitet och validitet som verktyg för träning av körning i olika situationer (Petzold m.fl., 2013) och med förare med en diagnos inom autismspektrum (Reimer, Fried, Mehler, Joshi, Bolfek, Godfrey, Zaho, Goldin & Biederman, 2013; Cox m.fl., 2017). Forskning inom körsimulering fokuserar även på utveckling och utvärdering av tekniken och hur användarens körning i en simulerad miljö förhåller sig till en ”autentisk situation” via prestationer hos erfarna förare. Simulering i en fiktiv, digital miljö blir således en ett verktyg för att träna i säkra förhållanden med syfte att dels utveckla de färdigheter som krävs för körning, dels för att jämföra beteende vid körning i en simulator med körning i en autentisk situation hos den erfarna föraren. Exempelvis i Petzold med flera (2013), studeras förarens beteende (blickens rörelse) i en simulerad körning där nybörjare och erfarna förare jämförs i olika scenarier. Syftet med studierna handlar således mer om utveckling och optimering av simuleringsteknik som sådan, än om exempelvis relationen i en didaktisk praktik där den digitala miljön, användare och instruktör samspelar.

Relevanta spår i forskning om simulering i pedagogiskt syfte, dock inte med specifikt fokus på körning av bil eller andra maskiner, är studier som rör simulering som spel, samt i förhållande till innehållet i undervisning i termer av stödstrukturer (scaffolding) och överföring av kunskaper mellan olika sammanhang (transfer). Enligt Fu-Hsing, Charles, Kuo-Hsun, Cheng-Ling och I-Ying (2013), innebär digital simulering och dess utformning som spel att eleven tenderar att fokusera på spelet (i termer av att befinna sig i spelet och klara av dess utmaningar), snarare än att fokusera på det avsedda kunskapsinnehållet. Med andra

ord, möjligheten att skapa ”immersive experience” hos eleven i den digitala simulerings-/spelmiljön innebär inte per automatik att eleven kommer i kontakt med och utvecklar relevant kunskap. Att stötta elevernas lärande (genom scaffolding) utan att avbryta spelets ”flow”, blir således en central fråga i arbetet med digital simulering (Fu-Hsing m.fl., 2013).

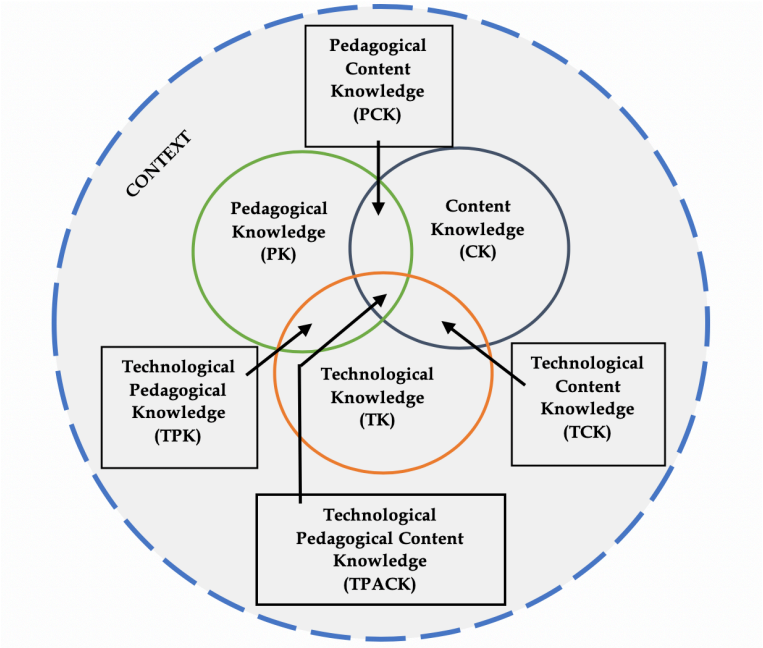
Begreppet transfer och mer specifikt transfer-of-training (Korteling m.fl., 2017) används för att belysa relationen mellan det yrkeskunnande som är i fokus i utbildning och sätten på vilka detta kunnande används i en yrkeskontext (Aarkrog, 2011). Generellt sett kan flera liknelser mellan simulerade scenarier i en utbildningssituation (inklusive deras fysiska, funktionella och psykiska element) och den ”riktiga världen” innebära att transfer av kunskaper mellan dessa två situationer kan ske. Korteling med flera (2017) hävdar dock att förhållandet mellan utbildning och yrkesliv är mer komplext. Att förutse vilket lärande som sker i en utbildningssituation och dess inverkan på det som äger rum i olika situationer i en mer eller mindre nära framtid är mycket svårt. De didaktiska aspekterna gällande val av kunskapsinnehåll, undervisningsformer och genomförande som är inbäddade i simuleringsmiljön, samt lärares kunskaper blir avgörande. Det räcker således inte med hög autentisk faktor eller fidelitet i en simuleringsmiljö om inte relevanta didaktiska beslut tas i samband med undervisning i förhållande till exempelvis svårighetsgrad, vad som görs (o)synligt i miljön och hur det som simuleras behandlas i undervisningen på ett mer abstrakt och generellt plan (Korteling, m.fl., 2017).

I en yrkesutbildning, förutsätts att den skolförlagda delen av utbildningen och lärandet på arbetsplatsen är starkt sammankopplade. I vissa fall finns förväntningar att den kunskap eleven utvecklar under utbildningen ska motsvara arbetsuppgifter som ingår i yrket. Idén om att eleverna lär sig under utbildning för att kunna genomföra mer eller mindre specifika arbetsuppgifter i yrket har behandlats i forskningen i termer av ”boundary-work” eller ”boundary-crossing” (t.ex. Akkerman & Bakker, 2011; Gieryn, 1983; Llewellyn, 1998; Tuomi-Gröhn & Engeström, 2003). Detta kan även gälla pendlingen mellan lärmiljöer under yrkesutbildningen och uppfattningen om vad eleven ”ska ta med sig” för kunskaper mellan miljöerna, men också vad respektive miljö kan erbjuda eleven och hur kunskap kan integreras. Den så kallade teori- och praktikrelationen utmanas därmed. Begreppet transfer kan användas för att förstå hur rörelser mellan olika praktiker är länkade men också separerade från varandra, med tydliga gränser i tid och rum (Aarkrog, 2011). Gränsöverskridande utbildning mellan kontexter (och fysiska rörelse där emellan) är centrala aspekter menar Berner (2010), med stöd i Gieryn (1983). Gränsarbete (boundary-work) kan dock innebära att gränserna mellan skola och arbete förstärks, snarare än suddas ut. I en digital miljö som ter sig mycket nära den autentiska miljön och yrkespraktiken, kan gränserna mellan utbildning och yrkesutövning överbryggas, men också förstärkas.

Sammanfattningsvis, finns behov av studier om simulatorstödd undervisning i yrkesutbildning. Studier om simulatorer i annan kontext eller studier om spel saknar relationen till lärprocesser och kunskapsutveckling. Relationen mellan övning av yrkeskunskap via simulatorer och på arbetsplats avseende vad eleven lär sig i de olika miljöerna, och hur undervisningen bäst kan designas för att dra nytta av de möjligheter som en simulator erbjuder är hittills okänd kunskap. Undervisningsnära studier är ett sätt att närma sig dessa frågor.

TPACK-modellen som analysredskap

I analysen av hur undervisningen tar form när körsimulatorer tas i bruk används teorin om Technological Pedagogical Content Knowledge (TPACK) (Herring, Koehler & Mishra 2008; Koehler & Mishra, 2009; Mishra & Koehler, 2006). TPACK framställs som en modell för hur olika kunskapsområden tar sig uttryck, formas och samverkar i undervisning när tekniska redskap används. Den är en utveckling av Lee Shulmans (1986, 1987) teori om Pedagogical Content Knowledge (PCK). PCK uppstår när två kunskapsområden, Pedagogical Knowledge (PK) och Content Knowledge (CK) samverkar och förenas i undervisning, vilket resulterar i att ett tredje specifikt kunskapsområde uppstår, PCK. Med användningen av allt fler tekniska och digitala redskap i undervisning utgör teknisk kunskap ytterligare ett kunskapsområde i förhållande till pedagogisk kunskap och innehållskunskap (Angeli & Valanides, 2009; Graham, Borup & Smith, 2012).



Figur 1. TPACK-modellen och dess kunskapsområden (modifierad från Koehler & Mishra, 2009).

Den visualiserade modellen av TPACK visar att när teknisk utrustning används i undervisning uppstår flera nya kunskapsområden i förhållande till PCK: teknisk kunskap (TK), det tekniska ämnesinnehållet (TCK) och teknikdidaktisk kunskap (TPK). Dessa kunskapsområden samverkar och nya integrerade kunskapsområden uppstår (som synliggörs i de överlappande fälten i modellen). Att använda TPACK-modellen som analytiskt redskap innebär att undervisning som involverar användning av teknik undersöks utifrån följande aspekter: de tekniska redskap som används, ämnesinnehåll och i vilken kontext undervisningen sker samt den didaktiska och tekniska kunskap undervisande lärare har. Det innebär att lärare som vill integrera tekniken i sin undervisning måste vara kompetenta inom modellens tre områden (Voogt, Fisser, Pareja Roblin, Tondeur & van Braak, 2013). Herring med flera (2008) uttrycker att undervisning med stöd av teknisk utrustning är situerad i en specifik kontext och tar därför form på varierande sätt. Därför är det av vikt att beskriva sammanhanget för undervisningen vid analyser utifrån TPACK-modellen. Doering, Veletsianos, Scharber och Miller (2009) lyfter fram TPACK-modellens dynamiska karaktär och det ömsesidiga förhållandet mellan kunskap i ett skolämne och det som sker i undervisningen. Cox och Graham (2009) synliggör utförligt i konceptuella analyser av de integrerade fälten i TPACK-modellen innehållet i de nya, specifika och integrerade kunskapsområden som skapas utifrån användning av teknik i undervisningen (se även Figur 1). I föreliggande studie används TPACK för att identifiera motsvarande fält och dess utmaningar och möjligheter vid simulatorstödd undervisning. TPACK bidrar således till att synliggöra kunskapsinnehåll, pedagogik och teknik samt hur dessa kunskapsområden samspelar och får betydelse i undervisningen och för lärarens val av stödstrukturer.

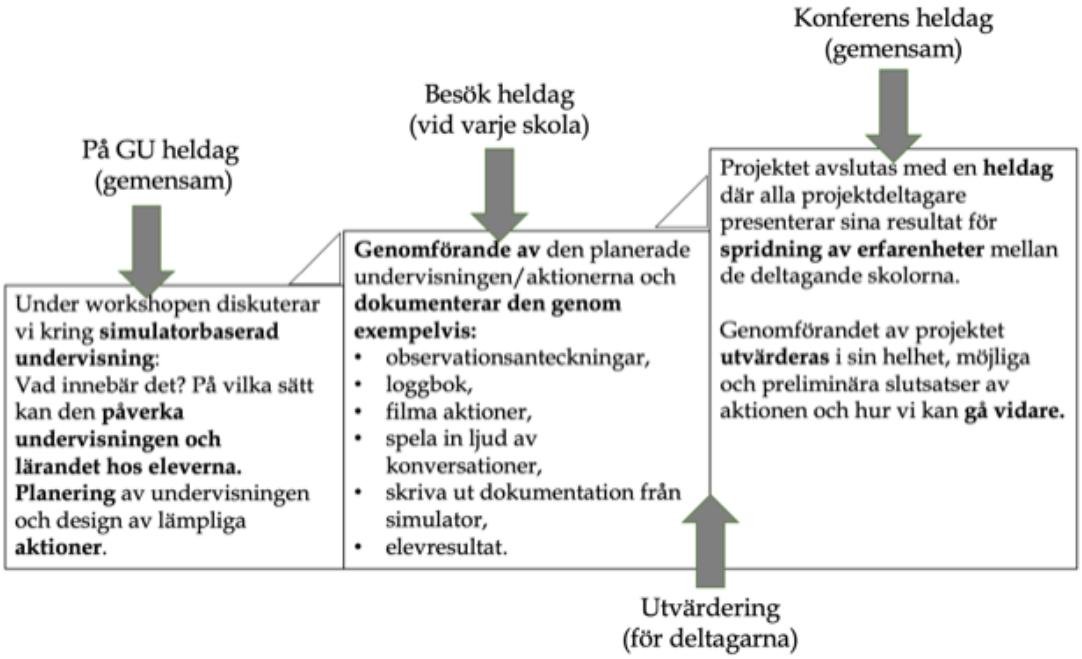
Metod

Studien genomförs vid två gymnasieskolor som använder digitala körsimulatorer i naturbruksutbildning, med inriktning mot skog respektive lantbruk. Från att undervisningen tidigare enbart har kunnat ske i autentisk miljö i skola och på arbetsplats, finns nu simulatormiljöer. Simulatormiljöerna är resultat av ett externfinansierat fyraårigt utvecklingsprojekt som har skapat möjligheter att inreda undervisningslokaler särskilt avsedda för simulatorstödd undervisning. Denna förändring får betydelse främst för yrkeslärarens arbete, där miljön skapar nya villkor för undervisningen. Yrkeslärare med ansvar för utbildning inom körteknik och angränsande arbetsuppgifter har involverats i den lokala processen att organisera simulatormiljöer och utformningen av simulatorstödd undervisning.

Yrkesutbildningens styrdokument samt yrkesbranschens behov av kompetens har varit vägledande för val av simulatorer och utveckling av miljön. Ett särskilt mål har varit att skapa så goda förutsättningar som möjligt för att alla elever ska utveckla relevant yrkeskunskap. Andra incitament var miljöaspekter,

ekonomi, säkerhet och tillgänglighet. Utvecklingen av simulatormiljöer i dessa skolor har således haft flera övergripande motiv som rör undervisningspraktiken och utbildningen. Yrkeslärares medverkan i skapande av simuleringsmiljöer har genererat samtal om undervisning, om konsekvenser för elevers lärprocesser och utveckling av yrkeskunskap. Efterhand har dessa samtal och frågor skapat intresse för undervisningsnära studier som mer systematiskt undersöker villkor, förutsättningar och effekter kring simulatorstödd undervisning.

I samband med arbetet med utveckling av simulatormiljöer i respektive skola, startade projektet Yrkesutbildning och Simulering (YRKSIM) där yrkeslärare tillsammans med forskare identifierade frågeställningar som utgångspunkt för undervisningsnära projekt. Studiens data genererades vid tre aktionsforskningsprojekt i två skolor, som här benämns skola A och B. YRKSIM inleddes med ett heldagsmöte där yrkeslärare, skolornas IKT-pedagog samt forskare genomförde kartläggning av yrkeslärarnas undervisningskontexter, formulerade frågeställningar och aktioner. Avslutningsvis bestämdes en plan för tre aktionsforskningsprojekt (Figur 2).



Figur 2. YRKSIM – Projektdesign.

Aktionsforskningsprojekten följde den spiralformade processen: planera, agera, observera och reflektera (Hardy, Rönnerman, Edwards-Groves, Fumasoli, Stensaker & Vukasovic, 2018), vilket gav möjlighet att både identifiera, pröva och utvärdera frågeställningar direkt knutna till simulatorstödd undervisning. De tre aktionsforskningsprojekten hade delvis olika syften och mål utifrån de behov som identifierades och prioriterades. Dock hade samtliga projekt tydligt fokus på

de didaktiska utmaningar och möjligheter som var en följd av planering och genomförande av simulatorstödd undervisning. En forskare knöts till varje skola. Sammanlagt fyra yrkeslärare var involverade. Aktioner, uppföljningar samt analyser genomfördes av yrkeslärare och forskare i samarbete. En forskare medverkade i projektet på Skola A tillsammans med två yrkeslärare (Aktionsforskningsprojekt 1), en forskare medverkade i de två projekten på Skola B (Aktionsforskningsprojekt 2 och 3) tillsammans med en yrkeslärare i respektive projektet. I resultatavsnittet ges en mer utförlig beskrivning av skolorna och aktionsforskningsprojekten inom YRKSIM (se Figur 2).

Studiens data hämtades från yrkeslärarnas uppföljning av respektive aktionsforskningsprojekt samt forskares loggböcker och intervjuer. Mer precist skapades följande data:

Tabell 1. Metoder för uppföljning av aktioner.

Skola A Aktionsforskning 1	Skola B Aktionsforskning 2	Skola B Aktionsforskning 3
Elevers självvärderingar med stöd av ett framställt underlag Lärares observationer av undervisning med stöd av observationsmall Inspelade gruppintervjuer med elever Kontinuerliga dokumenterade samtal mellan lärare och forskare	Systematiska elevobservationer med hjälp av olika matriser Lärarens observationsanteckningar Stillbilder och rörliga bilder Kontinuerliga dokumenterade samtal mellan lärare och forskare	Systematiska elevobservationer med hjälp av olika matriser Lärarens observationsanteckningar Stillbilder och rörliga bilder Kontinuerliga dokumenterade samtal mellan lärare och forskare

Data analyserades först var för sig och därefter gemensamt med utgångspunkt i studiens syfte att undersöka samt kritisk granska utmaningar och möjligheter vid simulatorstödd undervisning. I analysen användes TPACK för att dels identifiera och beskriva de tre kunskapsområdena PK, CK och TK (Figur 1), dels för en övergripande analys av vilken form TPACK antar i de tre aktionsforskningsprojekten. Utmaningar och möjligheter identifierades via de mönster som framträdde i analysen.

Medverkande lärare och elever var informerade om forskningsetiska principer om frivillighet, samtycke, konfidentialitet och nyttjande i samband med aktionsforskningsprojekten. Lärarna har även gett sitt godkännande till användningen av data i föreliggande artikel.

Resultat

De tre aktionsforskningsprojekten bildar utgångspunkt för studiens resultat. Inledningsvis presenteras aktioner, uppföljning och resultat för respektive projekt. Därefter görs en sammanfattande och fördjupad analys med stöd av TPACK-modellen.

Skola A: Körning av skogsmaskiner

Den aktuella undervisningen i Skola A gäller körning av skördare och skotare. En skördare är en terränggående maskin som kapar, kvistar och avpassar ett träd till stockar och en skotare är ett terrängfordon som används för transport av virke från avverkningsplatsen till en uppläggningsplats (Figur 3).

Figur 3. Skotare.

Körsimulatorerna finns i ett centralt beläget simulatorcenter i Skola A (Figur 4). När YRKSIM-projektet startar finns märkesspecifika körsimulatorer, vilket innebär att de exempelvis har samma typ av styrdon (joysticks) som en autentisk maskin av motsvarande modell. Under projektets gång tillkommer nya, och mer avancerade körsimulatorer i form av kombinationssimulatorer som kan anpassas till olika maskiner genom byte av styrdon, samt datorprogram som simulerar olika slags maskiner och fordon.

Figur 4. Simulatorcenter Skola A.

Initialt är en lärare med lång erfarenhet av undervisning i körning av skogsmaskiner, både autentiska och i körsimulator, engagerad i projektet. Senare involveras en yrkeslärare utan tidigare erfarenhet av simulatorstödd undervisning.

Kranhantering vid körning av skotare i simulator (Aktionsforskningsprojekt 1)
Efter kartläggningen av vad som är angeläget att undersöka och utveckla i den aktuella undervisningen riktas aktionen mot lärande av kranteknik vid körning av skotare, vilket är en central kunskap när timmer ska lastas i terräng och en viktig aspekt av ekonomisk körning. Den övergripande frågeställningen är hur simulatorkörning kan utveckla elevers förmåga till ekonomisk körning av skogsmaskiner, samt bidra till en högre ingångsnivå inför körning av autentisk skogsmaskin. Det yrkesämne som ingår i studien är skogsmaskiner och kursen terrängtransporter. Eleverna som representerar flera årskurser engageras som medforskare i projektet genom att ett underlag skapas för självskattning i förhållande till centrala kunskaper i kranhantering för körning av skotare. Inledningsvis gör yrkeslärarna en analys av vad som är centralt kunnande i körningen som resulterar i sex aspekter:

1. Kranrörelser (fysisk/motorisk träning mot automatisering)
2. Utskjutets användning (för effektiva arbetsprocesser)
3. Ekonomisk kranhantering (planering av kortaste väg)
4. Grippunkt (den optimala grippunkten)
5. Knippets lutning (positiv lutning mot grinden)
6. Flyt i kranhanteringen (bör-värde, helhetsbedömning)

Efter varje övningstillfälle skattar eleverna sin kunskap om respektive aspekt på en skala från 1 till 5. Uppföljningen i form av elevers självskattning blir parallellt ett redskap för elevers reflektion över sin egen kunskapsutveckling. De olika aspekterna ger även en möjlighet att betona det som framstår som viktigt att lära sig gällande körning av skotare. Yrkeslärarna observerar och dokumenterar elevers kunskapsutveckling vid simulatorkörningen, samt har löpande diskussioner om hur undervisningen kan utvecklas. Elevernas självskattningar sammanställs till grafer och analyseras av lärare och elever. Därefter genomförs elevintervjuer för att ta vara på elevernas erfarenheter av simulatorkörningen.

Utifrån sammanställningen av självvärderingar genomförs två gruppintervjuer med vardera fem elever från årskurs 1 och 2. Grupperna sätts samman av en yrkeslärare. Vid intervjuerna får eleverna se graferna över sina självskattningar som utgångspunkt för frågor om hur det är att lära sig köra skotare i simulator, och vilken kunskap de uppfattar att de har utvecklat genom simulatorkörningen. Eleverna uppmanas att beskriva vad de har lärt sig och vad de uppfattar som lätt respektive svårt, samt värdera för- och nackdelar vid simulatorkörning av skotare. Vid intervjutillfället har flera av eleverna erfarenheter av körning i autentiska maskiner och uppmanas därför att beskriva skillnader och likheter med simulatorkörningen. Intervjuerna genomförs av den yrkeslärare som inte är direkt involverad i undervisningen och forskaren. Intervjuerna spelas in, avlyssnas av båda yrkeslärarna och transkriberas i sin helhet av forskaren. Resultatet av intervjuer med elever beskrivs nedan i fyra kategorier.

Simulatorövningar för mängdträning och automatisering

Eleverna uppfattar att simulatorkörningen i hög grad handlar om den motoriska träningen.

> Det är bara att sitta och nöta egentligen. Bara att sitta och känna på kranen så att man får in alla tekniker samtidigt. (Elev 1)

Att få in alla tekniker samtidigt kan beskrivas som att eleverna ska automatisera handrörelserna, vilket innebär att göra flera handrörelser simultant, men också att planera kranens och utskjutets rörelse så effektivt som möjligt.

> Att man får in flera grejer samtidigt. Att du flyttar och får ut utskjutet samtidigt och att du öppnar grinden. Det tycker jag är rätt bra och det tänkte man inte på innan. (Elev 4)

Eleverna uttrycker att det krävs mycket träning för att automatisera kranhanteringen.

> Det svåraste är att få ett bra flyt. Att det ska gå så fort och effektivt som möjligt. (Elev 3)

Alla elever är överens om att simulatorer är bra för körträningen och att de i princip har lärt sig kranrörelserna genom simulatorövningar. Eleverna uttrycker samstämmigt att den motoriska träningen i simulatorer innebär att de är bättre förberedda för autentisk körning.

> Öva och bli bättre. För att lära sig och känna in hur det fungerar på ett ungefär för att sedan gå ut och göra det på riktigt. (Elev 5)

Simulatorerna har inbyggda program för olika övningar som används i undervisningen.

> Jo, John Deer-simulatorerna har ju ett studentprogram, där du kan gå in och då har du väldigt uppritat vad du ska göra och så poängbedöms det. Simultana kranrörelser och bränsleförbrukning och allt möjligt. Det är ju det som man behöver lära sig. (Elev 5)

I intervjuerna diskuteras de olika simulatorernas upplägg i övningarna, där det stegvisa upplägget som innebär att uppgifterna bygger på varandra uppfattas som mindre stimulerande.

> Elev 7: Det är just det att man måste utföra en viss del för att komma vidare.
>
> Elev 8: Om man måste börja om då tröttnar man ju. Först lär du dig att starta traktorn typ, sen åka framåt typ.
>
> Elev 10: Om du ska köra maskin så måste du veta alla delar innan du får gå vidare till nästa.
>
> Elev 7: Kolla alla oljor, göra rent filter.

Som framgått finns det en blandning av märkesspecifika simulatorer och kombinationssimulatorer i skolans utrustning. Eleverna menar att det kan vara bra med olika typer av simulatorer så att de kan få testa olika varianter. Det finns en gemensam standard för styrdonen på skotare, medan andra funktioner kan variera.

> Elev 3: Det är ungefär samma spakar. Kranens joystick är nästan uteslutande likadan.
>
> Elev 1: Den är likadan i alla maskiner. Det är bara placeringen av andra olika funktioner, så som lampor och vindrutetorkare – det kan vara olika.

Simulatorer och autentisk körning

Vid jämförelse av körning i simulatorer med körning i autentiska skotare beskriver elever utifrån sina varierande erfarenheter exempel på skillnader mellan vad som är möjligt att lära sig vid simulatorkörning och vilket kunnande som behöver utvecklas genom autentisk körning. Eleverna framhåller tydligt att simulatorer inte kan ersätta autentisk körning, men den motoriska förmågan i körningen går att utveckla i simulatorerna. De skillnader som lyfts fram är fidelitet som inte går att konstruera fullt ut i simulatorernas datorskärmar, men som har utvecklats betydligt med mer avancerad grafik i de nyare simulatorerna.

> Elev 2: Kanske det där med djupseendet. Det är svårt att se det i simulatorerna. Det är lättare i verkligheten.
>
> Elev 3: Framförallt avståndsbedömningen som är den största skillnaden. Sen är det miljön som blir annan. Det lutar och det låter, men själva krankörningen i maskin är ju exakt densamma.
>
> Elev 5: Det du inte känner i simulatorn, det är lutningen. I dom nya simulatorerna är det en platta som gör att stolen rör på sig. Så om du kör upp på en sten då lutar du. Svänger du för fort så känner du.
>
> Elev 6: Det är ju inte samma att sitta i simulatorerna som i en riktig maskin så det blir inte riktigt samma sak. Man ser inte så bra i simulatorerna.
>
> Elev 7: Dom nya är bättre än dom gamla. Det är mer verkligt. Det är större skärmar och att sätta sig i riktiga stolar…

En annan skillnad som eleverna beskriver gäller terrängkörningen och där stolarna på de nyinköpta simulatorerna kan röra sig i förhållande till den visualiserade terrängen. Användning av VR-glasögon ger ett mer verklighetstroget seende, men som kan skapa illamående.

> Jag tyckte att dom var jättebra för då kom man åt och då blir det verkligt om man typ välter nånting. (Elev 10)
>
> Sen har vi dom här VR-glasögonen. Då blir det lite mer verkligt. Men det går inte, jag mår jätteilla av dom. (Elev 6)

Simulatorer och riskfri körning

I en simulator kan man riskfritt träna farliga situationer där skador annars kan uppstå. Eleverna uttrycker att det inte är säkert att de tänker på att motsvarande situation som simuleras faktiskt kan uppstå i den autentiska körningen.

> Elev 1: Sen är det skaderisken, om det händer nåt med föraren där ute i skogen. Kör du i simulatorn då händer det inget, men är det på riktigt då…
>
> Elev 4: Oj, då. Man får väl börja om då. Men man tänker ju på vad som skulle hända om jag välter på riktigt.
>
> Elev 7: Man tar det mer som ett spel, liksom. Man startar bara om.
>
> Elev 3: På Wimek-simulatorn. Kollision med träd, kollision med maskin. Det står att du har skadat maskinen, typ. Då får man börja om. Om man kör på nån eller har skadat maskinen.
>
> Elev 9: Det är billigare att göra misstag på dom än i riktiga maskiner.
>
> Elev 2: Man tänker att nu har jag lärt mig hur man inte ska göra. Då får man träna på hur man ska göra.

Farliga situationer som uppstår i simulatorn tar eleverna kanske mer för ett spel än som en träning för att undvika sådana situationer när de kör i terräng. Det framgår att det inte finns några övningar i simulatorerna för att reflektera över sådana farliga händelser. Det handlar bara om att starta om simulatorn.

Yrkeslärares utmaningar och möjligheter till utveckling av undervisningen

Yrkeslärarna lyfter fram flera fördelar med simulatorerna: de kan ge möjlighet till mängdträning, är årstidsoberoende och ger träning i en trygg miljö. Eleverna ges möjlighet att automatisera kranhanteringen i simulatorerna vilket dels främjar ekonomisk körning, dels medför en tidsbesparing då eleverna blir bättre förberedda för körning i autentiska skotare. En utmaning som lärarna särskilt lyfter fram är:

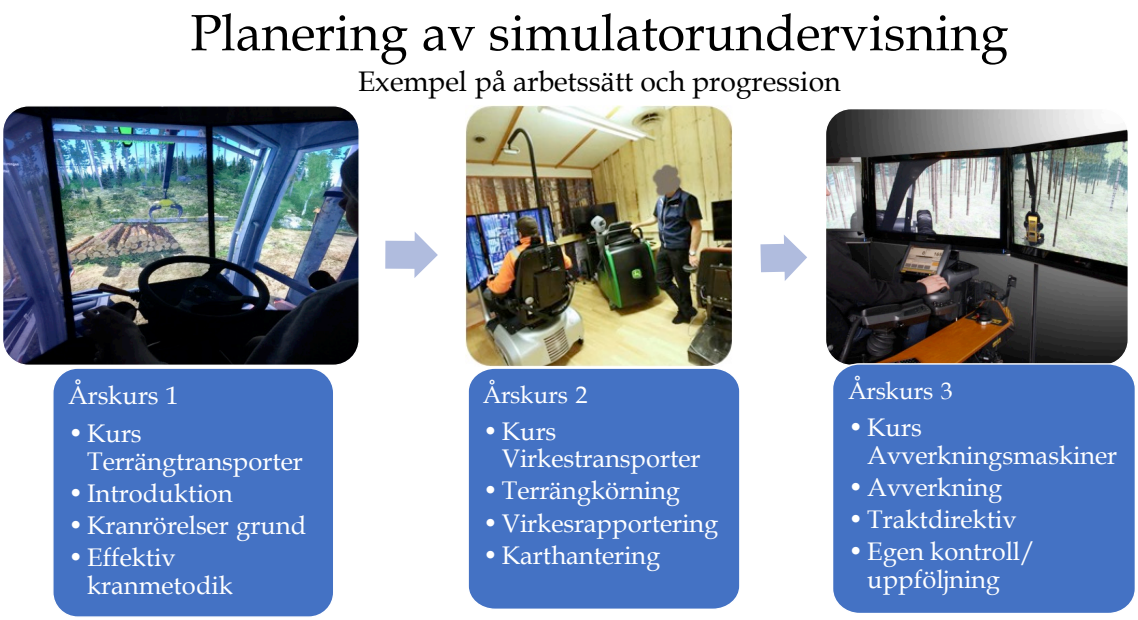
> Att eleverna inte respekterar simulatorn som ett redskap för lärande utan istället leker med utrustningen. Det kan skapa negativ inlärning som vi sedan får lida av vid autentisk maskinkörning. Konsekvenser vid våldsam körning uteblir i simulatorkörning, vilket det inte gör i verkligheten. (Ur lärarnas anteckningar)

Det finns därför behov av uppföljning av risker i körningen och lärarna menar att de behöver utvärdera sådana situationer i undervisningen genom att exempelvis använda blanketter för tillbudsrapporter. Aktionen skapar också konkreta idéer om hur undervisningen kan utvecklas, och där ämnesintegrering är en viktig aspekt.

> Konkret så kommer det fungera som så att vid exempelvis en mattelektion kan en simulatorlärare vara behjälplig för eleverna att skapa siffor eller matteproblem, som sedan används i matematikundervisningen. Tanken är alltså inte att plocka bort 30 procent av maskinkörningen ur maskinkurserna för att dedicera till simulatorkörning, utan snarare att integrera in simulatorerna i en blandning av kurser. (Ur lärarnas anteckningar)

Utifrån dessa samtal och frågan om hur lärarna kan använda simulatorerna fortsatt i undervisningen skapas ett förslag till ämnesintegrering och hur innehåll i olika kurser skulle kunna genomföras som uppgifter i samband med simulatorkörning. Det handlar om att exempelvis i årskurs 2 genomföra virkesrapportering och karthantering i samband med övningar i simulator. I årskurs 3 skulle traktdirektiv och egenkontroll kunna bli lämpliga uppgifter. Simulatorerna ger också möjlighet till gruppövningar som kan samordnas med att uppgifterna utförs, en möjlighet som lärarna kan använda i undervisningen fortsatt (Figur 5).

Aktionen handlar om hur simulatorkörning kan utveckla elevers förmåga till ekonomisk körning av skogsmaskiner samt bidra till en högre ingångsnivå vid körning av autentiska skogsmaskiner. Resultatet visar att eleverna utvecklar förmåga till effektiv kranhantering som i sin tur ger bättre förutsättningar för ekonomisk körning. Det framkommer även rika möjligheter att utveckla undervisningen med stöd av körsimulatorer i kombination med körning i autentiska maskiner. Lärarna lyfter genom sina observationer och didaktiska samtal fram vikten av att integrera körningen i simulatorerna med flera yrkesämneskurser och övriga ämnen över hela utbildningen. Eleverna har genom självskattningar med uppföljande samtal reflekterat över det egna lärandet av körning i simulatorer och gett ett viktigt bidrag till förståelsen av vilken kunskap som kan utvecklas vid simulatorkörningen.



Figur 5. Planering av simulatorstödd undervisning. Exempel på kursinnehåll och progression.

Skola B: Simulatorstödd undervisning och förutsättningar för lärande

Lärare och elever vid Skola B har tillgång till en körgård och en simulatormiljö som erbjuder kombinationssimulatorer, märkesspecifika skogs- och lantbruksmaskinssimulatorer samt en trafiksimulator (Figur 6).

Figur 6. Körgården och simulatorcenter i Skola B.

Två lärare medverkar i projektet och båda har engagerat sig i att utveckla och bedriva simulatorstödd undervisning redan före YRKSIM startade. Två aktioner genomförs inom ramen för YRKSIM, båda med fokus på olika delar av innehåll och kursmål inom ämnet fordonsteknik. Den övergripande frågeställningen som ligger till grund för båda aktionerna syftar till att nå en djupare förståelse för hur simulatorstödd undervisning kan skapa förutsättningar för lärande i förhållande

till ämnets syfte och dess centrala innehåll. Med detta som utgångspunkt, identifieras några områden för planering och genomförande av olika moment i undervisning: körning av, samt kunskapen om, skördetröskan (Aktionsforskningsprojekt 2) och trafikregler i samband med körning av basmaskin (Aktionsforskningsprojekt 3). En mer detaljerad redovisning av varje projekt presenteras nedan.

Undervisning i skördetrösksimulator (Aktionsforskningsprojekt 2)
Detta aktionsforskningsprojekt har sin utgångspunkt i den övergripande frågeställningen: hur kan undervisningen på befintlig märkesspecifik skördetröska planeras och genomföras för att skapa förutsättningar för lärande, mängdträning och förberedelse för att köra tröskan i skoljordbruket? Mer specifikt, hur påverkar de engelska instruktionerna för simulatorövningarna elevens möjligheter att dels uppfatta övningen, dels ge större ordförråd i, och motivation för det engelska språket? Samtliga simulatorövningar är självinstruerande med text och bild. Valt språk är engelska; nordiska språk är inte tillgängliga då simulatorn är direktimporterad från USA. Sex elever i årskurs 1 följs och observeras under simulatorövningar som består av Practice (övning) och Assessment (bedömning); exempelvis, Maneuvring, Basic harvesting och Intermediate harvesting. Uppföljningen sker via yrkeslärarens observationer utifrån en matris där anteckningar förs in på ett systematiskt sätt, bland annat aktuella moment i relation till kommande steg i övningen, och kompletteras med korta samtal med elever.

Figur 7. Körning av tröskan i simulator.

Sex elever i årskurs ett observeras under genomförande av fyra övningar i simulatorn och momenten "Practice" och "Assessment" (se Tabell 2). Eleverna får ta del av instruerande fackuttryck och information om vad som ska göras under övningen samt beskrivande fackuttryck om tröskans instrument och reglage (Figur 7). Eleverna har olika förkunskaper i att köra tröska och i engelska. Fyra elever observeras enskilt och två elever tillsammans.

Tabell 2. Övningar i märkesspecifik trösksimulator (ur lärarens anteckningar).

Övning 1	**Operator knowledge/Transport controls** Övningen handlar om att i 55 steg lära sig användning av fordonets reglage och tolkning av instrument samt göra uppstartsmoment på tröskan. Practice-momentet är instruerande i både engelska ord och i bild. På Assessment-momentet ska man klara testet utan dessa instruktioner.
Övning 2	**Maneuvering** Eleven gör här ett uppstartsmoment av tröskan, backar ut den ur ett garage samt kör en landsvägsrunda i trafik.
Övning 3	**Basic harvesting** Efter uppstart av maskinen tröskas ett regelbundet fält med vald gröda och tröskans tank töms stillastående vid fältkant.
Övning 4	**Intermediate harvesting** Eleven gör uppstart av tröskan, tröskar ett fält med böljande svängar och med avsmalnande och ökande bredder av fältet. Det kan uppkomma plötsliga hinder i fältet och tanktömning görs i farten.

Utifrån lärarens uppföljande dokumentation under elevernas genomförande av övningarna, urskiljs följande kopplingar mellan användning av simulator och lärarens samt elevernas arbete i kursen.

Simulatorers och övningars fidelitet

Elever har en positiv inställning till övningar i simulator inför "verklig körning av maskinen" i termer att "det är bra att lära sig grunderna". Övningarna upplevs som "bra och verklighetstrogna". Som tidigare nämnts är trösksimulatorn märkesspecifik och detta innebär att reglage, instrumentering och display är detsamma som i den autentiska tröskan. Säkerhet lyfts också som en viktig del i lärprocessen, som också innebär att lära sig grundprincipen för vad som sker inne i

en tröska. Elevernas kunskaper och erfarenheter av körning av autentiska maskiner är varierande, från mycket stor till elever som inte har kört tröska tidigare. Autenticitet i processen skapas gradvis i övningarna (särskilt Övning 1, Tabell 2) där det instruerande momentet inkluderar mycket stöd i form av ord och bild, som sedan ska memoreras för att genomföra momentet assessment där instruktionerna inte längre ingår. Det instruerande, inledande momentet, där instruktioner ges på engelska, innebär ytterligare ett steg för eleverna, särskilt när det gäller fackuttryck. Momentet öppnar för en möjlighet för att arbeta med en integrering med ämnet engelska dels i form av skapande av ordlistor, dels att stötta eleverna i deras lärande av relevant ämnesinnehåll.

Simulator och ämnesintegrering

Elevernas kunskaper i engelska visar sig ha en viss betydelse för att genomföra samtliga steg i Övning 1 (Tabell 2). Yrkesläraren beskriver hur det är nödvändigt med stöd (jmf. scaffolding) för att hjälpa eleverna att komma vidare i övningen genom att översätta till svenska. Å andra sidan anger yrkesläraren i sina anteckningar att instruktioner i övningarna även innehåller pilar och bilder som gör att med viss memorering kan elever lösa kommande övningar i både Practice och Assessment. En konsekvens av yrkeslärarens val av simulatorstödd undervisning blir således att scaffolding fyller funktionen att både skapa möjligheter till användning av simulatorn utifrån dess inbyggda övningar och moment utan att avbryta "flow" i upplevelsen, men också att reflektera kring övningen som sådan, där lärarens eller en kamrats stöd blir centralt. För elever med goda kunskaper i engelska är det inga större utmaningar att memorera i Practice för att sedan minnas under Assessment. I övrigt förstår dessa elever sammanhanget bättre. Vikten läggs dock mycket på memorering och repetition i samtliga övningar. Under övning 2–4 har kunskaper i engelska, likväl som i att köra tröskan mindre betydelse. Det är således mer repetition och memorering som gör att eleverna lär sig uppstart och körning i dessa moment, då det gäller för eleverna att ha registrerat instruktioner i form av engelska meningar och av bilder under Practice.

Trafikregler i simulator vid körning av basmaskin (Aktionsforskningsprojekt 3)

Detta projekt fokuserar på körning av basmaskin, i detta fall traktor inom ämnet fordonsteknik. Aktionen identifieras utifrån ett behov av att ge eleverna förutsättningar att utveckla sina kunskaper om trafikregler. Eleverna lär sig trafikregler innan de påbörjar körning i trafik. Simulatorn är då ett pedagogiskt verktyg som används för att träna tillämpning av trafikkunskaper och regler (Figur 8). Eleverna kan få individuell handledning samt fler övningstillfällen. Mer specifikt rör sig frågorna som aktionen vill belysa om möjligheter för eleverna att utveckla samma kunskaper vid körning i simulator som vid körning av traktor på väg

tillsammans med lärare. Ytterligare en fråga handlar om hur resultat vid simulatorkörning kan ses som tillförlitligt för elevernas förmåga att köra traktor i trafik.

Figur 8. Körning i simulator och med basmaskin i trafik.

Uppföljningen av aktionen består av observationer och detaljerade fältanteckningar av tre elever som går första året på gymnasiesärskolans 4-åriga program med naturbruksinriktning. Aktionen fokuserar på tio tillfällen då eleverna kör en simulator som simulerar körning med bil i trafik, då det i nuläget inte finns någon simulator på marknaden som simulerar körning av basmaskin i tätbebyggt område. Eleverna genomför också en körning i basmaskin. I samband med observationer och under analysen används en matris som stödjer bedömningen av körning i simulator respektive i basmaskin avseende ett antal kriterier, exempelvis regeltillämpning, körning mot mål, vänster- och högersväng. Matrisen är således ett verktyg för läraren för att besvara frågeställningen om huruvida och på vilket sätt träning i simulator kan användas för att ge återkoppling på, samt bedöma specifika delar av körning av basmaskin på ett tillförlitligt sätt. Utöver detta för läraren också anteckningar som inte följer en specifik matris, men som noggrant dokumenterar elevernas beteende vid simulatorövning och vid körning av basmaskin i trafik. Simulatorprogrammet som pågår cirka 40 minuter, avser bilkörning i tätbebyggt område med hastighet 40–50 km/h. Programmet väljs eftersom det är just dessa omständigheter som liknar körning av basmaskin i trafik, och då särskilt i ett tätbebyggt område. Exemplen nedan, som är utdrag ur lärarens fältanteckningar, illustrerar elevernas agerande under simulatorkörningen och körning i autentisk basmaskin samt delar av lärarens återkoppling.

Exempel 1

”Känns som riktig trafik”

Melvin startar programmet i simulatorn, det är hans första tillfälle i aktionsforskningen. Han har provat denna simulator en gång tidigare, det var i mitten på höstterminen.
Melvin kommenterar: Känns som riktig trafik.
Melvin har bra koll på koppling, broms och gas, han ligger på rätt varvtal vid växling
Simulatorn informerar med text att Melvin ”shift too early”. Melvin tycker inte själv att han gör något fel. Jag ger information om hur han kan minska hastigheten innan han trampar ner kopplingen vid ett högre varvtal inför en korsning.
Vid rödljus sitter Melvin och upprepat gasar lite, släpper och gasar lite mer. Detta registreras inte av simulatorn, åtminstone inte på ett sådant sätt att det ger en omedelbar feedback tillbaka till föraren. Melvin tar till sig instruktioner från simulatorn om au t.ex. titta i backspeglarna.
Melvin ifrågasätter varför simulatorn säger att han inte kan köra i 50 km/h genom en korsning som är huvudled där högsta begränsade hastigheten är 50 km/h. Jag förklarar situationen. Melvin tycker att det fungerar bra med både skriftlig och muntlig information men läser inte all skriftlig information. En del av den är på engelska och han förstår inte alla ord.
Melvin har bra koll på vägmärken och vilka regler som gäller i olika korsningar.
Melvin förstod inte att han körde för nära cyklister trots att det stod på skärmen att han körde för nära framförvarande fordon. Han tyckte inte att det fanns några framförvarande fordon då det inte fanns några som kom framifrån. Cyklisterna stod på cykelbanan till höger om bilen och cyklade om bilen och vidare i en vänstersväng framför bilen. Melvin skulle svänga höger med bilen.
Melvin kommenterar när han tycker att simulatorn är för känslig i sin bedömning t.ex. att köra för nära ett annat fordon vid sväng i korsning.

Under genomförande av simulatorprogrammet upplevs körningen som mycket verklig av Melvin. Den inbyggda funktionen att ge omedelbar återkoppling när något felaktigt sker ges skriftligt och på engelska, vilket innebär en utmaning för eleven. Yrkesläraren förmedlar simulatorns återkoppling, förklarar och utvecklar den, särskilt när Melvin visar att han inte håller med, eller förstår återkopplingen. Melvin genomför ytterligare en körning i simulator vid ett annat tillfälle och kör mycket bra, enligt lärarens bedömning. Yrkesläraren ställer därför frågan om Melvin vill köra med simulator en gång till eller om han ”känner sig mogen att ge sig ut i trafiken och köra MB-track nästa gång. Melvin svarar utan att tveka

det minsta att han vill köra MB-track nästa gång" (ur fältanteckningar). Yrkesläraren syfte under denna övning, är att utvärdera och bedöma simulators fidelitet när det gäller elevens kunskap om trafikregler i tätbebyggt område med de maskiner som eleverna ska lära sig att köra under utbildningen. Melvin är vid det här läget redan en relativt erfaren förare som själv kan bedöma simulatorövningens rimlighet och noggrannhet (i termer av fidelitet). Lärarens återkoppling blir, i detta exempel, en slags medling eller förklaring mellan det som eleven bedömer som "rimligt" (eller inte) i den typ av manöver som han ska utföra i simulator och det som ska bedömas, dvs kunskaperna om trafikreglerna, snarare än färdigheten att utföra själva körningen av maskinen. Simulatorn blir således (och är designad som) ett pedagogiskt verktyg med syftet att "scaffold" förarens beteende så att det anpassas till det som är "korrekt" i förhållande till reglerna som ska följas i en "riktig situation" i "riktig trafik". Under de typer av "immersive experiences" som en simulator kan frambringa, blir den riktade återkopplingen (av läraren och/eller simulator) till föraren en central del av hur erfarenheten kan upplevas som meningsfull i förhållande till elevens tidigare erfarenheter och uppfattningar av sin körning. Återkoppling och det som presenteras i simulatorns olika scenarier kan dock upplevas som en utmaning, ibland av både läraren och eleven under körning i simulator, som vi ser i exemplen nedan.

Exempel 2

"Det händer inte så snabbt i verkligheten som i simulatorn"

Jag övningskör med Melvin som vi bestämde vid föregående tillfälle då Melvin körde i simulatorn.
[…]
Melvin, är lugn, koncentrerad och samlad i sin körning. Allt flyter på, bra och han är godkänd på de flesta momenten. Melvin hade vid flera tillfällen bara en hand på ratten och fick påminnas om detta. Han glömde också att blinka vänster vid start från, vägkanten. Vid utfart från, enskild väg med stopplikt till allmän väg genom vänstersväng valde Melvin att placera traktorn på motsatta körfältet, d.v.s., för långt åt vänster. Melvin valde också vid ett par tillfällen lite väl låg växel. Melvin missade vid ett tillfälle ett viktigt vägmärke. Vi diskuterade efter körningen vad Melvin tycker om sin körning, han känner sig nöjd:
M: Tycker att det är lättare att köra traktor i verkligheten än att köra i simulatorn.
L: Vad är det som känns lättare?
M: Det händer inte så snabbt i verkligheten som i simulatorn t.ex. att det kommer cyklister och bilar i olika korsningar.

Körning i basmaskin i trafik visar sig vara ”lättare” för Melvin än körning i simulator. Läraren reflekterar kring detta, och skriver i sina anteckningar att Melvin ”uppvisar samma lugn bakom ratten vid körning i trafik som i simulatorn. Han är trygg och säker i sin körning och det är intressant att se att det är likadant vid körning med traktor i trafik som vid körning i simulator”. Gränserna med vad som är ”riktig” och ”autentisk” körning, och dess motsvarighet i körsimulator används i detta exempel som en motsättning där körning i simulator inte upplevs som ”på riktigt” på flera olika plan, både när det gäller fidelitet, men också som ett sämre alternativ till körning på vägen eller på körgården med riktiga maskiner.

Utmaningar med att ta emot återkoppling och hantera olika scenarier som uppenbarar sig plötsligt i simulatorn är en utmaning även för Erik och Anna, de två andra eleverna som deltar i aktionen. I Eriks fall, blir simulatorövningar en utmaning för hans tålamod då han hellre vill ”vara ute på körgården och köra traktorn” (ur fältanteckningar). Både Erik och Melvin har relativ omfattande körvana. För Anna, å andra sida, som inte har kört i samma omfattning, blir övningar i simulator en viktig del av träningen av just körvana.

Exempel 3

”Så här bra hade jag inte kunnat köra annars”

Vi diskuterar efter körningen vad Anna tycker om sin körning, hon känner sig nöjd för att vara första gången som hon kör traktor i trafiken:
A: Tycker att det är lättare att köra traktor i verkligheten än att köra i simulatorn?
L: Vad är det som känns lättare?
A: I verkligheten är det inte cyklister, gående och bilar som ”bara ploppar ner”, det gör det i simulatorn. Det går så snabbt i simulatorn med sådana och mellan en del korsningar.
l: Har du haft någon nytta av hur du har lärt dig an köra i simulatorn?
A: Ja, det har jag verkligen haft. Så här bra hade jag inte kunnat köra annars. Nu när jag har lärt mig så här mycket ska mamma och jag gå en handledarkurs och jag ska få börja att övningsköra med bil.

Svårigheten att hantera snabba förändringar vid körning i simulator beskrivs också av Anna i Exempel 3. Anna upplever simulatorn som ett viktigt inslag i sitt lärande för att uppnå större trygghet och körvana. När eleverna hanterar dessa typer av ”immersive experiences” under en övning i en körsimulator (Fu-Hsing m.fl., 2013) blir frågan om i vilket pedagogiskt syfte det är önskvärt att hålla isär den ”verkliga” från den ”autentiska” helt central. Simulatorn utgör, i samtliga

fall, ett medel för att träna, eller ett alternativ till ”riktig körning” som inte är ett mål i sig. Körning i trafik eller på körgården är det som föredras av eleverna vilket innebär att yrkesläraren behöver motivera för att legitimera omfattningen av simulatorövningar.

Simulatorkörning som lärandepraktik i naturbruksutbildning

De tre aktionsforskningsprojekten har olika frågeställningar, olika ämnesinnehåll och skilda kontexter, men det gemensamma syftet är utgångspunkt för analysen. Analysen visar vilka förutsättningar som kan skapas för undervisningen i körteknik då skolor utrustas med avancerade körsimulatorer för undervisningen. I analysen belyser vi med stöd av TPACK (Herring m.fl., 2008, Mishra & Koehler, 2006) vad som kännetecknar relationen mellan (ämnes)innehåll (CK), pedagogik (PK) och teknik (TK) (se Figur 1), samt vilken betydelse det får för undervisningen. Vi lyfter också fram vilken roll simulatorer kan spela för att stödja elevens utveckling av yrkeskunnande och övergången till användning av autentiska maskiner.

En central intention med simulatorstödd undervisning är att möjliggöra kopplingar och övergångar mellan övningar i simulator och autentiska arbetsuppgifter – i denna studie gällande körning av skogs- och lantbruksmaskiner. Resultaten av båda aktionerna i Skola B och yrkeslärares reflektioner visar betydande utmaningar när det gäller utveckling av kunskaper i körning av basmaskiner i simulator, mest på grund av att simulatorn inte simulerar körning av basmaskin i trafik. Däremot finns det också möjligheter bestående av ökat antal körtimmar, trygghetsskapande och säkerhet, mindre risk för skador samt för att ”tappa ansiktet” framför andra elever. Minskad miljöpåverkan är också en viktig faktor som simulatorstödd undervisning möjliggör.

De nya simulatorernas fidelitet har utvecklats via avancerad grafik, flera skärmar och stolar som rör sig. Det finns även möjlighet till användning av VR-glasögon. Denna avancerade teknik kan i sig skapa bättre förutsättningar för övergångar, så kallad ”transfer” och ”boundary-crossing” (Aarkrog, 2011; Toumi-Gröhn & Engeström, 2003), mellan simulatorövning och autentisk körning. Samtidigt behöver lärarna goda tekniska kunskaper (TK) om vad den avancerade tekniken kan erbjuda för att avgöra hur den kan användas i relation till det ämnesinnehåll (CK) som undervisningen ska riktas mot. Resultatet visar samstämmigt att simulatorövningar skapar nya förutsättningar för undervisningen.

Simulatorkörning och autentisk körning blir komplementära

Simulatorövningarnas självinstruerande och förutbestämda karaktär skapar möjligheter för elevens självständiga övningar. Yrkesläraren kan välja vilka övningar som elever ska få tillgång till mot bakgrund av sitt pedagogiska kunnande (PK). Simulatorövningar stimulerar samtal om autentisk körning. Yrkesläraren

bidrar då till en typ av gränsöverskridande, eller ”boundary-work” (Berner, 2010) mellan simulatorövning och autentisk situation där yrkesläraren i dialogen med eleven binder samman det simulerade med det autentiska, som i vissa fall enbart yrkesläraren ser eller har kunskap om. Det framgår också att elever som har erfarenhet av autentisk körning kan jämföra den med simulatorkörning och på så sätt tolka simulatorövningarna i förhållande till egen erfarenhet, vilket Korteling med flera (2017) benämner ”transfer-of-training”. Elever visar i dessa fall förståelse för vilket yrkeskunnande som simulatorkörningen kan bidra med och vad som behöver erfaras i autentisk körning.

Transfer bygger således på idén att det uppstår ett direkt kausalt samband mellan ett kunnande som utvecklas vid simulatorstödd undervisning och yrkeskunnande. Analysen i samtliga aktionsforskningsprojekt visar å andra sidan att det som eleverna gör i en simulatorövning också innefattar ett lärande om hur exempelvis en elev kommer att bli bedömd eller på annat sätt delta i undervisning i en autentisk maskin. Körning på körgården, i skogen, eller i trafiken är exempel på autentiska undervisningssituationer som bygger på lärarens didaktiska kunnande av samtliga dimensioner i TPACK. Det som kännetecknar lärarens arbete med planeringen av simulatorstödd undervisning är att andra och nya möjligheter till reflektion, samarbete, mängdträning skapas, vilket i sin tur bidrar till lärarens reflektion kring hur form, innehåll och artefakter (eller tekniska redskap) hänger samman i en undervisningssituation. TPACK-analysen bidrar till att förstå vilka utmaningar eller begränsningar som simulatorstödd undervisning innebär.

Under YRKSIM-projektet (Figur 2) och dess olika faser är fokus på formen och ”de nya simulatorerna” påtagligt. Många av yrkeslärarnas frågor (vilket framkommer i aktionsforskningsprojekt 1) behandlar relationen mellan innehåll (CK) och tekniskt kunnande (TK) om hur simulatorer fungerar och kan användas i undervisningen. Under arbetet med de tre aktionsforskningsprojekten ges yrkeslärarna (och elever i aktionsforskningsprojekt 1) förutsättningar att systematiskt planera, genomföra och granska olika typer av övningar och undervisningsmoment med hjälp av observationsmallar och bedömningsmatriser som synliggör kopplingen till det lärares professionella kunnande, men också kopplingen mellan det kunnande som eleverna utvecklar via simulatorövningar och utveckling av yrkeskunnande i användning av autentiska maskiner.

Lärarnas systematiska arbete under aktionerna och TPACK-analysen synliggör komplexiteten med transfer i yrkesutbildning eftersom det både för eleverna och yrkeslärarna är en utmaning att identifiera vilket yrkeskunnande från simulatorstödd undervisning som sedan används i autentiska situationer, till exempel körning på skolans körgård. Upplevelsen av simulatorövningen som ett spel kan via lärarens gränsöverskridande förhållningssätt riktas mer mot en upplevelse av att genomföra en arbetsuppgift (jfr Fu-Hsing m.fl., 2013).

Lärarnas interaktion och stöd behövs

I studiens aktioner utgår lärarna från innehållet i aktuella yrkesämnen och vad de uppfattar att simulatorerna skulle kunna bidra med som integrerade i undervisningen. Yrkeslärares professionella val och ställningstagande är beroende av deras kunskap om vilka möjligheter simulatorerna kan erbjuda, men också om vad som inte kan tillgodoses. Simulatorövningen kan betraktas som en resurs som samspelar med andra undervisningsformer, incitament och även ämnesintegrering. I aktionsforskningsprojekt 1 vill lärarna undersöka om simulatorkörning kan bidra till att eleverna utvecklar flyt i kranhantering vid körning av skotare. Det är ett yrkeskunnande som är centralt, och som det tar tid att utveckla genom motorisk träning för automatisering. Lärarnas erfarenhet av tidigare yrkesverksamhet och undervisning bidrar till att de kan urskilja hur simulatorerna kan understödja övergången till körning i autentiska maskiner. Lärarna skapar stödstrukturer som samspelar med simulatorernas övningar som syftar till att synliggöra de aspekter som är centrala för kranhantering och att engagera elever i värderingen av deras kunskapsutveckling.

I planering av simulatorstödd undervisning behövs, förutom innehållskunskap, även kunskap om hur olika undervisningsformer tillsammans kan stödja elevens lärprocess. Simulatorövningar kan betraktas som en resurs som samspelar med andra undervisningsformer och som också främjar ämnesintegrering. Möjligheten till upprepad träning av ett särskilt moment betonas i aktionsforskningsprojekt 3 där lärarens syfte att använda simulatorn som ett verktyg för träning och bedömning, gör att simulatorns fidelitet i förhållande till autentisk körning hamnar i förgrunden. Med andra ord, den färdighet som eleven utvecklar behöver anpassas till övningar i autentisk miljö eller till helt andra typer av uppgifter. Analys av materialet i aktionsforskningsprojekt 2 visar exempelvis hur simulatorn ställer krav på ett annat kunskapsinnehåll än det som aktualiseras i det aktuella yrkesämnet (i det här fallet engelska språket) vilket kan bidra till naturlig och ömsesidig ämnesintegrering.

Simulator som spel skapar datadrivet lärande

En viktig aspekt av simulatorkörningen är möjligheten att öva riskfritt. Anknytningen till spelidén gör att övningen blir mer realistisk, en händelse där eleven ska klara olika moment. Å andra sidan är övningen i likhet med ett spel orealistisk, genom att eleven kan misslyckas utan större konsekvenser. Den möjligheten innebär att det finns en risk att eleverna inte inser riskbeteenden utan ser simulatorkörningen mer som ett spel. Detta är något som lärarna i aktion 1 betraktar som problematiskt och uttrycker som ”negativ inlärning”, då risken finns för att det kan påverka körning i autentiska maskiner negativt. Fu-Hsing med flera (2013) visar också att simulatorernas utformning som spel kan innebära att eleven mer fokuserar mot spelet och inte mot det avsedda ämnesinnehållet. Lärarna

i aktionsforskningsprojekt 1 menar att de behöver skapa stödstrukturer, exempelvis genom att använda tillbudsrapporter, som ger eleverna möjlighet att reflektera över motsvarande risker i autentisk körning av skogsmaskiner.

Simulatorerna genererar kontinuerligt data som kan bilda underlag för analys, återkoppling och bedömning av varje elevs kunskapsutveckling. I vår studie visar lärarna en avvaktande hållning till användningen av data genererad i simulatorerna, där de vill undersöka mer om hur data kan användas konstruktivt för återkoppling i undervisningen.

Sammanfattningsvis visar analysen att yrkeslärarnas pedagogiska kunnande vid körning med autentiska maskiner inte automatiskt kan föras över till simulatorstödd undervisning (se också Niess, 2011). Yrkeslärare och elever behöver utveckla ett (nytt) kunnande i att förstå, reflektera kring och använda data som genereras i samband med simulatorstödd undervisning. Simulatorn skapar därmed möjligheter, men kräver också välgrundade val och strategier för undervisningen som helhet. Eleven självständiga träning är i likhet med andra uppgifter som kan bearbetas utanför undervisningen i behov av lärarens stöd. En utmaning för yrkesläraren är att ”erövra” verktyget så att det tjänar sitt syfte i en didaktisk och pedagogisk planering.

Implikationer för undervisning

Studiens syfte var att undersöka samt kritiskt granska utmaningar och möjligheter vid simulatorstödd undervisning i gymnasial yrkesutbildning, med fokus på undervisning och på elevers lärprocess. Lärare och forskare har i nära samverkan prövat och studerat ett urval av frågor identifierade av medverkande lärare. Den praktiknära ansatsen ger möjlighet tillsammans med lärare möta och bedriva forskning utifrån yrkespraktikens egna frågor vilket i detta fall ger ett kunskapsbidrag om simulatorstödd undervisning i yrkesutbildning.

Projektens frågeställningar initierades vid ett gemensamt möte (se Figur 1), där aktioner och uppföljningar planerades gemensamt. Yrkeslärare genomförde undervisningsnära aktioner som följdes av forskare som främst gav stöd för det systematiska upplägget av aktionerna. Analys och slutsatser bearbetades i samverkan mellan lärare och forskare. Resultaten spreds i olika sammanhang inklusive genom deltagande på internationella konferenser där både lärare och forskare deltog i. Praktiknära studier kan ses som ett bidrag till utvecklingen av kunskap om undervisning. YRKSIM-projektet blev ett resultat av denna intention, där utgångspunkten var att simulatorer skulle användas i undervisning. Projekten YRKSIM bidrog till att utmaningar och möjligheter vid integrering av teknik i undervisning i termer av att ny didaktisk kunskap kunde synliggöras. Simulatorer utvecklar inte undervisning och verksamheten av sig själva, och utgör inte lösningen. Digitala redskap (i detta fall komplexa redskap som består av

olika, datadrivna applikationer) behöver integreras som en del i olika undervisningssituationer via ett systematiskt och reflekterande arbete. Studien presenterar exempel på hur detta arbete kan bedrivas. Studien visar dessutom att det finns utvecklingspotential i dessa typer av samarbete då de bidrar till att en skola kan driva sitt utvecklingsarbete (med utgångspunkt i elevers lärande och utveckling). Metoden att använda elevers självskattning har exempelvis inspirerat lärarna att använda den fortsatt i undervisningen. I olika sammanhang betonas lärarens betydelse för en skolas resultat samt att rektorer sällan kan följa det som pågår i undervisningen. Här ser vi hur aktionsforskningsprojekt kan bidra till att lärare involveras direkt i ett systematiskt förbättringsarbete. Studien visar också hur förändringar i den lokala praktiken i form av implementering av ny komplex digital teknik via inköp av mjukvara och hårdvara, inte enbart kan mötas med formell kompetensutveckling utan det behövs också ett systematiskt och praktiknära arbete som lärare utför i sin dagliga undervisning.

Om författarna

Susanne Gustavsson är universitetslektor i pedagogik vid Institutionen för pedagogik och specialpedagogik vid Göteborgs universitet. Forskningsområde är yrkesutbildningens undervisningspraktik och yrkeslärande i skola och på arbetsplats samt skolutveckling och företrädesvis praktiknära studier och projekt. Hon undervisar i yrkeslärarutbildningen samt har uppdrag i rektorsprogrammet.

Giulia Messina Dahlberg är universitetslektor vid Institutionen för pedagogik och specialpedagogik vid Göteborgs universitet. Giulias forskningsintresse rör kommunikativa praktiker när individer hanterar en rad uppdrag både i och utanför institutionella utbildningssammanhang som ligger över gränserna mellan fysiska och virtuella miljöer. Hon är särskilt intresserad av de sätt på vilka sådana gränser skapas och förhandlas i handling för att ge (eller förhindra) tillgång till lärande och deltagande. I sin forskning och kursutveckling har Messina Dahlberg nyligen arbetat med villkoren för rättvisa och inkludering för studenter med funktionsnedsättningar i högre utbildning. Hon är en aktiv forskare i Vetenskapsrådets projekt PAL, Delaktighet för alla?

Ingrid Berglund är universitetslektor vid Institutionen för pedagogik och specialpedagogik vid Göteborgs universitet. Hennes forskningsintresse finns inom området yrkeskunnande och yrkesdidaktik inom olika yrkesområden i såväl skolförlagt som arbetsplatsförlagt lärande. Användning av digitala redskap i yrkesutbildning är ett av hennes specialintressen, liksom bedömning och betygssättning av yrkeskunnande. Hon är huvudsakligen verksam inom yrkeslärarutbildningen vid Göteborgs universitet.

Referenser

Aarkrog, V. (2011). A taxonomy for teaching transfer skills in the Danish VET system. *Nordic Journal of Vocational Education and Training, 1*(1), 1–13.

Angeli, C. & Valanides N. (2009). Epistemological and methodological issues for the conceptualization, development, and assessment of ICT-TPCK: Advances in Technological Pedagogical Content Knowledge (TPCK). *Computers & Education, 52*, 154–168.

Akkerman, S. & Bakker, A. (2011). Boundary crossing and boundary objects. *Review of Educational Research, 81*, 132–169.

Berner, B. (2010). Crossing boundaries and maintaining difference between school and industry: Forms of boundary-work in Swedish vocational education. *Journal of Education and Work, 23*(1), 27–42.

Cox, S. & Graham, C.R. (2009). Using an elaborated model of the TPACK framework to analyze and depict teacher knowledge. *TechTrends, 53*(5), 60–69.

Cox, D.J., Brown, T., Ross, V., Moncrief, M., Schmitt, R., Gaffney, G. & Reeve, R. (2017). Can youth with autism spectrum disorder use virtual reality driving simulation training to evaluate and improve driving performance? An exploratory study. *Journal of Autism and Developmental Disorders, 47*(8), 2544–2555.

de Winter, J.C.F., van Leeuwen, P.M. & Happee, R. (2012). Advantages and disadvantages of driving simulators: A discussion. *Proceedings of Measuring Behavior 2012* (Utrecht, the Netherlands, August 28–31, 2012*)*.

Dahlstrom, N., Dekker, S., Van Winsen, R. & Nyce, J. (2009). Fidelity and validity of simulator training. *Theoretical Issues in Ergonomics Science*, *10*(4), 305–314.

Doering, A., Veletsianos, G., Scharber, C. & Miller, C. (2009). Using the Technological, Pedagogical, and Content Knowledge framework to design online learning environments and professional development. *Journal of Educational Computing Research, 41*, 319–346.

Fu-Hsing, T., Charles K., Kuo-Hsun H., Cheng-Ling A. C. & I-Ying H. (2013). The importance and use of targeted content knowledge with scaffolding aid in educational simulation games. *Interactive Learning Environments, 21*(2), 116–128.

Gieryn, T. (1983). Boundary-work and the demarcation of science from non-science: Strains and interests in professional ideologies of scientists. *American Sociological Review, 48*(6), 781–795.

Graham, C.R., Borup, J. & Smith, N.B. (2012). Using TPACK as a framework to understand teacher candidates' technology integration decisions. *Journal of Computer Assisted Learning*, 28(6), 530–546.

Hardy, I., Rönnerman, K., Edwards-Groves, C., Fumasoli, T., Stensaker, B. & Vukasovic, M. (2018). Transforming professional learning: Educational action research in practice. *European Educational Research Journal, 17*(3), 421–441.

Herring, M.C., Koehler, M.J. & Mishra, P. (Red.) (2008). *Handbook of Technological Pedagogical Content Knowledge (TPCK) for educators.* New York: Routledge.

Hirsch, P., Bellavance, F., Tahari, S. & Faubert, J. (2015). Towards the validation of a driving simulator-based hazard response test for novice drivers. *Proceedings of the Eighth International Driving Symposium on Human Factors in Driver Assessment, Training, and Vehicle design*. (Salt Lake City, Utah, USA, June 22-26, 2015).

Llewellyn, S. (1998). Boundary work: Costing and caring in the social services. *Accounting, Organizations and Society, 23*(1), 23–47.

Korteling, H., Helsdingen, A. & Sluimer, R. (2017). An empirical evaluation of transfer-of-training of two flight simulation games. *Simulation & Gaming, 48*(1), 8–35.

Koehler, M.J. & Mishra, P. (2009). What is technological pedagogical content knowledge? *Contemporary Issues in Technology and Teacher Education (CITE), 9*(1), 60–70.

Niess, M.L. (2011). Investigating TPACK: Knowledge growth in teaching with technology. *Journal of Educational Computing Research, 44*(3), 299–317.

Mishra, P. & Koehler, M.J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record, 108*, 1017–1054.

Palak, D. & Walls, R.T. (2014). Teachers' beliefs and technology practices: A mixed-methods approach. *Journal of Research on Technology in Education, 41*(4), 417–441.

Petzold, T., Weiss, T., Krems, J.F. & Bannert, M. (2013). The development of a cognitive skills training to support driver education: Comparing performance of experienced and trained learner drivers. *Proceedings of the Seventh International Driving Symposium on Human Factors in Driver Assessment, Training, and Vehicle design.* (Bolton Landing, New York, June 16, 2013)

Reimer, B., Fried, R., Mehler, B., Joshi, G., Bolfek, A., Godfrey, K., Zaho, N., Goldin R. & Biederman, J. (2013). Brief report: Examining driving behavior in young adults with high functioning autism spectrum disorders: A pilot study. *Journal of Autism Developmental Disorders, 43*, 2211–2217.

Shulman, L.S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher, 15*(2), 4–14.

Shulman, L.S. (1987). Knowledge and teaching: Foundations of the new reform. *Harvard Education Review 57*, 1–21.

Tuomi-Gröhn, T. & Engeström, Y. (Red.) (2003). *Between school and work: New perspectives on transfer and boundary-crossing.* Boston: Pergamon.

Voogt, J., Fisser, P., Pareja Roblin, N., Tondeur, J. & van Braak, J. (2013). Using theoretical perspectives in developing and understanding of TPACK. *Journal of Computer Assisted Learning, 29,* 109–121.

Nordic Journal of Vocational Education and Training, 2020

Five years with vocational teacher education online

Steinar Karstensen & Runar Oudmayer

Oslo Metropolitan University, Norway (steinar.karstensen@oslomet.no)

Abstract

After running online Technical and Vocational Teacher Education (TVTE) classes for five years we have collated our experiences and thematically probed them through the following questions: (1) What are the pedagogical and didactic considerations with online TVTE (2) What are the technical challenges? (3) What opportunities and limitations have emerged? (4) How do the teachers and students experience online teaching? (5) How do teachers compare online teaching with on-campus teaching? Our experiences where accumulated through the TVTE in the Technological Programme (TP) at Oslo Metropolitan University (OsloMet), and are based on both teacher and student responses, learning logs, evaluations, and anonymised student data.

In short, online study has helped us to achieve a larger geographical spread of students. The students experience online study as flexible, as they do not have to meet on campus every week. The technology has worked and allows for further development of the subjects being offered. It appears to be an equal opportunity offered compared to the campus-based with greater flexibility according to where the student is located. The workload also appears to be manageable for teachers who are engaged in the online class environment.

Keywords: online learning, distance learning, vocational teacher education

NJVET, Vol. 10, No. 1, 137–154 Magazine article doi: 10.3384/njvet.2242-458X.20101137

Hosted by Linköping University Electronic Press

Introduction

At the start of the autumn semester of 2014, vocational teacher education in technology subjects (TP) initiated its first online programme. The purpose was to offer more flexible learning platforms to students.

In the digital strategic plan from OsloMet (2017) they say that in a digitalised world, the new demand for services is set. A world where the individual expects the flexibility of services that can be made available where they are, and when they need them. Something that should reflect in a simpler everyday life that can be adapted to the individual's life situation and needs (OsloMet, 2017).

Since the original start-up, four classes have completed a three-year bachelor education in spring 2020. New classes are started annually. Initially the class consisted of just under 20 students, now there are classes of 30 students or more. Teaching staff have also increased accordingly, from just one teacher in the first few years, to a team of five led by a class teacher responsible for the professional subject, where up to four vocational subjects per class are also attended by different time-based vocational teachers.

The purpose of this article is to systematically correlate online teaching experiences with online teaching. The following questions are addressed in this paper: (1) What are the pedagogical and didactic considerations with online Technical and Vocational Teacher Education (TVTE)? (2) What are the technical challenges? (3) What opportunities and limitations have emerged? (4) How do the teachers and students experience online teaching? (5) How do teachers compare online teaching with on-campus teaching?

Oslo Metropolitan University (OsloMet) offers TVTE in eight of their nine educational programmes. This article concerns technological programmes (TP), which is a generic term covering four educational programmes: the programme for Building and Construction (BA), the programme for Electricity and Electronics (EF), the programme for Service and Transport (SS) and the programme for Technical and Industrial Production (TIP), all grouped together under the collective term technological programmes (TVTE-TP). This training is intended to help meet the requirement for a combination of teaching and vocational skills (UDIR, 2017).

The educational programmes enable students to obtain the qualifications required to work as teachers in several individual trades within the overall category. For example, the EF programme is made up of electricians, electronics engineers, telecommunications technicians, etc. Together the four educational programmes represent 109 different trades.

The programme is a three-year bachelor's degree which enables practitioners of a profession to qualify as Technical Vocational Education and Training (TVET) teachers. It is made up of a total of 180 credits, with 60 credits representing the pedacogical subject base and 120 credits for technical and vocational subjects.

Learning outcomes are divided into knowledge, skills and general competence in the same way that the Norwegian National Qualifications Framework (NKR) (NKR, 2009) for lifelong learning is based on the European Qualification Framework (EQF, 2012).

TVTE-TP students typically have an average age of 40 and hold trade certificates or skilled craftsman's/journeyman's certificates and most of them have several years' practical experience in their professions (Karstensen, 2014).

Organisation of the TVTE-TP programme

The TVTE-TP programme started as an ordinary campus study in 2006 and was expanded to include an online programme in 2014. Both standard and digital programmes normally begin with a five-day on-campus gathering to allow students and staff to become acquainted with each other and the course. After this, the on-campus class continues with weekly physical gatherings. The online class however, has two physical gatherings over a period of two days per semester, and all other activities are conducted online. They also establish study groups of four to six people at the first physical meeting across the programmes. The study groups meet in different ways depending largely on the geographic location of the individual. The intention is that they should remain together as a group for the rest of the course. During the course, there are tasks to be solved individually and in study groups, in addition to supervised professional training. The class has joint education in the programme of professional study but is divided into their respective educational programmes when it comes to technical and vocational subjects (Karstensen, 2014).

Teachers of pedagogical subjects teach the groups frequently and also function as year group coordinators. Consequently, they have additional contact and more extensive experience with the students online. Lecturers in technical and vocational subjects (who normally just have a part time teacher position at OsloMet) work with their students within their educational programme and normally only have one online meeting, in addition to online academic supervision. The number of students in the four technical programmes included in this survey ranges from 3–4 up to 12–15 in each group. A lot of the teaching is conducted in such a way that both teachers of professional studies and lecturers work with the same work requirements.

The 2014 group was the first online class. At start-up, it was planned that the online course would be the same as the one offered on-campus. It was also planned that there would be some joint teaching for the two courses, in that the online class could take part in on-campus activities. The following shared platforms were mainly used: Fronter as a Learning Management System (LMS), Adobe Connect as a synchronous communication program and Microsoft Office

support programs. The first year is well documented in *From campus to online learning* (Karstensen, 2015).

A new group started in 2015. It followed practically the same arrangement as the first-year group. During the first year, the teachers experienced that they couldn't find any joint solutions for both the online and on-campus teaching. With the limited equipment and resources available, teachers had a choice between solely online teaching or physical teaching on-campus.

Since they wanted to use multimedia texts to a greater extent than earlier, Wikispaces was included as a new platform in addition to those they already had. Through this, they discovered that it was fully possible to have study groups that did not have any physical gatherings. The groups established themselves independently, but the geographical location of the members was no longer important.

The 2016-year group was re-organised with fewer gatherings for the whole class and more groupwork. This was a didactic adjustment implemented to achieve more engagement among the students. A normal gathering-day would therefore start with one to two hours of joint teaching for the whole class followed by groupwork and another joint meeting of approximately one hour at the end of the day.

The students used the LMS Fronter and Wikispaces from start-up. Gradually, OsloMet's Office 365 replaced Wikispaces, and Fronter was replaced by Canvas. In line with the flipped classroom method, some of the teaching material was recorded on video and made available to students before the meeting and could thus be used to jointly address and discuss issues about the content that the students had engaged with beforehand.

Based on past experiences we saw a need for an even more flexible programme, independent of startup, location and time requirements (Foss, Gustavsson, Johansen, Karstensen, Rodheim, Schneider & Sønsteli, 2011). With this as the starting point, a plan was created for the 2017-year group to prepare the students to start their programme. Many of these materials were made available via an Open edX solution. Information was distributed to all students who had been accepted for admission and they had the opportunity to work through the material prior to the start of the semester. An important factor enabling students to find possible collaborators and ideally to have established a study group by the first day of the course. The starting week, which was normally five days, was reduced to two. Office 365, Wikispaces and Canvas were also important platforms for this group for the interaction among students, and between students and teachers.

The 2018-year group followed the same arrangement as the previous group, however based on experiences from the previous year, information in preparation for the course start was shared through a single webpage. We found that the use of multiple platforms in 2017 created some confusion for students in that it

was difficult to know where to find what. In addition, some of the students had issues with registration and in accessing the different university platforms. By using a blog webpage that did not require login, we reduced a lot of administration work related to student registration and access into the system. On the other hand, the options available to build student-to-student relationships were limited in the blog webpage. A reason for having a flexible starting date was to give those students who could not attend the starting week for various reasons the flexibility to enrol at a later date. According to Werhner (2010) there is a growing demand for distance education, as students find that the flexibility of online classes allows them to combine their studies with other life commitments, such as family and job. There may be some confusion in using the concepts of distance learning, especially where online and web-based learning can also be used by campus-based services as an education tool. We do not want to distinguish between use in the classroom or as part of distance learning but describe and use these as a tool in our context. Colleges and universities see distance education as a means to increase students enrolment without the additional expense of building more classrooms or adding staff (Werhner, 2010). What type of online learning should be used – synchronous (live time) e-learning (e.g., video conferencing, live text or audio chat, etc.) or asynchronous (at one's own pace) e-learning (e.g., email, blogging, etc.) – depends on several factors. Online synchronous communication, i.e. via videoconferencing systems, can be less convenient and more intimidating for students who prefer flexibility in both time and space. However, Woodcock, Sisco, and Eady (2015) suggest that synchronous communication allows greater coherence and focus on tasks, increased participation, and more frequent completion of students' work and courses than in studies where asynchronous communication is the main alternative.

To define distance education Moore (2013) used the theory of transactional distance. In this theory, distance education is not simply a geographic separation of learners and teachers, but, more importantly, a pedagogical concept. It is a concept describing the universe of teacher-learner relationships that exist when learners and teachers are separated in space and/or in time. With separation, there is a psychological and communicative space to be crossed, a space of potential misunderstanding between the inputs of teachers and those of the learners. This psychological and communicative separation is framed in terms of transactional distance. One set of variables that determine transactional distance are the elements in the course design, or the ways in which the teaching programme is structured so that it can be delivered through various communicative media (Moore, 2013). In the policy for digital transformation at OsloMet (2018), new technology enables student-active learning methods that ensure both increased learning outcomes for the student and a more motivating teaching environment for the teacher. In an article that has analysed and mapped out trends in online learning, Zawacki-Richter och Naidu (2016) found that learning is seen

as a social process, facilitated by interaction among participants. The provision of opportunities for interaction, communication and collaboration between students and their teachers, as well as among students, via two-way communication, is proposed as a constituent element of distance education. In such settings, learning and teaching are the result of careful design and orchestration of the learning environment, the communication processes, the learner support and use of learning materials. Distance education demands and needs innovative solutions to the challenges posed by the physical separation of the learners from their teachers (Zawacki-Richter & Naidu, 2016, p. 249).

In their review of the factors influencing E-Learning, Nortvig, Petersen and Balle (2018) show that some factors seem to dominate more than others – for example, the educator's presence in online settings, the interactions between students, teachers and content, and designed connections between online and offline activities, as well as between campus-related and supervised professional training-related activities. This suggests that it is not just the online format alone that affects learning outcomes, satisfaction and student retention. However, students' experiences of the learning community appear to be significantly influenced by the online element. The review also sheds light on the paradoxes of the online environment, as the software used creates new opportunities for interactivity between student and content, between student and teacher, and among students themselves. At the same time we have e.g. learning platforms (LMS) that are also independent of students' geographical location, asynchronous participation and limited visual contact (Nortvig et al., 2018, p. 50). Creating a sense of belonging to a meaningful learning community is therefore an important factor for learning experiences, especially because it is difficult to make their social presence perceptible. Nevertheless, student-student interactions and collaborative activities are not necessarily the sole prerequisite for online students to feel part of a learning community. As Moore (2013) also highlights, other variables exist besides those of teaching and learning. Moore mentions distance education administration, distance education history, distance learner motivation. Some of them are more global than others, such as transactional distance and distance learner motivation (Moore, 2013). Studies comparing face-to-face teaching to online and/or blended learning reveals that no inherent features of any of the three teaching formats produce either better or poorer learning outcomes for students. What leads to one outcome over another is not the format itself, but is circumstantial and context-dependent (Nortvig et al., 2018; Werhner, 2010). There are different perspectives as to what quality in online learning is and should be. There are also major differences between professional and social needs and achievements within different fields of study and individual subjects, and there are human resources related to the interests and technological skills that are taking place. The study situation for a student in an on-campus course is different than for a student who participates in online education (Nordkvelle, Netteland & Fossland, 2013). The

interaction between the teacher and learner, and among learners, affects the quality and success of online learning, and the learner's ability to master the outcomes associated with the targeted content or skill area, as well as the broad outcomes of higher education, such as critical thinking, problem-solving, and communication (Association of American Colleges and Universities, 2015, in Andrade, 2015, pp. 2–4). In adult education, students and teachers should share a common responsibility and be more equal in achieving a good result (Holt & Stokke, 2014). This is in line with how adults view themselves as self-governing individuals. It is the practice of adult education, separate from the education of children, to treat the transaction between learning and teaching as the mutual responsibility of students and teachers. 'The role of the teacher is actually redefined as that of a process consultant, resource manager and co-investigator.' (Knowles, 1990).

Perseverance and dropouts

Perseverance is necessary to successfully complete a course online. Dropout rates in online and distance education are higher than in campus. Furthermore, student satisfaction has been shown to be a very intuitive and straightforward variable that is positively associated with perseverance. Factors related to dropout rates do not always lend themselves to easy measurement, as these might include any number of factors from scheduling conflicts, family issues, and financial problems, to technical issues and academic integration (Weidlich & Bastiaens, 2018). Furthermore, high dropout rates do not only apply to online classes. Lillevik Rokkones, Landro, and Utvær (2019) discuss dropout rates in TVTE at the Norwegian University of Science and Technology (NTNU), concerning campus classes. Their study shows that dropout rates vary greatly between annual cohorts. The 2007-cohort in their study had a 34.5 per cent dropout rate, yet for the 2013 cohort the dropout rate was 11.1 per cent. The average dropout rate across the eight cohorts that started between 2007 and 2014 was 25.8 per cent. Compared to other teacher training programmes, TVTE is different in that occasionally the dropout rate can be especially high early in the course.

A study of dropouts and persistent learners by Park and Choi (2009) showed statistical differences in their perceptions of family and organisational support, satisfaction and relevance. From their framework it was possible to predict whether someone would dropout or persevere, which includes levels of family support, organisational support, satisfaction, and relevance, in addition to individual characteristics. Organisational support and relevance were shown to be particularly predictive (Park & Choi, 2009).

Methodology

The teachers at our campus have a dual role, firstly as educators of vocational teachers and secondly as researchers into their own practice (Hiim, 2010; Tiller,

2004). As researchers, our role is to develop theoretical knowledge through researching our own practice.

According to Hiim (2010), the basic requirement of research work is that it should contribute to the development of knowledge. By researching our own practice as educators of vocational teachers our aim is to develop our knowledge of students' learning through the development of their learning strategies.

From the very first intake, the students of our online programme were aware that this was a new and novel opportunity to study at OsloMet online and that therefore the programme would be undergoing continuous development. It was vitally important that students constantly gave feedback on what worked and what could be done differently. From this perspective, the course design and implementation has been characterised by action-oriented thinking. At the same time, the development work is also characterised by a phenomenological approach, through which data from student feedback has been systematically analysed. The empirical data are obtained through reflection from both teachers and student logs, feedback, dialogue and participation in the programme.

In addition, the methodological approaches have been heuristic. According to Moustakas (1990), heuristic research begins with questions that need to be attended to and represents a systematic search that involves seven concepts: identifying with the focus of inquiry, self-dialogue, tacit knowing, intuition, indwelling, focusing, and the internal frame of reference. These concepts assist the researcher in reflecting on his/her hunches, thoughts, images, and deeper knowledge, and connecting to the greater meaning of the phenomena being researched. Heuristic inquiry does not exclude the researcher from the study; rather it incorporates the researcher's experiences with the experiences of co–researchers. The researcher is required to have a direct experience of the phenomenon in question (Douglass & Moustakas, 1985; Moustakas, 1990, p. 38).

The article is based on the materials available from 2015 to 2019. The materials were gathered through reflection logs, feedback and dialogue with and from students and teachers participating in the programme. Statements from the dialogue with the teachers are given in the results with informant 1 to 5 (Informant 1–5). The results also include data retrieved from the administrative system for comparison with the on-campus class in relation to demographics, admission and completion.

Results

Our results show that the online study has helped us to achieve a broader geographical spread in relation to student enrolments. The students experience our programme as a flexible study where they do not have to meet on campus every week. The technology has worked well so far and allows for continuous and further development. It appears to be on an equal footing academically with its

campus-based alternative but offers greater flexibility according to where the student is located. The workload also appears to be manageable for the teacher who is engaged in the online class. We go deeper into this in the following section to answer our initial research question.

What are the pedagogical and didactical considerations of the online TVTE?

When the decision to implement online studies was first made, a targeted effort was made to find good ways to design and implement the online programme for our TVTE-TP programme. What constitutes good pedagogy and didactics for online studies? Should the studies be 'gathering-based' or entirely online?

The analysis of our data shows that pedagogical and didactical challenges exist and must be considered when carrying out online teaching, although our starting point for facilitating online teaching was; 'It must be possible to do online what we do in the classroom'. We see that there has been a gradual didactical adaptation to prevent lessons from becoming monotonous and uninspiring. 'I don't hold lectures very often; we have one to one-and-half-hour sessions followed by groupwork and discussions. The students then present their work.' (Informant 5)

All the teachers are aware that special adaptations must be made in their pedagogical and didactic approach towards online teaching. The implementation of online teaching is more than just moving the classroom online. The retainment of 'study groups' has functioned well and has given teachers some room to alternate between lectures and group work. As with on-campus teaching, individual adaptations must be made from year to year. Some students say there is too much group work, while others say there is too little, etc. The content of the lessons is also significant when choosing the approaches to use.

The extent to which a learning environment can be established between students, and between students and teachers in any given on-campus class, and whether its absence or reduction in online classes affects the class and each individual student, continues to be a major issue. We see that teachers who have a significantly smaller number of hours online miss this environment to a greater extent than teachers who have the students frequently and/or long sessions online. The students, however, do not seem equally concerned with this. They claim that they form good relationships with each other, despite the large physical distance between them. Additionally, they find that their groups cooperate well, both online and during physical gatherings.

A trial with video feedback on students' work was a form of pedagogical adaptation to promote stronger contact between teacher and student. This proved to be successful and was well-received by the students.

What are the technical challenges?

Surprisingly, there have been very few technical problems with the online platforms and solution that we have used. Generally, the technical problems have been perceived as user errors or have been caused by inexperienced users.

The subject-specific hourly paid teachers find that they have more problems than the teachers in the professional studies precisely because they lack experience in dealing with emergency situations during classes since they only have a few sessions during the semester. For inexperienced teachers, small problems can quickly become quite large. Like for example that the sound goes away, the microphone does not work, the camera does not show a picture, etc. even though it is basically just pressing the right buttons and is arranged relatively quickly, it becomes stressful.

A considerable amount of time is set aside during the start of the programme and the initial attendance on campus, to fine tune the technical solutions and equipment needs the students must fulfil. 'However, this also relies on the students having the right equipment in place; a good headset, camera and satisfactory internet connection.' (Informant 5)

During the campus meeting, students can test the online tools and the web-based solutions. After this, few problems are encountered. It is also important that the students have adequate infrastructure at home. Success in distance courses is associated with the learners' ability to take responsibility for controlling the factors that affect their learning (Andrade, 2015).

Student feedback suggests that they find it equally fine to meet both on campus and online, but they also think it is okay to do so asynchronously. It seems like it is a combination that works well. It also appears that they are afraid that all the course elements will be asynchronous, or that they will never meet on campus.

What opportunities and limitations have emerged?

There is considerable agreement among the teachers involved that the flexibility of online courses offers many opportunities, first and foremost because the students do not need to travel to the university campus, but also because it is possible to present the content in a more flexible (asynchronous) way. 'The course is wherever you are. I believe that online courses attract more students than on-campus courses only. I believe that more students think they will be able to do the course because it's online.' (Informant 1)

The students spend a lot of time working in groups online and the groups have regular online meetings. Teachers also say that by making themselves more available, it reduces the risk of workload piling up within standard working hours. Questions can be dealt with, then and there, and enables them to give the

students more effective feedback. This means that the students can receive swift asynchronous feedback.

The students' experiences with online teaching facilitate rapid initiation of the follow-up and academic supervision of students undergoing supervised professional training. So far, the feedback for this follow-up has been very good.

OsloMet has gradually introduced the use of Office 365 at all levels. As a result, we have many excellent shared solutions to use for digital services. This also gives our students many possibilities to develop good digital skills to take into their own classrooms.

Numerous possibilities exist for the further development of our online courses. They can vary in content, shape and form. One possibility is to develop the option for asynchronous participation. At present, the online teaching resembles more of an 'online classroom'. We envisage that the content could possibly be adapted with finished content components for students to review and complete at their own pace. This transition to a more asynchronous course would likely lead to the perception that the course is even more flexible as well.

How do the teachers and students experience online teaching?

The teachers clearly express that they appreciate the possibility to work through online teaching, with all the challenges and possibilities it presents. They indicate that it is exciting to work with online teaching and to be allowed to be involved in its further development. 'I think it's great fun to be involved in this.' (Informant 1)

From early on in their studies, the students gain good user experiences that also benefit the teachers' practice. Those teachers with less experience often find that students can help them when user problems arise. Even though students have expressed that there are many platforms to relate to, it is evident to the teachers that the students seem confident and satisfied.

In terms of content and results, several of our interviewees confirm that the teachers find online teaching to be just as rewarding as on-campus teaching, even though it may feel a bit unusual to not have the same contact with the class as in a physical classroom.

There are several indications that students are very comfortable with the study group work, which is mainly done online. Occasionally, the teachers have the impression that the students do not really think about being in a classroom or in the online platform AdobeConnect.

One goal that we have continuously fallen short of has been gathering several classes online for one simultaneous lecture. To date, our experiences with this have not been particularly good, and the students have reported that they do not greatly benefit from such digital gatherings.

The software that we use is essentially for large lectures (and webinars). Therefore, it requires much more management and is mainly used for monologue style

lecturing. There are features however, such as random grouping, that allow parts of the lessons to be more flexible and comprehensive.

How do teachers compare online teaching with on-campus teaching?

When we asked the respondents for their views on how on-campus and online teaching differ, we found that the main trend was that they strongly emphasised the possibilities in on-campus teaching, while in the case of online teaching. Respondents mainly talked about it in terms of its disadvantages. 'I'm certain that online teaching equals on-campus teaching, but it needs to be planned differently.' (Informant 3)

The common denominator between the respondents is that they emphasise fewer opportunities to form social relationships. The students, however, have only given a small amount of feedback, and it does not suggest the same issue. They say they feel they have good relationships with fellow students.

The teachers see some advantages with online teaching including that they consider it as 'equal' to on-campus teaching, and that it offers some possibilities that are not so easily attainable through on-campus gatherings. Groupwork often involves the sharing of reflections and thoughts with your 'neighbour' (the person physically sitting next to you at a particular time). With online teaching, teachers can randomly split groups each time or create groups that they want to keep for a short period of time (this may depend somewhat on the context).

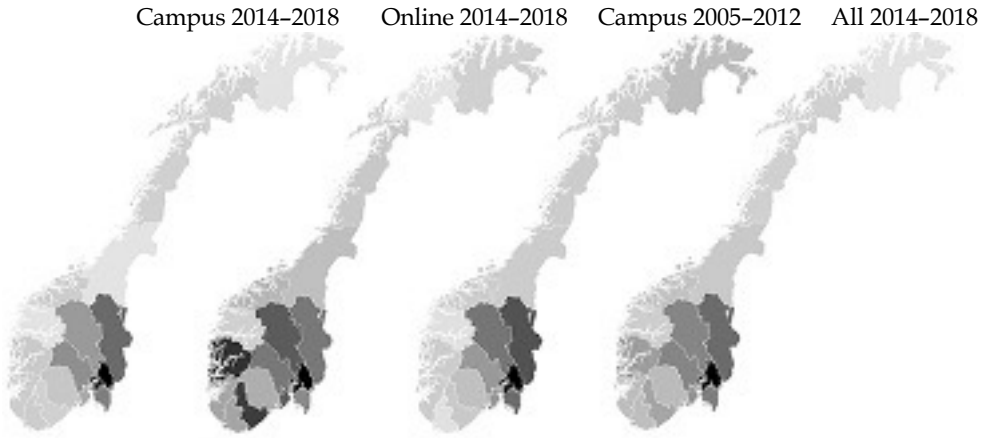


Figure 1. Graphic representation of regions (counties) in Norway where the students attending the on-campus and online programmes offered came from before and after the online programme started.

The graphic presentation in Figure 1 shows the distribution of students based on geographical regions (counties) in Norway. The data are from the student administrative system. The darker the counties, the higher the density of students. The

grey tone on the four maps are scaled differently based on the maximum number of students in the indication. As such, the presentation cannot be used to indicate which type of study programme has the highest density of students. This has been done to promote visualisation of the distribution and not the number of students on each type of programme. The first two maps show the domiciles of students on campus and online from 2014 to 2018, respectively. As the maps show, the density of students around eastern-central areas of Norway or near OsloMet is distinctively related to the on-campus programme. The online programme also has students in the same local community, but the density is higher towards the south and west of Norway. The last two maps illustrate the distribution before the online programme was offered, as well as the campus programme, between 2005–2012, and the total distribution thereafter (that is, the on-campus and online programmes combined). As the maps show, the online programme has contributed to a larger possible recruitment area for TVTE and thus contributed towards the societal mission of offering TVTE throughout Norway, in collaboration with the Norwegian University of Science and Technology (NTNU) (Grande, Lyckander, Landro & Rokkones, 2014).

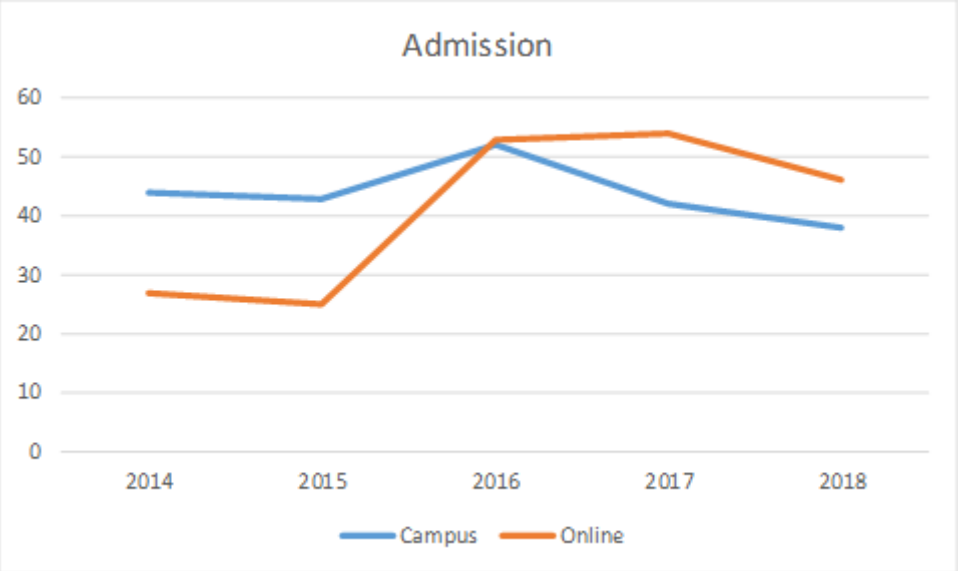


Figure 2. Admission on campus and online.

The graphs in Figure 2 show the number of students who have been offered a place on either on-campus or online courses during the period. In addition to offering a flexible course of study for students through the online programme, one of the objectives was to enrol more students so that OsloMet could meet the quota for the number of students that are expected to graduate each year. The target figure (in 2012) for TVTE-TP was 60 students. Since the typical age of those admitted to this type of programme was between 40 and 50, this was an

impossible task to achieve. As the graph shows, the total number of admissions increased from the first year for the online programme. In the course of the first two years, the on-campus and online programmes became just as popular (2016). The following two years, however, admission to the online programme surpassed that of the on-campus programme. However, it does not appear that the online programme 'steals' students from the on-campus programme – rather, they complement each other. In 2018, admission rates dropped for both types of programmes, the cause for which has not been assessed.

Table 1. Online TVTE-TP 2014 to 2018.

	Online all field of study								
	Active	**Completed**	**Withdraw**	**Transfer**	**Leave**	**Ended**	**Drawn**	**Expired**	**Total**
2014		63 %	4 %	7 %	0 %	15 %	11 %	0 %	27
2015		68 %	16 %	0 %	0 %	4 %	8 %	4 %	25
2016	51 %		9 %	9 %	2 %	13 %	15 %	0 %	53
2017	61 %		7 %	7 %	2 %	9 %	13 %	2 %	54
2018	59 %		7 %	7 %	0 %	11 %	22 %	0 %	46
			8 %	8 %	1 %	11 %	15 %	1 %	205
	57 %	65 %							

Table 2. Campus TVTE-TP 2014 to 2018.

	Campus all field of study								
	Active	**Completed**	**Withdraw**	**Transfer**	**Leave**	**Ended**	**Drawn**	**Expired**	**Total**
2014		59 %	2 %	2 %	0 %	14 %	20 %	2 %	44
2015		58 %	12 %	9 %	0 %	14 %	7 %	0 %	43
2016	71 %		6 %	8 %	2 %	6 %	6 %	2 %	52
2017	79 %		5 %	2 %	2 %	2 %	7 %	2 %	42
2018	82 %		5 %	5 %	0 %	5 %	3 %	0 %	38
			6 %	5 %	1 %	8 %	9 %	1 %	219
	77 %	59 %							

Tables 1 and 2 show the total number of applicants for campus-based and online-based courses. Bachelor's degree programmes for vocational teachers last for a period of three years, but since the article covers a period of five years, the last three cohorts had yet to complete their studies. The 2016 group had started work on their bachelor's theses in 2019. The 2017 group were now in their fourth semester, and the 2018 group were in their second. We have listed the cohorts that were still active when this study was conducted under 'Active'. Those who had completed their course are highlighted in the 'Completed' column.

The figures show that during the five-year period, 59 per cent of students completed the on-campus programme and 65 per cent the online programme. If we look at the cohorts that were still active, the picture is somewhat different. It shows that overall, 77 per cent of those who applied for admission on campus were still active. For the online programme, however, the figure is significantly lower with 57 per cent still active. As shown in Figure 2 above, the interest for online-based studies has sharply increased, and from the 2016-year group onwards there have been more applicants for online-based studies than for on-campus studies. The demographic composition of online students is different compared to those who apply for on-campus programmes. We also know that, for example, accessibility and flexibility mean a lot to our applicants for online-based studies.

We do not know for certain why the number of applicants for online-based studies has been declining. From our data, we can see that the dropout rate is higher among these applicants early in the course. For example, a significant number of students have refused the offer (withdrawn) or had their admission to a course or specific programme of study withdrawn (Expired – Students who have not completed the examination or applied for extended admission to a course or specific programme of study). We do not have exact data on this, but there is reason to believe that this happens relatively early in the programme (from the first day up to the beginning of the second semester). Among those who have dropped out from the course during their period of study, we also see a significant increase in the number of applicants for online studies.

Of those who apply for a transfer from on-campus to online or vice versa, it is largely the same for both programmes. For students who are on leave of absence, there is no significant difference.

Nevertheless, if we look at those who have lost their right to admission to a course or specific programme of study (withdrawn), we see that the dropout rate is slightly higher for the online programmes but follows the same trend.

Summary

After 'five years online' the offer of online studies has had positive results. Admission is offered to students across a wider area in Norway without this seeming to affect the number of students who would normally be admitted to campus programmes.

Teachers involved in online studies consider their contribution and participation in a new programme as positive. They find it interesting and challenging to be allowed to help establish new pedagogical practices in a field that in many ways differs from on-campus classroom teaching, but also has many similarities. Both teachers and students emphasise the opportunity for flexibility that the online programme provides. We see that the online programme attracts many

students who would not normally have time or the possibility to complete the course of study if they followed the ordinary campus-based programme.

The purpose of this study has been to obtain a picture of the first five years with both online and campus-based studies. The study uncovered many interesting areas that are well worth looking at in more detail, such as a greater focus on what is possible synchronously versus asynchronously, and how to establish good student relationships in the beginning that will make students feel safe and feel looked after and taken care of in an online environment. At the same time, it important that the students also contribute (preferably with their learning work) in a digital online environment and gain expertise on this.

Notes on contributors

Steinar Karstensen is an Associate Professor at the Department of Vocational Teacher Education at OsloMet – Oslo Metropolitan University, Norway. His area of interest is technology in work and learning. The field of technology and learning focuses on the development of technological competence, digitalisation, automation, robotisation, simulation, and relations between technology and learning in different professions, and what implications this has for vocational education in secondary school and for vocational teacher education. He is also the leader of a research group with the same area of interest.

Runar Oudmayer is Assistant Professor at the Department of Vocational Teacher Education at OsloMet – Oslo Metropolitan University, Norway. His area of interest is technology and information technology, ICT in teaching and learning, digitalisation, robotisation, virtual reality, and simulation impact on vocational teacher education.

References

Andrade, M.S. (2015). Teaching online: A theory-based approach to student success. *Journal of Education and Training Studies, 3*(5), 1–9.

Douglass, B.G., & Moustakas, C. (1985). Heuristic inquiry: The internal search to know. *Journal of Humanistic Psychology, 25*(3), 39–55.

Foss, S., Gustavsson, A., Johansen, F., Karstensen, S., Rodheim, S., Schneider, M., & Sønsteli, S.T. (2011). *Kvalitet i flexibelt lärande: En tekstsamling for bedre utdanning med digitale medier* [Quality in flexible learning: A text collection for better education with digital media]. Karlstad: UNISKA Universitetsalliansen Inre Skandinavien.

Grande, S.Ø., Lyckander, R., Landro, J., & Rokkones, K. (2014). *Fram i lyset! En kartlegging av status og behov for lærerutdanning for yrkesfag* [Accentuate! A survey of the status and need for teacher education for vocational subjects]. Retrieved 25. June, 2020, from https://www.ntnu.no/documents/150035/20502917/Fram+i+lyset!/60886d96-25e0-4ef3-b67d-a153770ef7c4

Hiim, H. (2010). *Pedagogisk aksjonsforskning: Tilnærminger, eksempler og kunnskapsfilosofisk grunnlag* [Pedagogical action research: Approaches, examples and the philosophy of knowledge]. Oslo: Gyldendal Akademisk.

Holt, J., & Stokke, K.E. (2014). *Teaching literacy, numeracy and ICT to adults: The basic skills programme (BKA program) for workers in building construction (bricklayers, carpenters and foundation workers).* Paper presented at the ATEE ANNUAL CONFERENCE 2014, Brussel.

Karstensen, S. (2014). *What do the teacher training students see when they look and what do they say they see when they are out on the observation in school for the first time.* Paper presented at the ATEE ANNUAL CONFERENCE 2014, Brussel.

Karstensen, S. (2015). *From campus to online learning – experience from the first year of online training in Technical and Vocational Teacher Education (TVTE).* Paper presented at the ATEE ANNUAL CONFERENCE 2015, Brussel.

Knowles, M.S. (1990). *The adult learner: A neglected species* (4th ed.). Houston: Gulf Pub. Co.

Lillevik Rokkones, K., Landro, J., & Utvær, B.K. (2019). Bachelorutdanning for yrkesfaglærere, i et historisk og utviklingsorientert perspektiv [Bachelor programme for vocational teachers, in a historical and development-oriented perspective]. *Nordic Journal of Vocational Education and Training, 8*(3), 141–159.

Moore, M.G. (2013). *Handbook of distance education* (3rd ed.). New York: Routledge.

Moustakas, C. (1990). *Heuristic research: Design, methodology, and applications*. Thousand Oaks: SAGE Publications.

NKR. (2009). *Nasjonalt kvalifikasjonsrammeverk for høyere utdanning* [National qualifications framework for higher education] (NKR). Retrieved 25. June,

2020, from https://www.regjeringen.no/no/tema/utdanning/hoyere-utdanning/nasjonalt-kvalifikasjonsrammeverk/id564809/

Nordkvelle, Y., Netteland, G., & Fossland, T.M. (2013). *Kvalitet i fleksibel høyere utdanning: Nordiske perspektiver*. Trondheim: Akademika.

Nortvig, A-M., Petersen, A.K., & Balle, S.H. (2018). A literature review of the factors influencing e-learning and blended learning in relation to learning outcome, student satisfaction and engagement. *Electronic Journal of e-Learning, 16*(1), 46–55.

OsloMet. (2017). *Digital strategic plan*. Retrieved 25. June, 2020, from https://www.oslomet.no/en/about/strategy-vision

OsloMet. (2018). The digital university of the future. In *Strategy for digital transformation 2018–2024*. Retrieved 25. June, 2020, from https://ansatt.oslomet.no/documents/585743/77463421/Strategy+for+digital+transformation.pdf

Park, J-H., & Choi, H.J. (2009). Factors influencing adult learners' decision to drop out or persist in online learning. *Journal of Educational Technology & Society, 12*(4), 207–217.

Tiller, T. (2004). *Aksjonsforskning i skole og utdanning* [Action research in school and education]. Kristiansand: Høyskoleforl.

UDIR. (2017). Facts about Norwegian education. Retrieved 4. March, 2019, from http://www.udir.no/in-english/

Weidlich, J., & Bastiaens, T.J. (2018). Technology matters: The impact of transactional distance on satisfaction in online distance learning. *International Review of Research in Open and Distributed Learning, 19*(3), 222–242.

Werhner, M.J. (2010). A comparison of the performance of online versus traditional on-campus earth science students on identical exams. *Journal of Geoscience Education, 58*(5), 310–312.

Woodcock, S., Sisco, A., & Eady, M. (2015). The learning experience: Training teachers using online synchronous environments. *Journal of Educational Research and Practice, 5*(1), 21–34.

Zawacki-Richter, O., & Naidu, S. (2016). Mapping research trends from 35 years of publications in distance education. *Distance Education, 37*(3), 245–269.