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

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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

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 situations. 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 practice 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.

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