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'The mannequin is more lifelike': The significance of fidelity for students' learning in simulation-based training in the social- and healthcare programmes

Vibe Aarkrog

Aarhus University, Denmark (viaa@edu.au.dk)

Abstract

The article concerns fidelity in relation to using mannequins in simulation-based training in social- and healthcare education. The article addresses two issues. What influences fidelity, and how does the degree of fidelity influence the students' learning processes? Simulation-based training is organized in three phases; briefing, scenario, and debriefing. The article focuses on the scenario phase. A central issue in relation to the scenario phase is fidelity; i.e. the degree to which the scenario matches the practice it is intended to simulate. The article deals with the factors that influence the students' perception of fidelity and with the impact of degree of fidelity on the students' learning processes. The empirical data include obser-views, combining observations with interviews with students and teachers in social- and healthcare colleges. The analysis shows that a high degree of fidelity simulation in the sense of employing a mannequin has advantages, such as engaging students in learning and enabling them to try out practical skills. Moreover, the degree of fidelity should be adjusted to the students' practical experiences in order to optimize their learning process. Lower degrees of fidelity may have a positive impact on developing creative thinking and reducing the students' anxiety. The implication for developing practice is that the social- and healthcare colleges employ a multifaceted approach to fidelity based on ensuring optimal learning conditions for the students. The implication for further research is to specify and systematize the interrelation of learning outcome targets, students' qualifications and the usages of different degrees of fidelity.

Keywords: fidelity, learning process, simulation, social- and healthcare programme.

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Introduction

While high fidelity simulation is widely used within training of nurses and training of doctors, it has only recently been included in the social- and healthcare programmes. In this article, high-fidelity simulation refers to simulations using mannequins. As is the case with other new pedagogical tools, the teachers as well as the students are excited about the opportunities related to the use of high technological mannequins. However, it is important to specify the scope of usage of the pedagogical tool. In relation to this, one of the issues concerns the interrelation of fidelity and learning. The aim in this article is to discuss and clarify how degrees of fidelity influence social- and healthcare students' learning process.

Simulation-based training includes three phases: briefing, scenario, and debriefing. A great many articles deal with the importance of the briefing and debriefing phases for students' learning outcomes (Aarkrog, 2018; Johnston, Coyer & Nash, 2017; Loo, Krishnasamy & Lim, 2018).

However, the challenges for simulation-based training, for instance concerning reflection in the debriefing phase, do not appear to differ significantly from the challenges in other kinds of practice-based training. What distinguishes simulation-based training is the simulation activity, which takes place in the scenario phase. The central issue in this article concerns the fidelity of the scenario.

This article presents results from an empirical study of simulation-based training in social- and healthcare education, 'SIMU at SOSU'[1], that runs in the period 2017–2019. The research project is part of a developmental project, conducted at five Danish social- and healthcare colleges. In 'SIMU at SOSU' teachers develop and try out technologically based simulations with the aim of strengthening the quality and effectiveness of simulation-based training in the social- and healthcare programmes. This article focuses on the data that concern how the degree of fidelity in the scenario influences the students' learning process. The argument is that the learning outcome targets as well as the students' qualifications should decide the degree of fidelity.

Research into simulation-based training

A number of studies show that simulation-based training improves the learners' learning process and learning outcome, e.g. the learners' motivation (Dennis, Sainsbury, Redwood, Ng & Furness, 2016) and ability for reflection (Poikela, Ruokamo & Teräs, 2015), and it has been argued that simulation-based learning leads to relatively more resilient learning (Akroyd, Jordan & Rowlands, 2016; Cook, Brydges, Zendejas, Hamstra & Hatala, 2013). Research also questions the effect of simulation-based learning (Arafeh, 2017; Kinney & Henderson, 2008) or points to the difficulties in assessing the effect of simulation-based learning (Atesok, Satava, Marsh & Hurwitz, 2017).

Definitions and clarifications of fidelity

Fidelity concerns the realism of the scenario, i.e. the degree of correspondence between simulation and real practice: 'The concept of simulator fidelity is usually understood as the degree to which a simulator looks, feels, and acts like a human patient' (Hamstra, Brydges, Hatala, Zendejas & Cook, 2014, p. 387).

It is common to distinguish between high-fidelity simulation and low-fidelity simulation. High-fidelity simulation refers to scenarios that include multiple elements identical to the real-life situation that is being simulated. High-fidelity simulations often, however need not, employ advanced technology, e.g. by using mannequins. Low-fidelity, meanwhile, refers to scenarios that deviate from the real-life situation that is being simulated; while mannequins may still be employed, the technology is likely to be less sophisticated (Lee, Grantham & Russell, 2008).[2]

However, a number of studies show that the distinction between high-fidelity simulation and low-fidelity simulation is more multifaceted than just a question of the degree of technology. Several differentiations of fidelity have been suggested. Hamstra et al. (2014) distinguish between structural fidelity (appearance) and functional fidelity (behaviour). Lioce, Meakin, Fey, Chmil, Mariani and Alinier (2015) identify three aspects of fidelity. 1. 'Physical fidelity' refers to the physical environment, corresponding to structural fidelity. 2. 'Conceptual fidelity' refers to the coherence of the various elements in the simulation, e.g. that symptoms displayed by the patient match the diagnosis. 3. 'Psychological fidelity' concerns the realism of events and conditions in the scenario, e.g. that it is possible to communicate with the patient, time pressure and that the noises and smells in the room correspond to real life (Lioce et al., 2015). Dieckmann, Gaba and Rall (2007) distinguish three modes of realism in the scenario: physical mode referring to the physical characteristics of the equipment including the mannequins, semantic mode referring to the realism of concepts and their relationships, e.g. theories or information, and phenomenal mode concerning the participants' experiences in the simulation, including their accept of differences between the simulation and the clinical practice (ibid., pp. 184–185). Likewise, arguing that the assessment of the level of fidelity of the simulation should be based on the learner's experience rather than on the kind of simulators, Tun, Alinier, Tang and Kneebone (2015) propose a three-dimensional framework for fidelity including the three axes patient, clinical scenario, and healthcare simulation facilities. 'Patient' includes all forms of interaction with patients, including physical treatment, communication and other social acts. 'Clinical scenario' refers to the progression and complexity of the scenario, including the teachers' role in the scenario. Finally, the 'healthcare facilities' dimension concerns the clinical equipment and environment (Tun et al., 2015). This framework can be used to adjust the degree of fidelity according to particular learning objectives and to the learners' competence levels. For example, a novice learner may benefit from learning

in a scenario that does not include a high degree of fidelity concerning 'healthcare facilities' and thereby does not demand an understanding of the highly complex equipment found in real situations. This framework is useful in relation to SIMU at SOSU, the students' differing in relation to their practical experiences.

The elaborations of the concept of fidelity reflect that fidelity should be defined through the learners' experiences and produced by the learners (Ahn & Rimpiläinen, 2018).

Eventually, as indicated above, high-fidelity simulation may also be established without employing high technology. In a study of nurses' and doctors' engagement in the learning process, a high-fidelity simulation of a 'humanistic nature', i.e. a live person, was applied, the teacher playing a patient. With the teacher's insight into the illness, the teacher was not only able to play the role convincingly, but also guide the learners in the scenario. The study shows that a teacher with knowledge about an illness 'can suspend the disbelief that often happens when manikins or actors seem unrealistic' (Dwyer, Searl, McAllister, Guering & Friel, 2015, p. 431). Furthermore, a scenario using a live person was shown to reduce students' anxiety, simply because they were asked to perform in a scenario that more closely resembled a real clinical context than scenarios using a mannequin (ibid., p. 435). These results have also inspired the analysis of the data in SIMU at SOSU.

Thus, fidelity can be established not only through the equipment in the room but also through the actions there, the learners' experiences of fidelity being central. Consequently, the analysis of the interrelation of fidelity and learning will focus on the equipment, the teacher's role and the students' actions.

Research-based literature about the impact of fidelity on learning

Research into fidelity mostly examines which kind and degree of fidelity best supports students' learning outcomes, often the students' transfer of learning into practice, with some studies indicating that high-fidelity simulation is crucial to students' learning outcome (Kirkman, 2013; Presado, Colaco, Rafael, Baixinho, Felix, Saraiva & Rebelo, 2018; Spetalen & Sannerud, 2013; Walsh, Tran, Waseem, Khan & Haase, 2017).

Other studies – comparing high- and low-fidelity simulation in health professions – show that compared to low-fidelity, high-fidelity simulation does not in particular yield the learners' transfer of learning into practice (Bredmose, Habig, Davies, Grier & Lockey, 2010; Chen, Grierson & Norman, 2015; Kinney & Henderson, 2008; Norman, Dore & Grierson, 2012) or develop their knowledge and skills, the low-fidelity simulation group even showing a higher level of self-confidence than the medium-fidelity group (Bowling & Underwood, 2016).

Among the reasons for taking an interest in comparing high- and low-fidelity simulation, a study shows that compared to high- fidelity simulations, low-fidelity simulations are cost effective compared to high-fidelity simulations (Lapkin & Lewett-Jones, 2011).

Thus, the studies show that high-fidelity simulation does not necessarily result in a better learning outcome than low-fidelity simulation. An explanation is that, in order to establish high-fidelity, it is necessary to simulate all elements from the real practice, including all aspects of the patient, the context and the activities. However, when the aim is to provide the learner with realistic experiences, the simulated practice becomes complex and stressful. From a learning perspective, these realistic situations may bring about an extraneous cognitive load that is not conducive to the learning process (Chen et al., 2015; Grierson, 2014; Norman et al., 2012; Tosterud, Hedelin & Hall-Lord, 2013). Concerning students' learning *processes*, a study addressing the technical aspects of high-fidelity simulation in particular showed that high fidelity is valuable for the students' engagement, realism producing an urgency in the situation (Lawrence, Messias & Carson, 2018).

In a study of nursing students' perceptions of the learning methods in high-fidelity simulation and low-fidelity simulation, high-fidelity simulations involved realistic, holistic patient situations using technology, while low-fidelity simulations were pen and paper studies or used either prosthetic limbs or static mannequins. The results showed that the students were most satisfied with the pen and paper-based simulation (Tosterud et al., 2013).

Also focusing on the learning process, Grierson argues that the advantage of simulation-based training is that one can establish learning situations that are not possible in real practices. In simulations, it is possible to construct a variety of situations and experiences and to learn through error. With the aim of optimizing skills acquisition and transfer to other situations, it is not necessarily important to establish contextual realism, i.e. high fidelity: 'simulations should ensure that learners engage information that is fundamental to the desired skill performance, even when practice conditions are manipulated to increase the variability and/or complexity of the learning experience' (Grierson, 2014, p. 287). The implication is that the fidelity of the simulation should not be so high that it prevents the manipulation of practice to create optimal learning conditions.

Thus, the degree of fidelity should be based on the desired learning outcome goals. According to Hamstra et al. (2014), the current assumption within simulation-based training is that the higher the degree of fidelity, the better the learning. Furthermore, the primary aim in simulation-based training has been to develop high-fidelity technological solutions rather than focusing on educational goals. Hamstra et al. reject this approach, arguing that the question teachers need to ask themselves is: '"What are we going to teach?" rather than "How will we use the existing platform to teach this skill?"' (ibid., p. 389). Hamstra et al. argue that

functional fidelity has greater impact than structural fidelity in relation to a number of learning goals, such as goals that involve communication and teamwork (ibid, p. 388–389). Furthermore, when considering the balance between structural fidelity and functional fidelity, it is crucial to remain focused on the primary educational aim, i.e. the transfer of what is learnt to real-world situations (ibid., p. 389–390).

The lesson learnt from the literature review above is that the definitions of high fidelity is multifaceted and that the point of departure for specifying the optimal degree of fidelity should be a combination of the educational goals and the students' experiences of fidelity. In relation to developing simulation-based training in the social- and healthcare programmes, knowledge is needed about what influences the students' experiences of fidelity as well as how degrees of fidelity influence the students' learning process.

Consequently, the aim in the analysis is to examine the following two questions:

1. Which factors are important for the social- and healthcare students' experience of fidelity?
2. How do degrees of fidelity influence the students' learning process?

Research design

The research project studies the impact of technologically based simulations on students' learning processes and learning outcomes, using an action research approach. The teachers at five colleges developed and tested simulation-based training. Data were collected regarding the students' learning processes and learning outcomes from this training. The findings were discussed with the teachers, who then used these findings to develop and improve the simulation-based training. The empirical data in this article stem from the first round of data collection in spring 2018.

The empirical data include obser-views conducted in five social- and healthcare colleges (Kragelund, Moser & Zadelhoff, 2015). Obser-view is a contraction of observation and interview and implies that the researcher first observes and then conducts interviews with participants in the observed situations, focusing on discussing and reflecting on the observations. One simulation-based lesson (briefing, scenario and debriefing) was observed at each of the five colleges. Each lesson lasted 40 minutes: 10 minutes for briefing, 10 minutes for scenario and 20 minutes for debriefing. In three of the five simulations, the students were attending the one-year school-based basic course of the social- and healthcare programme and therefore had no practical experience with training or working in real workplaces. In the remaining two simulations, the students were attending the main course of the social- and healthcare programme, in

which students alternate between college-based and work-based training, so these students did have such practical experience.

The data were collected by two researchers, one collecting data at two of the five colleges, the other at the remaining three. At each of the five colleges, a group of four students participated in the simulation that was studied. In the scenario, two students treated and interacted with the patient while the other two observed the scenario. At each college, one group of students and one teacher were followed, meaning that the data collected included a total of 20 students and five teachers.

Concerning ethical issues, the teachers were responsible for selecting the students for the obser-views. Participation was non-compulsory. The teachers were instructed to inform the students about the data collection process and analyses and to ensure the students that they would be anonymous in the presentation of results. Parental consent was not needed, all students being over 18 years old. In the beginning of the interview, the interviewer informed the students about the purpose of the project and about the focus in the analysis and dissemination, including that the students would appear anonymously in any publication from the project.

The observations focused on the teacher's way of organising the briefing and debriefing phases and on the students' reactions to that. During the briefing, the observation concerned how the teacher prepared the students for the scenario, introduced the students to or reviewed theory or theoretical concepts, and summarized the learning outcome goals. The observations of the debriefing phase concerned the teacher's way of conducting the reflection process and the students' responses to that. The observation of the scenario that is in focus in this article concerned which forms of fidelity were employed, the teacher's role in the scenario, and the students' performance.

The interviews with the students as well as with the teachers took their point of departure in the observations and were conducted immediately after the observations. The focus group interview with the students included two themes, one being how the students perceived that the various activities in the three phases influenced their learning process. The other theme was the students' perceptions of the teacher's activities in the three phases. In the individual interviews with the teachers, they were asked to argue for their planning of the three phases and for their decisions throughout simulation. The interviews with the students and the teachers were recorded and transcribed partly as resume, partly in direct quotation.

The two researchers, who collected the data, also did the analysis. The analysis for this article has focused on the students' experiences of fidelity and of the impact of fidelity on their learning process. A comparison of the analysis of the two researchers' data showed that the students' experiences of fidelity and the impact of the simulation-based training on the students' learning processes were largely

the same across the five colleges, with some differences between students attending the basic and main courses.

Results

In the analysis of data, the aim has been to clarify how the social- and healthcare students experience fidelity, and how the degree of fidelity affects the students' learning processes.

When quoting passages from the interviews, it is indicated whether the students and teachers are affiliated with the basic course (BC student, BC teacher) or the main course (MC student, MC teacher). This distinction is made due to some variation in the two groups' perception of fidelity, in particular based on whether they have practical work experience or not, cf. above.

As mentioned above, the observed scenarios have a duration of ten minutes. In the observed scenarios, the high technological mannequin, suffering from an illness, lays in a bed in a room that – depending on the kind of patient – has been furnished as a hospital ward or as a room in an old people's home. The furnishing is not perfect; for example, in one of the scenarios, the students want to offer the patient a glass of water, but have to make do with an imaginary glass. However, in each scenario it is easy to see what the room is supposed to represent. In some of the scenarios, the room is divided into two spaces: a treatment room and a technical room for operating the mannequin's speech, breathing and symptoms. A teacher voices the mannequin, including coughs, expressions of pain etc. In the scenarios with no technical room, the teacher does this while sitting at the sickbed. The students must wear professional uniforms. The door to the scenario room is closed; when the students enter the room following the briefing phase, they transform from students to professional social- and healthcare workers.

Which factors are important for the social- and healthcare students' experience of fidelity?

Comparing simulations to scenarios involving role-play, the students all agreed that using a mannequin is much better than role-play. One of the students went so far as to say, *'The mannequin is **more** lifelike'* (BC student). This was mainly due to the mannequin's appearance, but also to the room's furnishing and equipment.

Furthermore, fidelity was strengthened by teachers voicing the mannequin, compared to scenarios where the role of the patient is played by a student. Unlike the teacher, the students do not generally know much about the illnesses they are portraying and are consequently unable to realistically illustrate the symptoms:

> It is good that the teacher and not the students does the voice of the mannequin. The teacher knows much more about how the patient reacts and she can direct us to try out specific things. I was challenged (in the scenario), which I would not have been if a student had done the voice-over. (BC student)

When the students have difficulties in authentically illustrating the patient's illness, it is difficult to maintain fidelity and, according to the students, role-play scenarios often end in laughter.[3] As such, the relatively high fidelity when using the mannequin compared to role-play is partly due to the structural fidelity, but, perhaps even more so, to the functional fidelity of the simulation (cf. definition above), the crucial distinction being that a person with knowledge about the particular illness voices the mannequin in the scenarios.

Another observation from the scenarios was that the students perceived the fidelity of the situation differently depending on how far they were in the programme. The novice students, with no practical experience within social- and healthcare, were more apt to perceive the tasks in the scenario as highly credible, than were those with practical experience. As an example, a first-year student with no practical experience, who was trying to put a compression stocking on a patient (the mannequin) for the first time, said: *'In the scenario, I learnt to put on compression stockings. It reassures me that I have tried it, even though there were nails in the leg'* (BC student). The student feels that she has learnt to put compression stockings on a patient, and she feels reassured that she will now be able to do so in a real-world situation. She feels that the situation reflects realism. Another student from this group who had previously worked at an old people's home, smiled, signalling that she knew that you have not learnt to put on compression stockings by trying it out in a simulated practice. The simulation cannot capture the complexity of real practices, where even a seemingly straightforward task, such as putting compression stockings on a patient, can require a wide array of different knowledge and competence.

Related to this observation, the distinction between having and not having practical experience led the students to focus on different factors in the scenario. Whereas students with no or limited practical experience focused on treating the patient's physical ailments, more experienced students also focused on the communicative aspects of the interaction with the patient. These differing focuses were mirrored in differing perceptions of fidelity. For novice students with no practical experience, a realistic depiction of the patient's illness was sufficient, whereas the more experienced students pointed out that the scenario should also accurately reflect the way the patient communicates, and the interior and facilities in a hospital ward (cf. Tun et al., 2015).

Fidelity depends on the students' willingness to be deceived. The observations of the scenarios showed that, in most of the scenarios, the students were fully engaged and accepted the deception. For example, in one of the scenarios where the teacher was voicing the mannequin from a bedside position, the students remained focused on the patient even though the speech and expressions of pain came from the teacher's mouth. Afterwards, one of the students said, *'I did not even notice the teacher during the simulation or that the teacher was doing the voice'* (BC student). In another scenario, one student in particular resisted being deceived.

The student distanced himself from the scenario, for instance by not wanting to wear a uniform, arguing: *'It is not important to wear a uniform in a simulation; in real life, it is'* (BC student). Asked about whether he noticed the teacher at the bedside during the scenario, he replied *'I certainly noticed that'* (BC student). Thus, the students themselves contribute to the degree of fidelity by being more or less willing to be deceived.

Apart from playing the patient authentically, the teacher can maintain fidelity in the scenario by making the patient guide the students. In one of the scenarios, the mannequin, as voiced by the teacher, complained that she had difficulties in breathing. With the student at a loss, the teacher-as-mannequin said: *'Yesterday I had a different social- and healthcare assistant, and she put pillows under my arms and that helped a lot'* (BC Teacher). The student smiled and placed pillows under the mannequin's arms.

Thus, the analysis shows that the equipment in the room, the use of mannequin, as well as the teacher voicing the mannequin, are all important factors for the students' experience of fidelity. Furthermore, the data show that the students differ in their perceptions of credibility on whether they have practical experiences from real workplaces or not. The students' willingness to be deceived contributes to the degree of fidelity.

How do degrees of fidelity influence the students' learning process?

In the second part of the analysis, I examine how the degree of fidelity in simulation-based training affects students' learning processes.

According to the interviews with the students, they have to take a number of issues into account when performing in the scenario, *'There are so many things you have to pay attention to and remember: respiration, ergonomics and so on'* (BC student). On the one hand, a high degree of complexity ensures high fidelity by presenting students with a realistic situation in which they, for example, have to measure the patient's blood pressure while communicating with the patient and, at the same time, being aware of factors such as ensuring the room is well-aired. On the other hand, the students find it somewhat stressful having to cope with the various demands in the room. Students in the basic course, who have not yet had practical experience working on a ward, are especially likely to feel this pressure. The feeling of pressure may interfere negatively with the learning process: the many impressions confuse the students and obstruct a focused performance.

A high degree of fidelity makes the students feel that they are in a real practice. Their main ambition being to perform well in real practices the students want to perform at their very best in the scenario. Therefore, the students are nervous when entering the scenario. According to the interviews with both teachers and students, many of the students have reservations about or even refuse to partici-

pate in the scenario, their main worry being that they will make fools of themselves. The simulation-based training means that the students, as in real-world situations, are thrown in at the deep end:

> You realize that the patient [the mannequin] is getting worse, and so you try to do something and communicate with the patient to see if that helps. You will not learn how to communicate until you are in the situation. (BC student)

The students must suddenly demonstrate their manual and communicative skills. As one teacher says:

> Most of the students will be opposed to this kind of training. It oversteps the students' boundaries to participate in simulation, partly because they have to be actors, partly because they are not yet ready to demonstrate their practical skills. (BC teacher)

This may also be part of the explanation, why the students, who observe the scenario, find that they learn a lot from observing without taking part. Released from the anxiety of performing and demonstrating their actions, the observers are able to concentrate on learning by observing practice.

The students take simulation-based training seriously because such simulations test their ability to perform in real-world situations. The students try to simulate real situations as closely as possible, thereby ensuring high fidelity. Consequently, it is important for them to accomplish the task given in the scenario with no interruptions, perceiving interruptions as a sign of being unprofessional. The obser-views showed that, due to the students' anxiety about the scenario, some of them would have preferred a dress rehearsal before entering the 'real' scenario, in order to perform as professionally as possible. Thus, a relatively high degree of fidelity engages the students in the simulations; however also establish an exam-like atmosphere.

The data also point to advantages of simulations employing a lower degree of fidelity. In one of the group interviews, the students were annoyed that there was no glass or water in the room when the patient asked for a drink. At the same time, however, they were proud that they reacted by inventing an imaginary glass and water. Thus, the students produce reality through their actions (Ahn & Rimpiläinen, 2018). Low-fidelity events or situations may develop students' creative thinking and adaptability – competences that will be useful in their future jobs.

Finally, the data show that the teacher, voicing the mannequin, has an important impact on the students' learning process. This raises the question whether the teacher playing the patient in a role-play could substitute the mannequin. Do the social- and healthcare colleges need to invest in high technology mannequins? The interviews with the students and the teachers show that it is relevant to invest in mannequins. According to the teachers, the mannequins are able to display e.g. shortness of breathing for a much longer time, than the teacher

would be able to manage physically. According to the students, they are more comfortable treating a mannequin than their teacher: '*It would be awkward, touching and treating the teacher*' (BC Student).

Summing up, the analysis shows that the use of a mannequin strengthens the students' engagement in the scenario. They experience a better learning process using a high-tech mannequin than, for instance, role-play. However, high fidelity, in the sense high complexity, should be adjusted to the students' qualifications, e.g. to their practical experiences. A relatively low degree of fidelity may benefit the students' creative thinking. High fidelity can have a negative influence on the learning process, particularly for novice students. Students who are relatively far in the educational programme can cope with a higher degree of fidelity, in the sense of greater complexity reflecting real-world situations, than novice students. In general, the students try to maximize fidelity because they want to appear as professional as possible when observed in the scenario. Ironically, however, reducing fidelity may enhance students' learning processes, the observer students perhaps having greater opportunities for learning. Focusing on the scenario more as a learning opportunity than as professional performance may also reduce students' anxiety.

The results point to defining the optimal balance between on the one hand experiencing a realistic demand on acting in a practical situation, and on the other hand ensuring a conducive learning environment.

Discussion

The results of the analysis are that the mannequin combined with the teacher voicing the mannequin are important for the students' experience of fidelity. The students' qualifications, i.e. their practical experiences, influence their experience of fidelity as well as does their willingness to be deceived. The students express that the mannequin supports their learning process, however strengthened by the teacher ability to support the learning process through voicing the doll. Thorough high fidelity in relation to all aspects of the simulation can put a pressure on the students, and lower degrees of fidelity can have a positive impact on the students' creative thinking as well as taking the load of anxiety from their shoulders.

The results of the analysis of simulation-based training of social- and healthcare students are in line with results of previous research, even though this research mainly deals with the training of nurses or doctors. Thus, in terms of enhancing the learning process, the analysis confirms that it is useful to distinguish between various forms of fidelity, e.g. between structural and functional fidelity (Hamstra et al., 2014). Furthermore, that a focus on producing reality instead of merely imitating reality (Ahn & Rimpiläinen, 2018) benefits the students' learning process and consequently their learning outcome. As found in relation

to nurse students (Lawrence et al., 2018), the students in the social- and healthcare programme enjoy learning in a high-fidelity setting. The analysis shows that structural fidelity seems to have some significance, with students taking simulations with a mannequin more seriously than those based on role-play. However, what the mannequin does (functional fidelity) seems to be even more important; it is important that the mannequin's actions reflect the disease it is supposed to simulate and that the students are able to communicate with the mannequin. Consequently, high fidelity depends on the competences of the person voicing and controlling the mannequin. He or she must have knowledge about and experiences with the condition. In the study, this role is played by the teacher, which means that the teacher is to some degree responsible for ensuring high fidelity. This raises an interesting issue, which could be investigated further: Would the students' learning processes and learning outcomes be the same or even better, if a human-based high-fidelity simulation (cf. Dwyer et al., 2015, above) replaced a technology-based high-fidelity simulation? The analysis shows that the mannequin plays an important role in the students' learning process.

The analysis also confirmed findings in previous research showing that high fidelity means high complexity and extraneous cognitive load (e.g. Grierson, 2014). Complexity has a negative impact on students' learning processes, in particular among novice students, suggesting that the degree of fidelity should be adapted to students' competences and experiences (Tun et al., 2015).

One important aspect of the findings concerns the students' anxiety in relation to simulation-based training. This aspect has been addressed in previous research, with one study even arguing that low-fidelity simulations, such as case studies, are best suited to developing students' self-confidence, as they do not require students to mimic professional performance (Bowling & Underwood, 2016). In relation to the students in the social- and healthcare programmes, however, substituting high-fidelity simulation with low-fidelity case studies would deprive the students of the opportunity to learn through practical training in realistic environments, which is the main motivation for the students to engage in this kind of training.

Nevertheless, because the students have a great deal of respect for practical training and improve their self-confidence through practical performance, they are also nervous about this kind of training – an anxiety that may impede their learning processes. The analysis shows that the optimal degree of fidelity for motivating students for learning may differ from the optimal degree of fidelity for ensuring the best learning outcome. Preparing students for simulation-based training includes motivating them to assume a hybrid role, switching roles between identifying as professionals, fully engaged in simulations of complex real-world situations, and as students, critically reflecting on their own performance. The results of the analysis show that the 'observation students' appreciate learn-

ing through observations. Consequently, it may benefit students' learning processes and learning outcomes if the role-switch is incorporated in the scenario, instead of postponing 'the student identity' to the debriefing phase.,. However, this needs to be investigated, for example in a quasi-experimental study comparing simulation-based training that alternates between practical performance and theory-informed reflection *in* the scenario with simulation-based training in which the scenario only includes practical performance with theory-informed reflection postponed to the debriefing phase.

The study of simulation-based training at the five social- and healthcare colleges has a potential methodological weakness. The experiences with technology-based simulations among twenty students and five teachers from five social- and healthcare colleges can be argued not to be a representative sample. However, the colleges do not differ from other social- and healthcare colleges in Denmark with regard to diversity in size, the teachers' educational backgrounds and practical experiences or the student population. Furthermore, the studies at each of the five colleges have more or less the same results; results which also correspond to results from previous research in other parts of the health sector. As such, it seems fair to assume that the findings can be applied, at least to some degree, at a more general level.

Conclusion

In the study of students' learning in technology-based simulations that use mannequins, the article has focused particularly on the interrelation of fidelity in the scenario and students' learning processes. The study shows that simulation-based training using a mannequin appeals to the social- and healthcare students because this method enables them to learn through the performance of practical tasks. Compared to role-play that also involves the performance of practical tasks, the advantage of the simulated scenario is that it enables a high degree of fidelity concerning the mannequin's appearance and behaviour, as well as the furnishing of the room. The study also shows that the degree of fidelity rests on the participants' actions, not least the teacher voicing the mannequin.

Furthermore, the study shows that the students, depending on their practical experiences, can cope with different degrees of fidelity.

Showing that the students benefit from learning in technology-based high-fidelity simulations, (with the caveat that there is no clear-cut definition of high fidelity), the study concludes that teachers within the social- and healthcare education – in further development of simulation-based training – should seek to combine fidelity through high technological equipment with other degrees of fidelity, the focus being on the students' qualifications and the learning outcome targets. Furthermore, the teacher should develop practices that in the scenario

enable a systematic alternation between being students and students playing professional practitioners.

An implication for further research is to specify the interrelation for various levels of fidelity with the students' engagement in learning. Furthermore, to compare the outcome of separating scenario and debriefing with integrating reflection in the scenario.

Endnotes

[1] SIMU is an abbreviation for simulation and SOSU is the Danish abbreviation for social- and healthcare education.

[2] A number of studies also refer to medium or mid-level fidelity (Seropian, Brown, Gavilanes & Driggers, 2004). The distinctions are somewhat imprecise; however, medium fidelity generally involves the use of some kind of advanced technology, whereas the low-fidelity simulators are statics (ibid.), however may include using some kind of technology, e.g. an interactive CD-ROM (Kinney & Henderson, 2008).

[3] Students may also be more apt to laugh in role-play scenarios than in mannequin-based simulation due to the more theatre-like aspects. Laughter abates the students' anxiety at exposing themselves as actors. Thus, using a mannequin establishes a sense of seriousness among the students that – compared to role-play – enhances the fidelity of the simulation.

Note on contributor

Vibe Aarkrog is an associate professor within vocational education and training (VET) at The Danish School of Education, Aarhus University. Her research field is pedagogy in relation to the coherence of the theoretical and practical parts of VET with a specific focus on transfer of learning.

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