Deteriorating patient training using non-immersive virtual reality: A descriptive qualitative study

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Abstract

Recent nurse education pedagogical strategies are starting to embrace the use of virtual patient simulations in higher education settings. This study evaluated student, simulation technician and lecturer perspectives on student performance following virtual training for care of a deteriorating diabetic patient. Second year nursing students learned using a virtual patient simulation which was a follow-up of a randomised controlled trial which took place during the academic year 2017/2018. Group and individual interviews were conducted comprising the 21 staff and students involved in the virtual reality simulation in four individual lecture sessions. Five themes emerged from this study: engagement, immersion, confidence, knowledge, and challenges. Student participants found that the virtual reality exercise aided their understanding of the complex concepts associated with hypoglycaemia, provided immediate feedback about their clinical decisions, could be completed multiple times and that it provided more opportunities for safe practice, complimenting their ward and clinical skills experiences. Simulation technicians and lecturing staff also recognised these benefits but identified challenges, including time and cost constraints. We recommend further research into potential benefits and challenges, including likely consequences of increased use of virtual reality technologies for nurse education curriculum design.

Key Words

Virtual Technologies; Virtual Reality; Nurse Education; Diabetes care

Background

Around one fifth of all patients in hospital have diabetes (*1)*. Diabetes can be a complex condition to manage, and for healthcare professionals, inadequate knowledge about diabetes treatments can result in serious consequences for the patient. One common area of knowledge deficit is in relation to the recognition, treatment, and management of hypoglycaemia. Hypoglycaemia is described as an abnormally low blood glucose (<3.9 mmol/L) and is considered to be a diabetic emergency (*2)*. Simulations are increasingly being offered as part of the educational experience and valued for their more authentic approaches in preparing for live clinical experience (*3)*. Hence, we designed a Virtual Reality (VR) simulation to provide such an authentic approach to the way we taught diabetes within the University based school of nursing.

The original study was a randomised controlled trial (RCT) involving second year nursing students *(n=171)* divided into two groups, control *(n=88)* and experimental *(n=83).* These results strengthened the idea that prior computing experience is not essential when learning with VR. The control group used normative teaching methods which was a paper based version of the VR simulation. The VR simulation was found to be an educationally inclusive tool for teaching and learning. The Large-scale experimental design analysed using a robust approach (Partial Least Squares-Structural Equation Modelling) provided confidence in the results and permitted the claim that the VR simulation was effective in improving student learning. Moreover, the research demonstrated that VR simulation provides an opportunity for experiential learning and safe practice of clinical skills. The evaluation indicated that the VR simulation was highly interactive and encouraged personalised and situational learning. The experience provided unique advantages, with instant feedback enabled via the VR simulation, and this accelerated student learning of the concepts involved in diagnosing and treating a deteriorating patient suffering from hypoglycaemia.

There is a paucity of quality published literature on the application and/or integration of VR into nursing education. Moreover, the majority of nursing studies have examined the views and attitudes of student users, with few capturing the perspectives of educators (4), and none, to our knowledge, that have integrated the views of simulation technicians. In the UK simulation technicians are called learning technologists. This paper reports richer aspects of our study through qualitative description, bridging the gap in the literature about the experiences of simulation technicians and lecturers, in addition to capturing student views.

Method

The aim was to explore nursing students, simulation technician and lecturer experiences of using a VR simulation to support learning about the recognition and management of an acute diabetic emergency. This descriptive qualitative study used focus group discussions (FGDs) and individual interviews to evaluate a VR diabetes simulation. The VR simulation (Figure 1) was commissioned with Daden Ltd, having benchmarked suppliers and ascertained that they could produce a suitable VR exercise. Daden Ltd programmed the VR application based on the deteriorating patient script. After piloting, communication with Daden Ltd and reiteration, the low-cost , proof of concept simulation was completed and was ready for use on students' laptops.

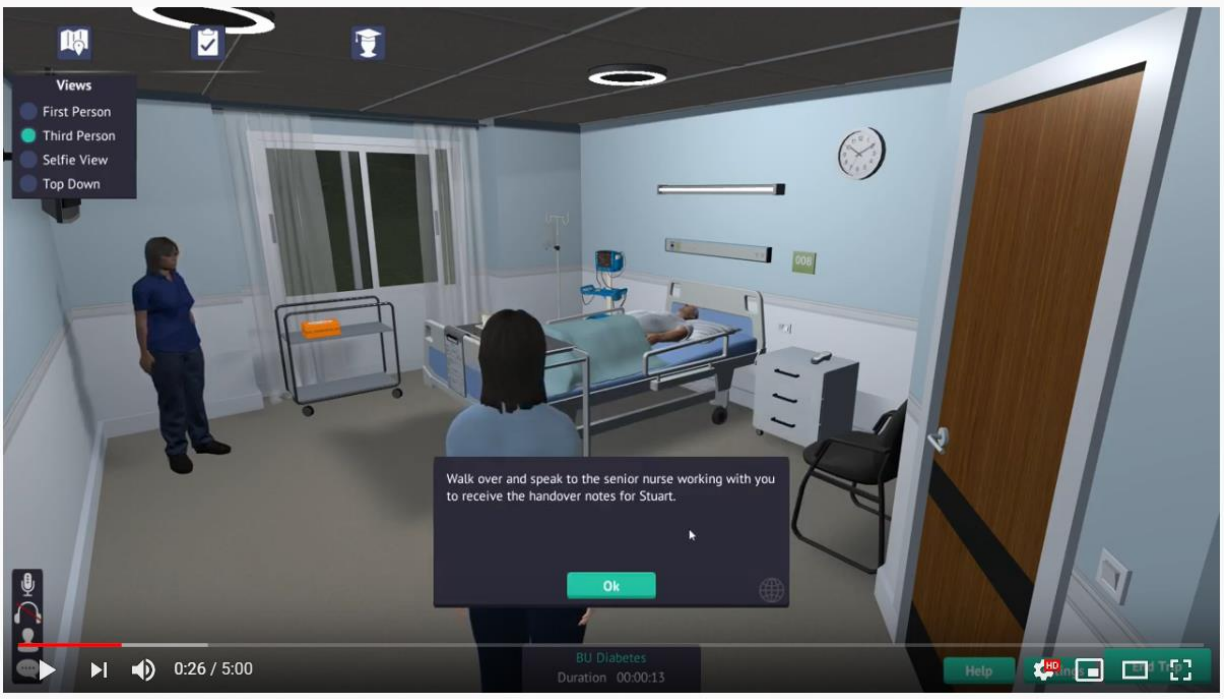

Figure 1 The Software showing the pop up text boxes used.

In the simulation, students played the part of the nurse avatar who stayed within the private room. A virtual handoff (which we refer to as handover in the UK) gave the nursing student knowledge about the patient's condition, current medication and observations which had been recorded the night before. The handoff also provided extensive details relating to the patient's history and condition. When the student approached the bed, the patient presented as irritable and very sleepy.

The student had to make a safe clinical decision about how to react and communicate with the patient. If the student made unsafe decisions, they were given instant feedback (via text boxes) and that they needed to think again quickly because the patient was deteriorating. The patient was programmed to look unwell if the student did not correct the patient's blood glucose quickly. They were then presented with clinical decisions in multiple-choice questions via pop-up text boxes. Each clinical decision was followed up with instant feedback so that the student could learn and improve. The student could complete the simulation multiple times and the lecturer was sent data analytics about each student's performance.

This study sits in the context of the English higher education training for nurses. In England, nursing degrees consist of three years, in which students engage with nursing theory and science, as well as practicals and simulations. Placements are a compulsory element of the nursing degree, with 2,300 hours of clinical placement required for pre-registration nursing training. This context is comparable to that with other countries in the Global North, but expectations on degree length, placement hours and salary expectations for graduates vary substantially internationally.

Student participants of the FGDs were conveniently sampled (*5)*, from the existing group of students who were involved in the virtual patient RCT. The recruitment of the students took place via email. The current study included five FGD sessions in total. The author acted as a moderator responsible for facilitating the discussion using a semi-structured approach to enable the voice of the participants to emerge. Prompts and cues were used to encourage participants to fully express their views and experiences and to establish an informal discussion context rather than a more formal interview approach. For example, the author asked, "Who has a different perspective on that?" and "How do others feel about that point?" Participants were provided with refreshments, as they had just completed the hour-long diabetes training exercise. Five simulation technicians and one lecturer were recruited via email invites and again their participation was voluntary.

FGDs were conducted to consolidate students' VR learning experiences. Simulation technicians who provided computing support to the students during their seminars were also invited to attend a FGD. A lecturer was interviewed individually to provide added perspective on the use of VR in their seminars. Individual interviews were considered, though FGDs were thought to be more suitable for the qualitative research conducted in this study. For example, (*6*) found that the main advantage of focus groups involves how group interactions can reveal both the participants' perceptions, attitudes, and framework of understanding, as well as recognising group norms, sub-cultural and cultural values. Respondents are given a voice, FGDs provide quick results, and ideas and themes can be developed more than in individual interviews. The approach also aids developing a collective narrative.

The doctoral researcher conducted both student and simulation technicians FGDs and an individual face-to-face semi-structured interview with the lecturer. FGDs were held within a week of the seminars while the lecturer was interviewed after the conclusion of the whole study. A semi-structured focus group guide and an interview guide were developed and piloted. The FGDs lasted

approximately 20 minutes, while the interview lasted 40 minutes, these were the points where the sessions came to a natural end and there were no further comments or different opinions offered.

Prior to initiating the study, ethical clearance was obtained from a University ethics committee in the South of England. Participants completed a consent form prior to taking part in the intervention and were fully informed about data protection and anonymity. All participants received a pseudonym to guarantee that when accumulating, storing, and reporting findings, it was not possible to identify individual participants.

The lead author executed simple, exact transcriptions of FGD recordings. Transcripts were imported into the package NVivo Version 11, to code and analyse the qualitative data via thematic analysis. Both inductive and deductive coding techniques were utilised enabling exploration of the potential mechanisms and influences that had already been identified and to identify new sub-themes emerging from the data. Descriptive quotes were chosen based on the quality and succinctness with which students expressed each point, and on the representativeness of the quote in relation to the general theme. Thematic analyses followed the approach by *(7)*, six-step procedure: 1) Familiarization of data, 2) generating initial codes, 3) search for themes, 4) review themes, 5) define and name themes, and 6) producing the report. Study findings were reported according to the Consolidated Criteria for Reporting Qualitative Research checklist (COREQ) *(8)*.

Findings

The results from the focus groups and interviews comprising the 21 staff and students involved in the VR simulation in four individual lecture sessions saw five overall themes emerge. These are: engagement, immersion, confidence, knowledge, and challenges.

Engagement

Comments relating to engagement fell into two subcategories, namely “enjoyment” and “ease of use”. A striking finding in relation to the sub-theme “ease of use” was that participants found the VR simulation to be: “*quick and intuitive to figure out*” (S6), even if they had not played computer games in the past. Fifteen participants discussed how they felt that the VR was quick to download, and straightforward to navigate the avatar through. Simulation technicians agreed that students “*picked it up pretty easily*” (ST3).

Other positive views related to how helpful the inclusion of text boxes had been, and this was an unexpected advantage. Students welcomed the chance for repetition that text boxes provided. A few students raised the notion of how they felt VR technology, could help them to overcome some of their additional learning needs. The following comment illustrates this point: *“I do not have a science background. This exercise made it much easier for me to visualise and understand.” (S19*) Related to the discussion of the use of text boxes and potential audio features, were many comments made relating to how the “visual” element could aid learning. The fact that it is “interactive” and “experiential” was also highlighted by participants. One student who had

experienced multiple community placements but not hospital experience up unto this point commented:

> *"… for a second-year nursing student who has never been in a hospital before, can you believe it? It gives a lot of context to what I would actually be physically seeing, which is actually very useful." (S14)*

Eleven students mentioned the interactive gamification element of the software. Nine students felt that it was more interesting than their usual ways of learning. Simulation technicians shared this view, for example:

> *"It is easier for them to learn from something exciting like this than just a usual lecture when they are being talked to, with no interaction etc. This is good for experiential learning and will help along with going on wards etc". (ST5)*

Immersion

Immersion as an advantage was discussed by all but one of the FGD participants. Many of the views of the participants were about "*making it real*" and typical opinion was captured in this comment:

> *"It combines the advantages of a simulated ward with those of a drama role play, in that you can have the sense of urgency as well as deteriorating vital signs in the patient. If the patient is getting anxious and you need to take their blood pressure you could make your … (avatar) talk to the patient to calm them down. It really does make you really focused on the situation and it makes it feel a lot more real." (S17)*

The fact that the simulation was viewed as feeling "*real*" and immersive is important as there is a need to provide student nurses with scenarios of deteriorating patients, so that they can have an ongoing and repeated safe practice of identifying and treating such patients, whilst at the same time experiencing the sense of urgency and pressure that they would in a real life ward clinical situation. Moreover, some students felt as though they were thinking and acting in a different way when they were in the VR simulation. They referred to the realistic nature of the virtual props, e.g., the blood glucose monitor and the blood pressure machine, and discussed how their thinking replicated their thoughts in clinical placements. These types of comments that were related to the theme of immersion indicate that VR simulation could be one solution towards closing the theory-practice gap. Furthermore, it indicates that use of VR simulation can act as a bridge between normative instruction and clinical placement.

Confidence

Ten students believed that the instant feedback and reinforcement of learning would improve confidence:

> *"I think it would help my learning because it would make me think about the options that might be available. And make me work through why I would pick an answer. What*

would be good and bad about each step. That would improve my confidence, I feel. Yes, it would." (S7)

This comment implies evidence of students moving from lower order thinking, to higher levels, including understanding, analysing, and evaluating, for example. Several students felt that it was a less pressurised, safer environment, in which to learn than being on clinical placement.

"It is the reinforcement of that learning, and the real time feedback, safely, if they are getting it right or wrong. That is the beauty of the computer version, because you can make lots of mistakes and you're not affecting anybody are you?" (S2)

Students felt that: "*learning from their own mistakes*" (S9), combined with real time feedback, would boost confidence in their learning. It would be difficult to mimic such advantages through normative and large-scale instruction, particularly if that instruction were not supported by technology.

Knowledge

Moving on to the theme of knowledge most participants expressed that the exercise would/had improve/d student knowledge. Once again, typical student and simulation technician comments related to how "*seeing*" the avatars and props played a major part in improving their understanding and knowledge of the concepts involved, through targeting "*different ways of learning*." This notion was shared by one simulation technician:

"The knowledge of the students as a whole would improve as you are targeting different ways of learning." (ST 4)

Students felt that they had "*taken more in*" (S8) during the VR learning session than they had in any other previous lecture. Indeed, four students referred to linking theory to practice in their responses. One student's comment was very insightful, as not only did they explicitly state that the VR simulation linked theory to practice, but they went on to add that the undergraduate nursing students do not normally: *"get a chance to do that (link theory to practice) until we are in placement*." (S10) This might suggest that if VR technologies were used to regularly complement normative teaching methods, clinical skills sessions and clinical placements, the theory-practice gap might be bridged more quickly. The lecturer who was interviewed echoed this thought:

"I would hope that when they transfer that learning to a real situation, they would find it easier to translate that knowledge, that theory to the practice. So it is better for the theory-practice gap." (A1)

Reinforcement of learning emerged as a sub-theme within the overarching knowledge theme. Several students discussed reinforcement of learning, of which this comment is representative:

"… It gave you a choice of your actions, you can learn, then next time you can do it differently… I think it would help my learning because it would make me think about the options that might be available..." (S13)

A few students specifically highlighted the experiential or kinaesthetic element as being the point of action for reinforcement of the learning, in their comments. For example: "*I think the learning has gone in a lot. Actually, doing that, it does make you think*." (S3). Moreover, the VR simulation was felt to be particularly helpful for complex learning, as illustrated by the following remark:

> *"I thought that was very informative, the fact I can still remember is very good. And likewise, the whole thing was reinforcing what I had understood previously… The Gliclazide is something I will probably recall now having used the interaction on computer version." (S18)*

Five students discussed how they felt that using the VR simulation aided personalised learning, in which they could make mistakes and not be swayed by a group decision. They felt that they were often asked to respond to questions and activities as part of a group which meant that sometimes some learners switched off and some just gave the same answers as their friend.

Challenges

The data suggest that software/hardware concerns and ease in moving the avatar (initially) were raised by both simulation technicians and students and were the main concern about the VR simulation. Technicians (nine challenges cited by n=5) were more likely to cite possible challenges. This might be because technicians need to find solutions to these challenges and are aware of the practical implications of using such software in large-scale settings. The lecturer also discussed a barrier to implementing VR:

> *"I think it is about investment, so if you are going to do this work in an HE setting you have got to have investment, not just in terms of money but also in time and appreciating the work people do." (A1)*

Discussion

Findings reinforced our experimental findings on the efficacy of using non-immersive VR for nurse education. These qualitative results demonstrated that students found that the VR exercise aids understanding of the complex concepts associated with hypoglycaemia. Moreover, the exercise provides immediate feedback about their clinical decisions, can be completed multiple times, e.g., for revision/distance learning, aids visual learners, complements ward and clinical skills experiences, and finally that it provides more opportunities for safe practice. Technicians and the mental health lecturer also cited benefits of the computer version of the exercise. All participant groups highlighted the immersive and visualisation aspects of the VR simulation which were viewed as strengths. The most cited advantage of the simulation was ease of use, and these answers included comments about being able to repeat the exercise.

In relation to engagement, both technicians and students recognised that this type of learning was more interactive than traditional methods. This is especially important for complex subject matter and for students who struggle with scientific concepts and/or who have additional learning needs. Students felt that a combination of audio and text boxes would be beneficial in future iterations of the VR software, particularly in terms of inclusion of students with learning needs. Students commented that text boxes aided recall of drug names. The complex nature of pharmacotherapy,

high rates of medication errors, and the expanding scope of the practice of registered nurses, particularly in relation to pharmaceuticals, are all viewed as challenges (9). Gaming, simulation, and online teaching formats are recommended for pharmaceutics (10). The deteriorating patient case study contained several tricky pharmaceutical terms, including Gliclazide and Sulfonylureas. Such spellings could prove difficult, particularly for those who have dyslexia, a learning need which can often manifest in short-term memory challenges, and difficulties not only in acquiring vocabulary, but also in pronouncing new words. Hence, a combination of both audio and visual prompts would be beneficial for such students. Additionally, gamification platforms have previously been shown to support students with dyslexia who might be struggling in their education

Ease of use was a recurring theme within the qualitative findings. Our students remarked that the VR simulation was intuitive and easy to use, suggesting that students would not be put off the first time they used the simulation and would continue to use the simulation as a distance learning tool. This is significant because in the future, it is anticipated that online and distance learning modes will dominate *(11)*; indeed during the covid pandemic much of undergraduate nurse education was moved to online learning (12).

In relation to immersion, some students spoke of thinking as if they were on the ward, and expecting to find various pieces of equipment where they are located at the local hospital. This reminder of ward-based nursing practice during their teaching unit at the university is likely to impact on bridging the theory-practice gap. This was made apparent in the comment from the student who stated that she had not been on placement on a traditional ward setting yet, and that even just seeing, or visualising the ward and equipment (albeit in VR) was a learning opportunity for her. This suggests that other low-cost technologies such as 360-degree cameras in conjunction with the VR headset would also bring affordances, such as “visualisation of concepts” to first- and second-year nursing students. Though envisaging is one of the most obvious advantages of VR, critics might argue that this likewise can be achieved via video. Nonetheless, videos are inactive learning objects while VR permits interaction with the virtual environment.

In relation to confidence, students found that the immediate feedback provided by the VR exercise boosted their confidence when making clinical decisions within the scenario. This immediate feedback meant that students were able to change their decisions at any stage during the clinical scenario. Though this is something that might not be available or appropriate in a real-life ward setting, it has advantages in terms of aiding confidence and competency. The VR simulation allowed students to have many attempts, make mistakes, and yet not affect patients in a negative way. This highlights the inclusive nature of the VR software, as students with slower cognitive processing speeds (13), would not be disadvantaged when using the program. Recognising that the VR simulations provide instant feedback along with a less pressurised and safer environment which improve student confidence, highlight the value of creating and implementing similar simulations with HE students.

Turning now to the theme of knowledge, the textbox feature was reported to aid repetition and recall. Participants discussed how they felt the VR affordances of the software would help to bridge

the theory-practice gap, making it easier to translate the knowledge from lecture theatre to ward, via targeting different ways of learning when using VR. This finding was in contrast to one of the first meta-analysis undertaken (14), whose findings indicated that non-immersive VR simulation contributes insignificant differences in knowledge outcomes in comparison to normative instruction. Our students felt that they had learned more about how to treat patients with a deteriorating condition than they had in preceding lectures. The fact that the learning connection would be made at a sooner time than usual was also raised, along with the affordance that the VR case study could be repeated at students' leisure as well as being used to refresh students' learning prior to going out on placement or before an examination.

Another, finer detail that was highlighted was the affordance of personalised learning. All students could proceed with the patient case study at their own pace, something that has long been a challenge for traditional learning methods. The VR approach enabled learners to operate at their own pace and according to their own learning needs. Students expressed how much of their nurse education was carried out in small groups and that this sometimes led to more passive learning for some students. As students had to complete the VR training exercise on their own, they had to engage with and become active in their learning; this could aid achievement and possibly confidence.

Overall results suggested that the VR simulation was perceived as being an enjoyable and effective way of learning, though software instability and some initial difficulties in moving the avatar around were cited by students and technicians. These negative findings are the clues to any potential barriers to the scalability and sustainability of VR technology use in HE; and *(15),* trust that these types of teething problems can be rectified in order to continue to assess and refine teaching and learning with VR.

In relation to VR cost, the notion of fidelity is relevant. According to *(16)*, design and human affordances are more important than fidelity when evaluating the success of simulation pedagogy; the results of this paper certainly echo this point. The software tested in this study was deemed to be of low fidelity due to its low-cost nature; despite this, students found themselves immersed in the virtual ward. This indicates that future iterations of such VR simulations do not necessarily need to be of high cost and high fidelity to be successful in improving student enjoyment and learning outcomes. Investment is a major driving factor that must be considered. Findings from the qualitative results have heightened the need for initial investment in IT services support for such VR innovations, in addition to ongoing maintenance and support for the software, in order that technicians feel confident that the VR simulation will perform and respond in a reliable and consistent manner and in a variety of HE settings. Cost implications and funding to support such VR innovations in the education sector remain an ongoing challenge to all involved.

Limitations

The approach to creation of the VR simulation tested in this research is argued to be a real strength because it was developed through discussion with specialist nurses, nurse lecturers, simulation technicians and software developers. The views and experiences of simulation technicians and a

lecturer were captured to provide a more balanced evaluation of the study. However, one area for improvement is that students could be included at an earlier stage in the creation of new learning activities. During this research students were invited to provide feedback once the software had been developed. Earlier feedback from this group of participants would be advantageous. Finally, our study involves a small sample (17), and comparisons with nursing student samples in other contexts would further substantiate our findings.

Conclusions

This study aimed to examine the perspectives not only of student users of VR but also the lecturers and simulation technicians involved in order to develop a more rounded picture. This approach enabled identification of some challenges to the implementation of VR along with many advantages of its use to engage and improve student learning of complex concepts including diabetes. This study has extended the possibilities of what can be done in the physical classroom beyond the boundaries of the virtual learning environment, and this will contribute to the international evidence base helping plan for alternative learning solutions post Covid 19. A more authentic, work-based theory-practice bridge was created that in future can provide greater insight for students who are in remote classrooms. We hope that this paper provides inspiration and practical advice that will enable other educators to co-create similar training exercises. We wish to conclude this paper with a quote from one of the simulation technicians:

> *"Using this technology, is a really empowering way for students to be able to learn off campus... There are lots of positives around student engagement." (ST2)*

References

1. National Diabetes Inpatient Audit (NADIA) (2018).National Diabetes Inpatient Audit. Available at https://digital.nhs.uk/data-and-information/publications/statistical/national-diabetes-inpatient-audit/. Accessed March 16, 2021.
2. American Diabetes Association (2020) Diabetes Care. Available at https://care.diabetesjournals.org/content/43/Supplement_1/S1. Accessed March 16, 2021.
3. Bayram SB, Caliskan N. Effect of a game-based virtual reality phone application on tracheostomy care education for nursing students: A randomized controlled trial. *Nurse Education Today,* 2019; 79: 25-31.
4. Dagleish K, Launrenson M. Practical learning in virtual worlds: Confronting Literature with Health Educators' perspectives. *Journal of **Virtual** Worlds Research*; 2018; 12 (1):1-19.
5. Cohen L, Manion L, Morrison K. 2017. *Research Methods in Education,* Routledge; 2017.
6. Kristiansen T, Grønkjær M. Focus Groups as Social Arenas for the Negotiation of Normativity. *International Journal of Qualitative Methods*; 2017. doi:10.1177/1609406917747393
7. Braun V, Clarke, V. **Using thematic analysis in psychology** Qual. Res. Psychol. 2006; 3: 77-101.
8. Tong A, Sainsbury P, Craig, J. Consolidated criteria for reporting qualitative research (COREQ): a 32-item checklist for interviews and focus groups, *International Journal for Quality in Health Care*, 2007; 6 : 349–357.
9. Preston P, Leone-Sheehan D, Keys B. Nursing student perceptions of pharmacology education and safe medication administration: A qualitative research study. Nurse Education Today; 2019; 74:76-81.
10. GILL M, Anderson E, Hilsmann N. Best practices for teaching pharmacology to undergraduate nursing students: A systematic review of the literature. 2019. Nurse Education Today, 2019; 74:15-24.
11. Traxler J. Distance Learning--Predictions and Possibilities. *Educ. Sci.* 2018; *8*(1):35
12. Saban-Bezalel R, Mashal N. Different Factors Predict Idiom Comprehension in Children and Adolescents with ASD and Typical Development. *Journal of Autism & Developmental Disorders, 2019;* 49: 4740-4750.
13. Alexander, S., Shala, D., Jones, A., Alexader, N., Young, S., and Fairbrother, G. Responding to the challenge of a pandemic: the rapid conversion of electronic medical record training for nurses from classroom-based instructional learning to a blended learning approach in a large multisite organisation. *CIN Computers, Informatics, Nursing*, 2021; 39 (4), 171-165.
14. Cook D. Mastery Learning for Health Professionals Using Technology-Enhanced Simulation. A Systematic Review and Meta-Analysis. Academic Medicine. 2013; 88 (8): 1178-1186.
15. Akcayir M, Akcayir G, Advantages and challenges associated with AR for education: a systematic review of the literature. Educational research review. 2017; 20: 1-11.
16. Chiniara G. Clinical Simulation (Second Edition). Canada: Elsevier. 2019.
17. Malterud K, Siersma VD, Guassora AD. Sample Size in Qualitative Interview Studies: Guided by Information Power. Qual Health Res. 2016 Nov 1;26(13):1753–60.