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Technology for enhancing clinical skills: Evaluation of a prototype application for training in donning and doffing

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Original article

Abstract

The COVID-19 pandemic has brought about significant challenges in preparing nursing students with specific skills required in clinical settings. Amongst the major challenges faced was ensuring students are well prepared in the technique of donning and doffing to ensure infection control, avoid contamination and reduce unnecessary anxiety. A descriptive qualitative approach was used to study the experience of 14 student nurses who participated in a donning and doffing practical session prior to start of their clinical practice placement, including the use of a prototype application using AI. Purposive sampling was adopted and the data from individual interviews was analysed using thematic analysis. Four themes emerged, namely: an *Engaging Tool for Learning*; *Reducing the Chance of Error*; *Building Self-Confidence*; and *Eliminating the 'Buddy System'*. The early prototype generated positive themes, and its use in the educational setting to prepare students prior to clinical placement is encouraging and emphasises the importance of integrating technology in training with healthcare students.

Keywords

- clinical simulation
- artificial intelligence (AI)
- donning and doffing
- nurse training
- personal protective equipment

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Introduction

Since the first detection of COVID-19,[1] more than 290 million confirmed cases have been reported to the World Health Organization (WHO), which include more than five million death cases. Despite the availability of COVID-19 vaccines, this pandemic continues to provide extraordinary challenges on health sectors.[2] The COVID-19 pandemic prompted debates about transmission mechanisms, measures to prevent transmission, and treatment methods, including vaccination programs.[3] All healthcare professionals (HCPs) on the frontline are at high risk of infection. Amongst these group of service providers, student nurses on practical clinical placements need carefully be considered, as they might be more prone to contamination due to their limited experience and exposure of such high-risk situations. The best way to vastly reduce transmission and protect HCPs from infectious diseases remains in improving training techniques and adherence to proper use of personal protective equipment (PPE).[4]

Throughout the pandemic, updated guidelines on the use of PPE have been provided, which vary according to the level of exposure of HCPs according to their specific inpatient care role.[3] Despite such protocols, PPE use amongst HCPs during the COVID-19 pandemic is still discussed, mainly due to its inappropriate use.[5]. Phan et al.,[6] reported several incompliances with donning (wearing PPE) and doffing (removing PPE) practices, which ranged from the incorrect sequence and technique to inappropriate PPE selection, put HCPs at risk of infection.[7] In line with this, Hossain et al.[8] argued that proper education, reading guidelines and donning and doffing complexities are steering factors leading to proper versus improper use of PPE. Others argued that, in order to reduce errors, the use of PPE should be kept simple and recommended a 'buddy system' to ensure donning and doffing are performed correctly.[5]

In view of the above, an early prototype (experimental proof-of-concept) application was built to assist users with correct donning and doffing of PPE processes. Following development, the overall aim of this pilot study was to determine the perceptions about the early prototype and its applicability in training amongst a purposive sample of student nurses prior to starting their practice placement.

Experimental proof of concept

This research was an experimental proof-of-concept which, through an augmented reality and voice-controlled prototype, enables the user to wear PPE while observing visual information presented via a Visual Display Unit. The aim of the voice-activated prompting-feedback system is:

1. To explain the correct procedure and prompt users performing the process to wear the correct next PPE, and
2. In case of incorrect step, to clearly prompt users to perform the correct next action in the donning sequence.

The early prototype also includes Computer Vision and Artificial Intelligence (AI) techniques which detect a person, detect PPE and, subsequently, interpret adherence to correct donning and doffing in real-time through camera feed. It also detects whether the donning processes are executed in the correct sequence. The application was developed at the Malta College of Arts, Science and Technology (MCAST).

Methods

This research adopted a descriptive qualitative approach to facilitate the collection of detailed insights on the phenomenon under investigation from the participants. The study involved a total of 14 student nurses enrolled on the undergraduate general nursing degree program at the Malta College of Arts, Science and Technology (MCAST). Inclusion criteria specified participants who were currently student nurses in their final year of training, proficient in English, and have participated in a donning and doffing practical session prior to start of their clinical practice placement which included a tutorial and use of the application prototype. Non-probability purposive sampling was adopted.

Data collection

Data was collected through a series of individual semi structured face to face interviews lasting between 20 to 30 minutes. Ethical approval to carry out the study was secured from the Malta College of Arts Science and Technology (MCAST) ethics committee. Prior to the interviews a written consent was obtained, emphasizing voluntary participation and ensuring participant anonymity.

Data analysis

The data analysis in this study utilised Braun and Clarke's[9] thematic analysis method. Thematic analysis was selected for its efficacy in identifying significant patterns within the dataset, aligning with the

objectives of this descriptive qualitative inquiry. Initial coding was performed through multiple readings of the transcripts, employing a method using comments on Microsoft Word document and a data table extracted through an add on entitled DocTools ExtractData (a free add-in for Word). Themes were derived iteratively, integrating initial codes with the data.

In adhering to Lincoln and Guba guidelines for rigor, this study employed strategies to establish credibility, confirmability, and dependability Guba.[10] Credibility and confirmability were upheld using a validated semi-structured interview guide. Dependability was maintained during the interviews by having the researcher summarise the key points articulated, enabling clarification of any potential misinterpretations.

Results

Participants in the evaluation were student nurses (n = 14) actively registered as full-time students on the Bachelor of Science (Honours) in Nursing at the Malta College of Arts Science and Technology. Baseline demographic information (Table 1) was individually collected. Most of the participants were female (n = 10) and the average age was of 21 years. Most participants came from Malta.

Table 1. Characteristics of the study participants

Gender Female / Male	10 / 4
Age (in years) Mean (Range)	21 (20–23)
Nationality Malta / EU (other) / non-EU	11 / 3 / 0

From the data analysis, participants' perceptions about the prototype's use and applicability in training have been divided into four (4) main themes: *Engaging Tool for Learning, Reducing the Chance of Error, Building Self-Confidence and Eliminating the "Buddy System"*.

Engaging tool for learning

The majority of students noted how such a system provides an engaging and interactive way of learning in comparison to the usual type of lessons through following PowerPoint presentations and practicing the skill in class. This outcome was not a surprise noting the fact that interaction with technology plays a significant role in the day-to-day life of the younger population.

> This system is also a means of having fun when we learn. It gives the session a more interactive approach and keeps us focused with the task and skills to be learned. (Participant 5)

Others added that through practicing such an important skill in this manner prior to going to face the real thing in the ward gives them a more realistic idea of how they are managing in their learning and believe that through the use of technology they can continue practicing even at home should a set of PPEs be provided.

> It is interesting how maybe we can go on practicing at home. Today technology can be accessed from anywhere therefore I do see the possibility of continuing to train the skill outside class maybe even at home. (Participant 2)

> This is so exciting. I could do it as much as I want, I can practice at home. It is more relaxing knowing that I will be going on placement prepared to face patients possibly infected with COVID-19. (Participant 10)

Reducing the chance of error

Since the prototype is designed to allow users to follow a systematic donning approach, participants noted that this eliminates inappropriate sequence use.

> One of the greatest advantage in using this system is that if one step is missed, you are not allowed to move to the next step. In this way, we will be protecting ourselves as well as the patient before and after we care for a client who might have a transmissible disease. (Participant 5)

Moreover, some participants mentioned that clinical staff who might be overconfident in donning and doffing will be made aware of their behaviour if guidelines are not followed.

> I noted that some nurses who have been in practice for a long time, tend to not always follow the steps as advised, sometimes this happens without them knowing. They think that they are following the right steps, when in reality they will be missing on very important steps. If all will be requested to perform donning and doffing in front of this system, such nurses will realise their own errors. (Participant 9)

Building self-confidence

Participants described the usefulness of the prototype to overcome their fears of making errors and compromising their safety during the process. This was deemed important since from their previous encounters when caring for infected patients during practice

placements they often recalled how insecurity and fear of not having accurately performed the procedure according to protocol, left them agitated and an element of created psychological stress.

> It is very easy to miss a step, especially when it comes to the use of hand rub. Many other student nurses have repeatedly told me that they were very anxious that they did not perform hand rub appropriately, and so fear that they could have been infected with COVID. (Participant 1)

Some participants stated that despite donning and doffing steps were provided as written guidelines in clinical areas, they often encountered healthcare staff who were so busy conducting other duties that they often left them unattended to perform such a procedure even though they were on the wards to learn.

> Sometimes mentors and other staff are very busy especially when we had infected patients during the peak of the pandemic. We were often left alone and to be honest at times felt as if we have to learn to do it (referring to donning and doffing) on our own. Following the poster on the wall is not enough and it would require frequent training. This makes us often feel anxious and lack self-confidence but maybe it this helps. (Participant 7)

Eliminating the 'buddy system'

A student stated that if this prototype was to be used in clinical areas, there will not be the need of another person, referred to as a 'buddy system', to double-check that donning and doffing are done correctly.

> With the increase of workers being tested positive or on quarantine, the 'buddy system' during donning and doffing is not always possible. This system can replace having another person watch over you all the time. (Participant 2)

> Currently, we perform donning and doffing in front of a mirror when no 'buddy' is available. If such a system, where it prompts you what the next step is, or that you did not wear the face mask appropriately will be good for me. (Participant 13)

Discussion

Apart from its possible clinical applicability, this study has tested the prototype as a training tool in a classroom setting. Albeit similar in principle to the current research, the study by Merilampi et al.[11] has exploited a hybrid approach utilising the physical (students wearing PPE) in combination with a digital game-based approach with different clinical scenarios presented by the game. Thus, as opposed to this study, the clinical setting has to be provided by the digital game, which includes features whereby the student has to wear the correct PPE in the right sequence with the use of RFID-tagged equipment.[11] In line with this research, early results reported that participants identified the importance of such a learning tool which can be exploited beyond the classroom. Additionally, they also highlighted the utility of such learning tool in a home setting.[11] This was also raised by participating students in the current research, who recognised the usefulness of being able to continue practising at home and increase their self-awareness in conducting the procedure.

The 'buddy system' has been defined as "an effective method by which a deployed staff member shares in the responsibility for his or her partner's safety and well-being".[12] A 'buddy' involves the practice of pairing less experienced nurses with more experienced nurses in the critical care environment to enhance 'just-in-time learning needs'.[13] Research has recommended the use of a 'buddy system' to reduce errors even during donning and doffing.[5] However, despite being a low-cost practice, this system has been found to be underutilized.[14,15] Moreover, as highlighted by participants, in view of the shortage in personnel due to workload requirements, 'buddy systems' are not always possible. Therefore, this prototype could offer a reliable and effective 'buddy system' approach without the need for deploying an onsite or remote person to act as 'buddy'.

Study limitations

While the study employed a purposive sample of students this could have caused a positive skew in the identified key themes. Since participating students' study at the institution whereby the prototype was being developed, their responses may have been influenced by social desirability.

Conclusion

In conclusion, this small-scale study has provided valuable insights into the potential benefits of incorporating artificial intelligence (AI) applications to enhance nurse training in practical skills beyond the clinical setting. Despite its limited scope, the study's early prototype yielded positive themes from student responses, suggesting the promising efficacy of AI in nurse education.

However, it is imperative to acknowledge the need for further research to fully understand and maximize the potential of AI in nurse training. Given the evolving nature of personal protective equipment (PPE) and healthcare practices, continuous updates and enhancements

to AI applications are necessary. Additionally, future investigations should involve a larger and more diverse sample of students, including those in their early years of training, to capture a broader range of perspectives and experiences. These students, who may have limited exposure to certain clinical practices, could offer valuable insights into the applicability and relevance of AI-based training methods from a novice perspective.

In light of these considerations, future research endeavors should prioritize rigorous testing and validation of AI applications in nurse education, ensuring their effectiveness and relevance across various educational contexts and learner populations. By addressing these research gaps, we can further advance the integration of AI technologies to optimize nurse training and ultimately enhance patient care outcomes.

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