Abstract

The link between effective basic life support (BLS) and survival following cardiac arrest is well known. Nurses are often first responders at in- hospital cardiac arrests and receive annual BLS training to ensure they have the adequate skills, and student nurses are taught this in preparation for their clinical practice. However, it is clear that some nurses still lack confidence and skills to perform BLS in an emergency situation. This innovative study included 209 participants, used a mixed methods approach and examined three environments to compare confidence and skills in BLS training. The environments were non- immersive (basic skills room), immersive, (the immersive room with video technology), and the Octave (mixed reality facility).

The skills were measured using a Laerdal training manikin (QCPR manikin), with data recorded on a wireless Laerdal Simpad, and the pre and post confidence levels were measured using a questionnaire. The non-immersive and the immersive room rooms were familiar environments and the students felt more comfortable and relaxed and thus more confident. The Octave offered the higher level of simulation utilizing Virtual Reality (VR) technology. Students felt less comfortable and less confident in the Octave; we assert that this was because the environment was unfamiliar. The study identified that placing students in an unfamiliar environment influences the confidence and skills associated with BLS; this could be used as a way of preparing students / nurses with the necessary emotional resilience to cope in stressful situations.

Keywords

Student nurses, confidence, competence, clinical skills, virtual reality.

Background/ Significance / Purpose

Cardiac arrest requires effective basic life support (BLS). BLS refers to the maintenance of airway patency, supporting breathing and circulation (1), and is a vital element in the chain of survival (early recognition, high quality BLS, prompt defibrillation and effective post resuscitation care) (2). However, many student nurses lack confidence in their ability to carry out this skill (3). Traditionally

BLS training follows behaviouristic and experiential educational learning theories concentrating on developing psychomotor skills, mainly using low fidelity simulation (LFS) equipment (4). Nevertheless, LFS has limited capability to create sufficient realism, and as novice nurses lack the ability and experience to be able to create a clear mental picture in simulation (Vaughn et al) (5) this causes a barrier to learning. Hence, the use of medium fidelity simulation (MFS) equipment is now more common place within BLS training (6); some research utilises high fidelity simulation (HFS) equipment (7). MFS is increasingly used due to its ability to develop the learner's cognitive as well as psychomotor skills with the analysis of skills such as hand positioning and chest compression depth (8) and appears to be a key component in the improvement of the associated skills. HFS allows learners to develop essential skills such as team working and communication skills. This method follows a constructivist approach to educational theory by allowing the participants to actively engage in realistic scenarios and gain instant feedback. It is well known that different levels of simulation assist with skill acquisition and maintaining skills competence (3), thus, introducing VR as a form of high-fidelity simulation could enhance the competence and confidence gained during the BLS training.

The deficit in confidence (9; 10) and competence (skills) (5; 6;9) associated with BLS is well known and some literature suggests that an increase in the ability to do the practical skills equates to an increase in confidence (10). As BLS is a major issue of global concern (11; 12), with approximately 200,000 in hospital incidents in a year being reported (11). The fact that student nurses work in clinical environments where they are directly involved in caring for acutely ill patients, it is essential that they receive BLS training which equips them with adequate skills and confidence. Nurse educators must strive to equip the students with the necessary skills to be able to deliver BLS under pressure. The new challenges and requirements in nursing practice and education have called for alternative teaching strategies. (13). Cretzfeldt et al's international research (12) conducted in USA and Sweden using avatars for BLS training emphasised the need for new engaging learning methods. Driving forces such as, patient safety and limited clinical placement areas have also increased the need to incorporate technology driven simulation into nurse education programmes and integrating new technologies and levels of simulation have been viewed as crucial in bridging the theory and practice gap (13). Simulation and VR technology have gained significant attention within the health care and medical education industries around the world within recent years (14; 15).

This study explores the use of immersive VR technologies to enable nursing students to experience scenario based CPR training. VR systems allow high levels of immersion, (the psychological response to the technology) (16), and presence, (the subjective experience of being in a place or in an environment, even if physically in another environment) (16). Today, affordable Head Mounted Displays (HMD) such as such as the Oculus Rift (Oculus) are typically associated with VR, however more expensive large-scale projected display technologies are also available. These spatially immersive displays allow more than one user to physically occupy the environment, rendering a convincing and optically correct graphical environment for one of the users. The Octave system used in the study is an example of a spatially immersive VR system (17). One key benefit of such spatially immersive displays is that the user can see their own body, leading to less cognitive dissonance than head mounted systems and facilitating smoother physical interactions. This also allows physical items to be handled by the users, (in this case a CPR mannequin). This support for real objects is a key differentiator of these systems in the context of this experiment, leading to them being termed 'augmented virtuality' (18).

Immersion in the scenario allows students to practice the skills using the manikin in a safe environment . This enables risk free learning in complex situations as well as promoting team based and interdisciplinary approaches to learning in health care. (19). An American study by Rizzo and Kim (20) suggested that in some cases it can be useful not to copy reality exactly in VR, for example time consuming tasks to be better simulated. Often, students may have limited exposure to patients in emergency situations (21) and VR simulation based training applications allow high fidelity repetition of tasks that could improve responder skills through exposure to clinical scenarios (22). The use of simulation manikins allows haptic feedback to be experienced by the user. In an Italian study by Semeraro et al both a simulation system and VR environment are utilised to create a more realistic training environment for CPR (23). Unlike in this study they use a head mounted display and their participants are therefore encumbered and disassociated, which is not helpful when developing clinical skills. VR simulation is thought to be an effective approach for skills preparation in particularly in relation to communication, critical thinking and collaboration (9; 24). Studies have illustrated the positive effect of VR on clinical skill performance (24) emphasising the usefulness of this method of simulation in nurse education.

While the use of VR for skills teaching is not a new concept, dating back to aviation flight simulations during the 1960's (13) it seems that this kind of VR simulation for student nurse education is novel, allowing intricate clinical skills to be practiced without the risk of harming patients in clinical practice (24).VR in BLS training has the potential to enhance the delivery of the training and to provide a more realistic learning environment which challenges the students' confidence and skill. This ultimately can prepare the students for the 'real life' cardiac arrest, when they will need to use the basic life support skills in what is often a traumatic testing situation. It is envisaged that the use of higher fidelity simulation such as VR and immersive environments should test the confidence and their ability; repeated exposure could prepare them better to cope in the real situation.

Purpose/ Research question

The purpose of this study is to explore the use of immersive VR technologies in an unfamiliar environment for the students (The Octave), in comparison to the familiar environments of the immersive video technology and non-immersive clinical skills room. The objective is to enable nursing students to experience scenario based BLS training in these varying environments and to analyse the effect that these facilities have on the confidence and competence (skills) of the student nurses during BLS training.

Methods

This innovative project used a mixed methods approach and was created and delivered by members from the School of Health and Society, the Thinklab and the School of Computer Sciences. Ethical considerations were adhered to and institutional ethical approval was granted by the Research and Ethics committee at the University. The study included the use of 3 different environments:

1. Non immersive - a standard basic the skills room (see figure 1)
2. The immersive simulation room which employs fixed view point 360 degree video and stereo sound (see figure 2)
3. The state-of-the-art Octave suite offering the highest level of immersion and interaction within a mixed virtual and real space (see figure 3),

In total 208 participants were included in the study (non immersive n= 55; immersive n= 73; Octave n= 80).

Insert figure 1, 2, 3

Study Design

The study gathered quantitative data from the laerdal QCPR manikin and the pre validated confidence questionnaire. Some qualitative data was obtained and analysed from the post session questionnaire.

A pre- study pilot tested the data collection tool for validity and reliability. The study was carried out in the University using purposive sampling, a deliberate non- random method, which aims to sample a specific group of people. Participants were in their second year of a three-year course. Therefore, they had already had some training in the first year; this session was an update for their knowledge and skills. Informed consent was obtained prior to inclusion in the study, and participants were fully aware of the purpose and methods of the research study and their right to withdraw at any time- via the participant information sheet which was distributed prior to the study. Participants were also assured of confidentially and anonymity. All participants completed the same BLS refresher training before practicing their BLS skills on the QCPR manikin in one of the three environments and completed the same pre and post questionnaires. **Table 1** provides a clear outline of the research process in each of the three environments.

Insert table 1

Table 1 Outline of research process

The environments

The three different environments and levels of simulation allowed us to compare the BLS performance and confidence of the learners. The basic skills room had no added technology; it has hospital beds and lockers and imitates a ward environment. The immersive simulation room in comparison uses video technology which projects realistic images onto the wall, with audio. The suite is fully fitted with an audio-visual system which allows scenarios to be streamed, recorded and played back. It is a discrete, multi-camera and microphone system by which different views can be achieved. This was also set up to present an outdoor urban environment with included streets, houses and associated distractions and dangers such as road traffic. The “Octave” VR facility, is an octagonal space with a maximum diameter of ~6m surrounded by stereo wall and floor projection. This provides high end simulation, integrating nurse training and associated props with a realistic visual and aural sensation of an outdoor urban environment which included streets, houses and associated distractions and dangers such as road traffic. This system tracks the position of the user’s head and uses shutter glasses to present 3D visual cues whilst allowing users to walk around and interact with virtual objects within in a real space. Mounted around the top of the projection screens is an octagonal ring of 128 loudspeaker units controlled by a dedicated acoustic rendering system employing wave field synthesis. The visual and audio systems were hence linked to align visual and audio cues. The system employed novel techniques to visually and acoustically render moving objects giving a very realistic experience of nearby traffic (25). The Octave system’s capability as an ‘augmented virtuality’ (18) allows freedom of movement and several users can collaborate and naturally communicate with each other within the space whilst experiencing real and rendered sounds from their own perspectives and thus is very useful in BLS training.

Data collection

Collection of qualitative data regarding confidence levels was performed using an adapted version of a pre validated confidence tool (*26)*. Permission was sought and granted from the original author for the use of some aspects of the original tool. The validity and reliability of this was tested during the pilot study. Thirty six students took part in the pilot study and enabled the researchers to check the design was fit for purpose.

The pre training session questionnaire consisted of 10 item likert scale design (0%- 100% confidence) so participants could self evaluate their confidence levels in relation to doing the different steps required in BLS, these included their ability to: establish responsiveness, call for help, assess airway, initiate CPR and follow BLS guidelines . The post session questionnaire consisted of the same ten items for students to self report their confidence levels. This questionnaire also included some general comments boxes which provided some qualitative data regarding the session and the environment.

Quantitative data was obtained using a Laerdal Sim Pad and QCPR manikin which provided electronic data for each individual, regarding the participants' skills performance, including an overall BLS score, compression score, ventilation score, and data regarding compressions and ventilations.

Data Analysis

Data analysis of the quantitative data was performed using the Statistical Package for Social Sciences (SPSS version 23) **(see table 2).** Non parametric statistics were analysed using Wilcoxon / Mann Whitney U and Medians, p values were calculated to indicate statistical significance of the findings **(see table 2).** The responses from the open questions on the post course questionnaire were analysed and manually coded using content analysis revealing themes in the data. During this process the research team referred back to the aim of the study to ensure the focus remained. Participants with single missing data were excluded from the analysis.

Statistical comparisons were made using the non parametric Anova and Kruskal Wallis tests to determine if there were any statistically significant differences between the groups of the independent variables.

<u>Insert Table 2</u>

<u>Results- Qualitative data</u>

Verbatim comments from the post questionnaire provided qualitative data regarding the environment where the BLS training had taken place, the equipment used, things that the students liked and disliked about the training and the overall concept.

Regarding the environment no students commented on the realism of the environment in the skills room, the skills room was reported to be a 'relaxed environment' (n=7). The immersive environment was reported to give an 'insight into real life situation/ more realistic' (n=23). However, the majority of the students (n=27) commented specifically on the realism in the Octave with others commenting on how 'life like' it was (n =4).

The equipment gained positive feedback with students commenting on the 'equipment being available' (n=4) and the fact that the manikins were 'good' (n=8) and useful (n=4) in the skills room, however, in the Octave most students seemed to comment that the 'equipment was modern' (n =7) and 'very good' (n =10).

Students liked the 'team scenarios' (n 8) and the ability to 'practice on models' (n 5) however the Octave group commented on how they 'liked the reality of the virtual street' (n = 14) and the fact that it was 'more realistic than a classroom'   (n 12) (n=26 total) presumably basing their opinion on the BLS session which they had the previous year. Overall, the students reported liking the 'reality of the Octave' which was superior (n=26) to the other two areas with the immersive group commenting on the 'reality of the environment' (n=18) but that they 'felt more relaxed' and that they felt 'relaxed and less pressure' (n=5) perhaps as this is in the nursing simulation suite, this is more familiar environment.

Fundamentally, participants enjoyed the sessions; however some students in the skills room reported the scenarios to be ‘daunting’ and ‘disliked the interactions with manikins’. The Octave group (n=4) said that they felt ‘dizzy when they came out’ and some students reported feeling ‘overwhelmed’ and ‘didn’t like adjusting to the new environment’ (n= 8). In the main there were only a few things that participants didn’t like in the groups. The new environment (the Octave) was not known to the students as it is located in a building that student nurses don’t use, unlike the skills room and the immersive environment which are housed within the building where the student nurses are accustomed.

In response to their opinion about the overall concept, participants in the non- immersive (skills) room felt this environment was ‘good, increasing knowledge, and giving them more chance to practice’ (n=10). In the Immersive Environment- students felt the overall concept in this area was good (n=14), very good (n=5) or excellent (n=2), with some students reporting ‘feeling more confident’ (n=5).

Participants in the Octave commented that it was ‘a very good learning environment’ (n 24) which would make them more confident in a real situation (n19) with one of the students saying that the session was,

‘Excellent please can this be introduced and available as soon as possible. Life like environment has evoked emotions such as panic and will help us to develop skills that will enable us to cope with challenging circumstances’ , and another saying ‘Placing students in an environment as realistic as possible may help to develop their emotional intelligence, physical and clinical qualities required to deal with emergency situations’.

Three of the students specifically commented on the usefulness of this novel environment (the Octave) in the sense that it is ‘testing and challenging’, with one of the students commenting,

‘A brilliant idea, made me more aware of myself, learned more in that short time than sat in a skills room’.

Results: Quantitative data

Quantitative data was obtained from the confidence tool questionnaire and the QCPR manikin which provided electronic data. The following results show the evaluation of 209 student scores **(**non I= *Non Immersive environment***,** I= *immersive environment*, Oct**=** *Octave environment).* Table 2 shows parametric statistics, which is applicable given the corresponding Shapiro-Wilk normality tests confirm that we cannot reject the hypothesis that the sample comes from a population which has a normal distribution (e.g. for score1 Shapiro-Wilk W = 0.95774, p-value = 7.663e-06). With a one-way assessment of variance (Anova) the results show the mean overall scores (score 1) are significantly lower within a fully immersive 'Octave' space when compared to non-immersive and semi immersive scenarios. Table 2 also shows the corresponding non-parametric evaluation with median scores and a Kruskal–Wallis one-way analysis of variance give similar results.

Gain scores have also been calculated (i.e. differences between the means of the students recorded confidence levels before and after performing the given task) (see Table 2, figure 4 and figure 5). Typically, those confidence measures with significant differences show the confidence gains are higher in the non-immersive environments.

It is expected that within fully immersive environments there will be a detrimental impact on the student's ability to form tasks and feel confident in accomplishing those tasks. The environment recreated the dynamic 3D visuals and 3D sounds of traffic threats and other real-world distractions. Given the high presence and ecological validity of the Octave system, it could be argued that using such a space for training gives the students a more realistic self-assessment of their performance in a realistic context and hence better preparation for the real world. However, to some extent the mediating technology could also be a distraction (e.g. wearing 3D spectacles and the wow factor of the space).

Insert figure 4 and figure 5

Competence/ Skills

Parametric competence scores showed a statistically significant result **(**p=0.04) with mean overall basic life support scores of 46.6 non I, 46.9 I and 37.1 Oct, showing that overall students were more competent in the immersive suite. Similarly, students in the immersive environment gained significantly better results than in the other areas, when achieving compression depth, with mean scores of 48 in comparison to 41.2 in Non I and 41.4 in the Octave. Conversely, the non immersive environment proved more successful for hand position with mean scores of 92.5 non I, 83.5 I, and 72.7 Oct (p=0.0011).

Non parametric evaluation of competence scores revealed only the difference in compression scores to be statistically significant (31.5 Non I, 44.5 I and 27 Oct) (p=0.0426) again revealing the immersive suite to be better in gaining skill adequacy, potentially due to the familiar surroundings, but with an added element of realism.

Confidence

Parametric gain statistics (see table 2, figure 4) for confidence levels, reveal three measures that show a statistically significant gain score, these were the use of the bag valve mask ventilation, the ability to follow BLS guidelines and confidence in establishing a leadership role in BLS situations. These three measures found the non immersive environment to have the greater gain in confidence. Bag valve mask ventilation showed gain scores of 29.2 non I, 14.8 I, 15 Oct (p=<0.001). The confidence at being able to follow BLS guidelines showed gain scores of, 24.3 non I, 12.3 I, 13.4 Oct (p=<0.001), the confidence in establishing a leadership role 27.7 non I, 17.7 I, 19.3 Oct (p0.0163), perhaps highlighting the importance of low fidelity simulation in the development of associated skills, yet interestingly, the Octave environment showed a slightly better gain than the immersive environment. Perhaps the participants felt more confident testing their knowledge and skills in an unfamiliar environment, adversely the fear of the unknown before the training in the unfamiliar setting and the realisation after the training that it wasn't as bad as expected, may have increased their confidence gain significantly.

Non parametric testing gain scores revealed the ability to initiate CPR, perform bag mask ventilation and follow BLS guidelines as the measures which showed statistically significant gain in confidence. The non immersive environment showed the greatest gain score for confidence in initiating CPR, (25 non I, 10, I, 20 Oct) (p=0.0012), performing bag valve ventilation, (25 non I, 10 I, 15 Oct) (p=0.0066) and follow BLS guidelines (20 non I, 10 I, 10 Oct) (p=0.0024). Similar findings in two of the measures (initiating CPR and performing bag valve ventilation) reveal that the Octave was more successful in students confidence gain than the immersive suite.

We can infer from the results that if the learner continues to be exposed to VR training their confidence will increase, or it could be argued that if they had repeated exposure to this new environment it would lose the ability to test their skills in a challenging unfamiliar environment.

Discussion

The findings from this study have provided interesting thoughts regarding the challenges that learners may need to prepare them adequately for the many unfamiliar and challenging situations they may find themselves in as student nurses in clinical practice. The findings can also be generalised to students and learners in other disciplines globally.

Competence/ Skills

The parametric competence scores showed that overall students were more competent in the immersive suite. Similarly, students in the immersive environment gained significantly better results than in the other areas, when achieving compression depth. Interestingly, the non immersive environment proved more successful for hand position. Non parametric evaluation of competence scores revealed only the difference in compression scores to be statistically significant again revealing the immersive suite to be better in gaining skill adequacy, potentially due to the familiar surroundings, but with an added element of realism. For skill acquisition it would appear that the Octave scored lower than the other two environments. Perhaps this is due to distraction elements within the environment and the fact that it is unfamiliar to the students, perhaps the added technology and features brings with it sensory overload affecting the student ability to perform the skills ultimately affecting their competence. However, the immersive suite has added technology, on a lesser scale, yet it is in an environment which is familiar to the students. Technology it seems can act as a distraction and a barrier to learning in some cases with an often intrinsic resistance to change. Khalil et al (27) discuss this resistance and the fact that this can be a barrier to utilising the enhanced facilities, not just for the students but the staff as well (27).

The unfamiliar environment (Octave) was more challenging for the students, with verbatim comments, revealing that the students felt overwhelmed. They commented that the 'Octave was a new environment and that they needed to adjust'. Nevertheless, there appeared to be the understanding that this unfamiliarity would help them to prepare and increase their confidence in a real situation. Indeed, recent literature has highlighted the anxiety linked with such game technology (28). This has been criticised for focusing on cognitive learning outcomes, often ignoring the emotional aspects of learning, which of course can also significantly contribute to the learning, student performance and motivation (28). Recent study findings (28) indicate that using such technology found that some participants' experienced less positive emotions which included anxiety, nervousness, fear and stress. Conversely, this type of technology can be praised for providing a more dynamic and engaging learning experience, which is more memorable and useful particularly in line with visual learning styles.

With this in mind the more enhanced technology associated with the Octave located in an unfamiliar environment is much more likely to test the confidence and the skills of those performing BLS, and arguably this could be a perfect way of preparing the student nurses for the challenges in clinical practice which may face them, by taking them out of their 'comfort zone' of the familiar skills room and utilising an area such as the Octave. Indeed, this facility is not easily accessible and requires costly equipment, yet it is hoped that the technology associated with it can be transferred to a more accessible means as it is without doubt a valuable resource for learning. The challenges associated ahead of critical care placements are documented; students often lack knowledge and confidence in these areas (29). It is recognised that nurse education should utilise a variety of methods to ensure that nurses are competent and confident for clinical practice (30) and that more creative solutions to teaching may lessen the 'fear of the unknown' (31).

The 'Familiar 'environments (non immersive, immersive) seemed to make the students feel more comfortable, with verbatim comments concluding that they felt more 'confident/ relaxed' at the time of training. The non immersive room was also reported to be a 'more relaxed environment', providing a conclusion as to why the students reported to be more confident in those areas, in keeping with the quantitative findings of the study. As the immersive suite utilises video technology, this is a relatively more cost effective and an easily accessible solution.

Confidence

Self confidence in the ability to carry out nursing duties is crucial to effective performance and clinical skills performance has been reported to be the most influential source of confidence in nurses (30). The Parametric gain statistics for confidence levels, revealed three measures that show a statistically significant gain score, these were the use of the bag valve mask ventilation, ability to follow BLS guidelines and establish a leadership role in BLS situation. These three measures found the non immersive environment to have the greater gain. Yet interestingly, the Octave environment showed a slightly better gain than the immersive environment. It is understandable that the non immersive, familiar non threatening environment would make the students feel more comfortable and confident. With higher levels of simulation comes the risk of initiating feelings of fear within the learner which will in turn affect their confidence levels. Yet interestingly, the Octave which uses advanced technology shows a better gain of confidence than the immersive environment. Perhaps this can be equated to the 'fear of the unknown' and is an issue particularly in clinical settings , where a high level of anxiety can result in decreased learning (32), as the students in this study were not familiar with the Octave and the experience made them feel more confident following the training. This is concurrent with the findings from the verbatim comments which revealed that students found the Octave helpful for ‘gaining confidence’.

Similar findings from the non parametric testing gain scores revealed the ability to initiate CPR, perform bag mask ventilation and follow BLS guidelines as the measures which showed statistically significant gain in confidence with the non immersive environment showing the greatest gain. Similar findings in two of the measures (initiating CPR and performing bag valve ventilation) revealed that the Octave was more successful in students confidence gain than the immersive suite. Again the Octave adds the enhanced technology which makes the students feel more confident, yet the non immersive environment is a clear winning environment. This is understood to be due to the familiar surroundings, which doesn’t add any pressure to the students, they feel comfortable in the non immersive environment. In contrast, the unfamiliar environment (Octave) students reported to feel ‘overwhelmed as a result of the new environment’. In preparation for clinical practice perhaps this is a very useful experience as in a real life emergency such as a cardiac arrest it is normal to feel overwhelmed.

Students in this area also reported that they ‘needed time to adjust’. Realistically, cardiac arrests can happen anywhere and in a variety of different circumstances, it is not possible to prepare and have time to adjust in clinical practice, again proving the benefit of the Octave as an unfamiliar environment. One of the students made the crucial comment that they felt ‘the unfamiliar environment (Octave) helped them to develop emotional intelligence to deal with emergency situations’. Indeed, the development of emotional intelligence is crucial in preparing nurses to be able to deal with acute care situations and is referred to by Cleary et al (33) as an important element of success. Indeed, emotional intelligence is crucial in providing nurses with the resilience to utilise skills and knowledge in an emergency situation where you are often put on the spot and have to recall the BLS training that you have had in the past during a cardiac arrest.

It is perhaps the case that the fear of the unknown has a dramatic effect on the confidence and skills of those involved in this study. Importantly, as a nurse we can never be certain what will greet us during the shift, nurses need to be knowledgeable and possess the correct skills set to deal with the patient requirements, and they need the emotional resilience to be able to adapt to often rapidly changing circumstances and be able to deal with external stressors. (33) The psychological fear of change (metathesiophobia) or 'elephant in the room', can present a significant barrier to learning, but as demonstrated this could be useful in the preparation of student nurses who are constantly challenged with different situations.

It is fair to say that the levels of immersion have has a significant impact during the study. The realism that the higher levels of fidelity offer, are certainly more conducive to building confidence in some areas. In support of these findings, an international study carried out in American and Sweden by Creutzfeldt et al (12) identified an important aspect is the degree of realism and the sense of presence in virtual world training. They suggest that there is a risk that participants may perceive the training environment as 'awkward' and that they may experience a lack of real world resemblance. Our study presented a comparison of more realistic challenging learning environments alongside a familiar learning environment. The benefit of the more challenging environment is that it enables the nurses to an increase their confidence and skills in a more realistic environment, through repeated exposure, it presents a realistic overview of the realistic confidence and skills ability when faced with a cardiac arrest in real life. Pushing the boundaries of traditional BLS training environments may present a truer picture of their competence and confidence and alternating training areas for BLS to prevent students becoming 'comfortable' in their learning environment, may strengthen their ability to cope with emergency situations wherever they occur.

Similarly, in-situ simulation allows learners to adapt and utilise the skills and underpinning framework that have been learnt in a variety of settings and circumstances. Walker et al (34) describe

a British study whereby in-situ simulation was found to be beneficial particularly for staff who had less exposure to cardiac arrests. They advocate the use of this method of simulation as part of patient safety initiatives having identified a number of issues that, had they occurred during a real resuscitation attempt, may have led to patient harm or patient death. For these reasons they felt in situ simulation should be considered by every hospital as part of a patient safety initiative. Clearly this level of simulation has its uses and undeniable benefits, yet the obvious barriers to its wide spread use would include time, resources and space. As Lighthall et al, (35), reminds us in-situ simulation is more useful in understanding how health care providers and their environment function during a cardiac arrest situation, proving to be good preparation for the real event.

Nevertheless, for the purpose of educating student nurses it would be more suitable to utilise simulation out of the clinical environment due to the student numbers, and the immersive and VR technologies are important educational facilities which will enable the learners to develop the required skills and confidence in a safe environment without any risk to patients. Verbatim comments supportive of this include, 'Placing students' in an environment as realistic as possible may help to develop their emotional intelligence, physical and clinical qualities required to deal with emergency situations' shows an understanding of the significance of having a realistic learning environment in aiding to develop the necessary skills.

Conclusion

This study has examined and compared the effect a more challenging, unfamiliar novel learning environment has on basic life support associated skills and learner confidence levels, as opposed to more familiar learning environments.

New challenges in nurse education have encouraged nurse educators to seek alternative educational modalities such as simulation including VR. These methods allow the development of crucial skills, including communication and critical thinking. The use of VR and immersive technologies test the confidence and the ability of the students.

The difference in utilising unfamiliar as well as familiar environments should be considered, and educators should appreciate the value of using familiar environments to build the initial skills required but then pushing the boundaries by placing students in unfamiliar/ uncomfortable educational settings, to be able to increase their confidence and ability to cope in emergency situations. Immersing students in a high fidelity simulation experience allows students to further use their team skills as in reality there is often more than one rescuer present (12), and a lack of team coordination could hamper the effectiveness of BLS. A future study will explore the use of the variety of simulated environments and the effect on the development of team working skills.

The added educational benefits of VR and immersive simulation are clearly useful overall and particularly align to the ancient Chinese philosopher, Confucious who claimed in 450BC, 'Tell me, and I will forget. Show me, and I may remember. Involve me and I will understand'.

Recommendations for future studies

The recommendations following the study are that educators should alternate BLS training environments to prevent students becoming 'comfortable in their surroundings' strengthening their ability to cope with emergency situations wherever they occur. There should be repeated exposure to more realistic situations to demonstrate the increase in confidence in preparation for the real life situation.

Although this study has focussed on the education of nurses, the findings can be useful for other disciplines that required BLS training. The findings are transferable across multiple disciplines and of international significance, due to the potential impact on the skills and the confidence required to perform BLS.

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