Augmented Reality in Nursing Education

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Background:

The goal of nursing education is to foster the development of critical thinking leading to clinical judgment in promoting safe, quality patient care through the implementation of the nursing process. The key first step in the nursing process is nursing assessment. Nursing assessment skills, especially those related to physical assessment, are foundational skills for nurses with various teaching strategies employed to teach these skills in pre-licensure programs, including students practicing on each other, use of low and high-fidelity simulators, life models, and computer-based virtual reality (VR) simulations (Birks et al., 2014). Recommendations to investigate alternative approaches to teaching these nursing physical assessment skills have been suggested to improve student competency (AACN, 2021; Birks et al., 2014). With ever increasing introduction of technologies in nursing education, including technological resources for assessment skills, nurse educators must be knowledgeable of evidence-based approaches for the use of these technologies in supporting development of safe practitioners. One modality that has not been studied in depth is the use of augmented reality (AR).

Augmented reality is defined as "a type of virtual reality in which synthetic stimuli are superimposed on real-world objects, usually to make information that is otherwise imperceptible to human senses perceptible" (Lioce et al., 2020, p. 9). In exploring AR for procedural training, Lee et al., (2024) found that there were benefits to use of AR for teaching advanced practice nursing students the skill of lumbar puncture, especially in terms of providing students a self-paced, immersive learning experience. Urlings et al. (2023) identified that there are opportunities for use of technologies in healthcare education but there is a need for rigorous studies to determine best uses and cost-effectiveness of new technologies like AR, Virtual Reality (VR), and 3D printing.

Given the lack of research related to AR and recommendations for more rigorous studies, the purpose of this study was to examine the effects of AR on nursing student performance of the physical assessment skills of

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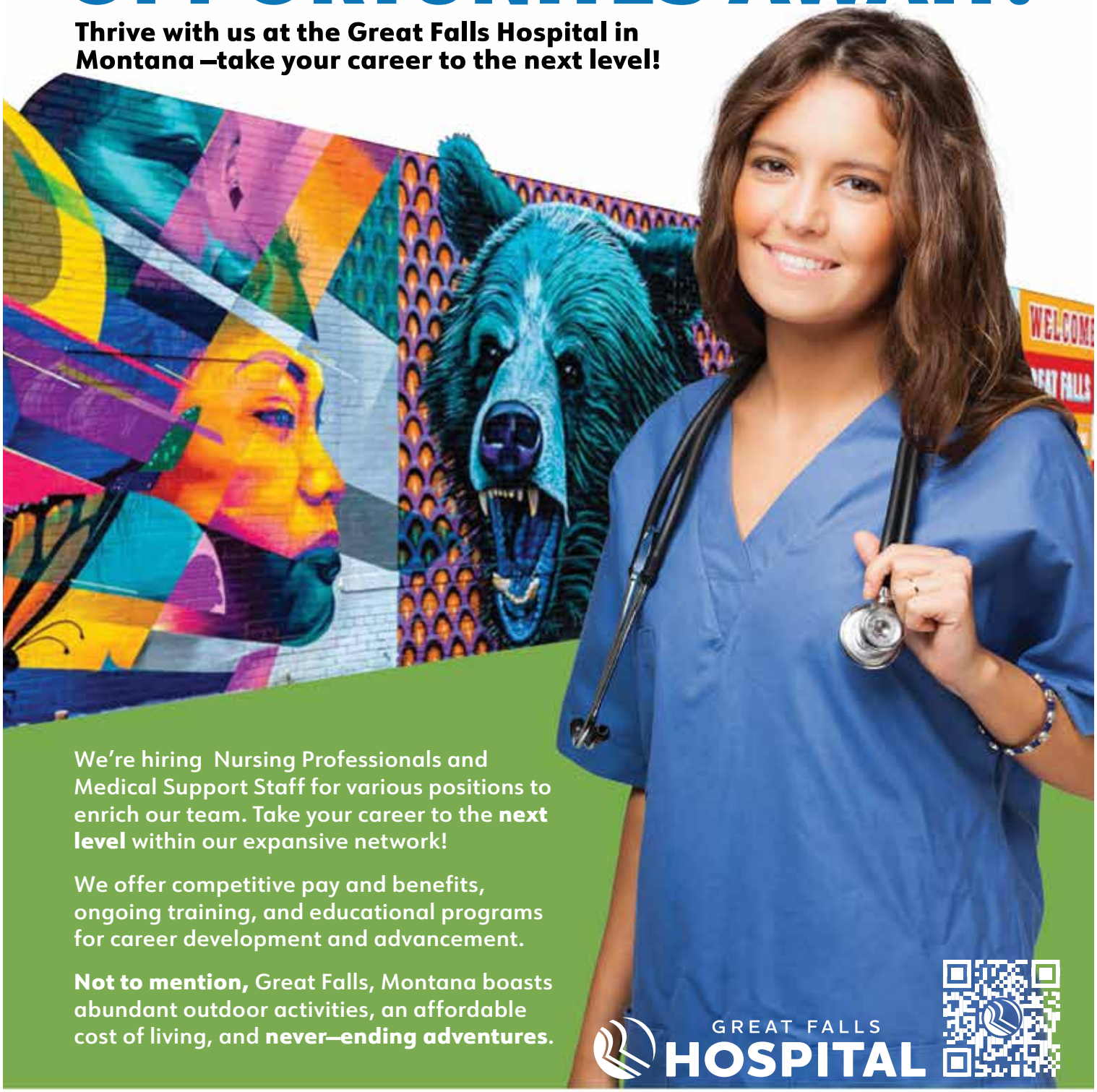

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the heart, lung, and abdomen. It was hypothesized that augmented reality as an adjunct to traditional training would improve skill acquisition related to physical assessment and have better learning outcomes than those with traditional learning alone. More specifically the study aims were to:

1. Examine an augmented reality (AR) experience for enhancing self-confidence of students learning physical assessment.
2. Explore the student experience in performing physical assessment enhanced with AR.
3. Compare learning outcomes in students participating in traditional mannequin training for physical assessment with those with traditional training enhanced with AR.

Research Design and Sampling:

Using a quasi-experimental research design, the researchers explored the effects of the use of an augmented reality training experience on the acquisition of heart, lung, and abdominal assessment skills. All undergraduate nursing students in a public university in the Mountain West enrolled in a physical assessment course in Spring 2022 were invited to participate. All students were in the first semester of their clinical component of the nursing program. To be eligible to participate, students were required to have normal or corrected to normal vision. Students were excluded if they were pregnant or had a history of epilepsy or other neurological disorders due to risks of simulator/motion sickness. Those who reported ongoing neck problems were excluded due to possible strain from wearing the AR equipment. Students were required to take part in the training but were not required to take part in the research study aspects. A research team member who was not responsible for grades solicited participation and consent. The study was approved by the affiliated university as exempt.

Procedures

While learning about assessment of the heart, lungs, and abdomen, students were randomized into two groups. After demonstration of the skills, the control group assessed a mannequin and a peer. The intervention group were offered the same experience but also had their training enhanced with the use of the AR Magic Leap Hololens device to enhance their experience. The AR head-mounted device provided an overlay view of the body's internal anatomy onto a mannequin, enabling participants to visualize the location of the bones, heart, lungs, and abdominal organs, which provided reference points as designated assessment skills were practiced, such as stethoscope placement. After practicing the assessment skills, participants demonstrated competency by performing an assessment while being evaluated by a faculty member using a performance rubric. Participants also completed paper-based instruments as noted under Instrumentation. Students were again assessed on performance of assessment (heart, lungs, abdomen) at the end of the semester. At the end of the semester, those students who did not get to experience the AR were given an opportunity to do so after demonstration of performance. Students participating in the research study were given an incentive (gift card). Data analysis recommendations were made by a statistical consultant based on the data characteristics and sample size and included calculation of descriptive statistics and comparison of group scores in terms of performance, self-confidence, and satisfaction.

Instrumentation

Outcomes for the study were measured using three instruments that included:

1) **Student Satisfaction and Self-Confidence in Learning** is a 13-item instrument designed to measure student satisfaction (five items) with the simulation activity and self-confidence in learning (eight items) using a five-point scale. Reliability was tested using Cronbach's alpha: satisfaction = 0.94; self-confidence = 0.87 (NLN, 2020).
2) **Heart, Lung, Thorax, and Abdominal Assessment Rubric**. Students were assessed using a rubric adapted from Physical Examination & Health Assessment (8th ed.) by Jarvis and Eckhardt (2020) published by Elsevier. Elsevier is a publishing company that specializes in scientific and medical subject matter. The rubric entitled Heart, Lung Thorax, & Abdominal Assessment Rubric was reviewed by seven experts who have vast experience in teaching physical assessment skills to undergraduate nursing students. Changes were made to the rubric according to feedback received from the experts. The rubric was piloted with 62 undergraduate nursing students during spring semester 2020. The rubric will be finalized based on usability and interrater reliability statistics.
3) **Demographic tool**. The demographic tool allowed researchers to understand the characteristics of the sample including sex (self-identification), age and previous experience with augmented reality.

Results

Forty students were recruited for the study with 37 students providing usable research data for analysis. Both groups were found to be similar in terms of gender identification, age, ethnicity, and AR learning experiences. Two-sample t-tests were utilized to determine if there were statistical differences in the mean total satisfaction in learning as well as mean total self-confidence in learning (treatment vs. control). Linear mixed models were utilized to determine statistical comparisons between treatment groups as well as from immediately post-training (T1) and end of semester time periods (T2) in terms of assessment performance (lungs, heart, abdomen, and total score). All statistical analyses were conducted using the R programming language (R version 4.2.0).

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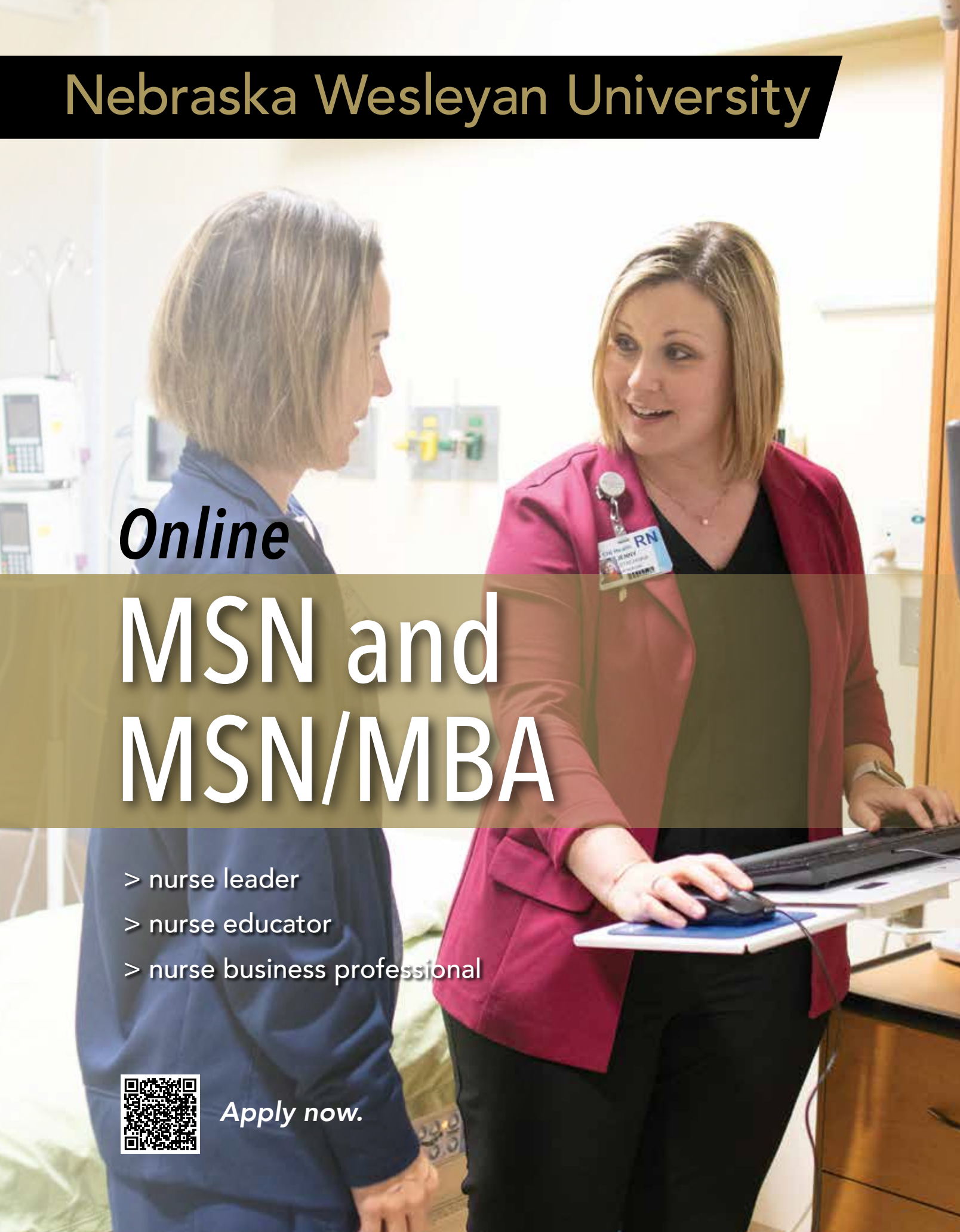
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The mean self-confidence score for the AR group was 31.94 vs. a mean of 31.26 for the control group but the means were not statistically different (p>0.7). The mean satisfaction score for the AR group was 14.94 vs. a mean of 14.84 for the control group but these means were not statistically different (p> 0.9). The overall mean performance scores for the AR group were 19.75 vs. 19.23 for the control group but the means were not statistically different (p> 0.6). When examining differences of sub-score results of specific anatomical areas at T1, no statistically significant differences were found between the AR group and control group in terms of lung assessment (7.47 AR; 6.41 control); heart assessment (AR 8.5; 8.73 control); or abdomen (3.9 AR; 4.1 control).

Additional performance testing at the end of semester (T2) indicated that the AR group mean score was 23.7; the control group 23. While the improvement from T1-T2 was greater in the AR group (19.75 to 23.7 = 3.95 points) than in the control group (19.23 to 23 = 3.77 points), the improvement was not statistically important (p=0.98). In terms of specific sub-score results, both groups experienced statistically significant increases in lung, heart, and abdomen performance scores from post-training to end of semester (all p-values between 0.001 and 0.03), although improvement differences were not statistically significant [p=0.33 (lung), p=0.46 (heart) and p=0.56 (abdominal)] for any of these three areas.

Discussion

In this project, there were no significant differences between students' who were taught the skills for physical assessment using traditional measures compared to students who had an enhanced learning experience using VR in terms of satisfaction, self-confidence, or performance. Of note, both groups experienced an increase in performance score at the end of the semester (T2), rather than a decrease as might be expected. This could be explained by the weekly practice of assessment by each group over the semester.

With the increased emphasis in nursing education to develop a competent nursing workforce (AACN, 2021), nurse educators must be prepared to provide competency-based learning and assessment strategies to develop the next generation of quality nurse graduates. This study, along with other previous work (Lee et al., 2024; Urlings et al. 2023), indicate the potential for AR to benefit nursing student learning. Given the results of this project, the use of AR has the possible direct benefit of improved physical assessment skills and memory retention by enhancing comprehension of spatial structure and function in participating subjects. There is also the benefit of increased interaction and engagement by students who use the AR in a more immersive user experience. In addition, society may benefit with improved health care outcomes using augmented reality to enhance the education of future nurses in physical assessment skills. Future studies with larger sample sizes are needed to determine the cost benefits and feasibility of using this type of technology to improve student learning related to physical assessment. Limitations of this work include lack of generalizability due to the use of a convenience sample of undergraduate students. An additional limitation is the evaluation of longer-term retention of learning with the use of AR, which was not measured in this study.

Conclusion

With the increasing number of technology products available to nurse educators, nursing faculty must understand the evidence to support the outcomes of these technologies. Considerations must include how outcomes match the learners in the organization, cost, and feasibility of technology use within the institution. AR may be one of these technologies to show potential learner impact to promote quality patient care.

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