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Effects of Online Learning Packages Using Simulation of Nursing Paediatric Critical Care Unit

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ABSTRACT

Background: Online learning packages using simulation have emerged as innovative tools to enhance nursing education in Paediatric Critical Care Units, offering interactive and flexible training experiences. The purpose of this study was to compare knowledge scores before and after receiving online learning packages using simulation of nursing paediatric critical care of registered nurses working in the Paediatric Intensive Care Unit (PICU) at University Hospital in North-eastern region of Thailand, whose work experiences were less than 3 years and had not completed the training course on paediatric intensive care nursing. **Methods:** The method is a quasi-experimental study, an online learning package using simulation of nursing paediatric critical care, and a one-group pre-post-test design. The samples in this study were professional nurses working in the Paediatric Intensive Care Unit (PICU) at a university hospital in the northeastern region of Thailand. **Results:** The results of the 14 registered nurses who participated in this study showed that there was a statistically significant Mean Difference (MD) in the score before and after receiving the online learning package 1 (MD -7.4), and the score after the 2-week follow-up period was (MD -3.9). Also, there was a statistically significant difference in the mean score after the program and the 2-week follow-up period with the score of 3.4. For an online learning package 2, there was a statistically significant difference in the mean score before and after receiving the package (MD -9.6 points), and the score after the 2-week follow-up period was (MD -6.1 points). It was also found that there was a statistically significant difference in the mean score after the program and the 2-week follow-up period with the score of 3.4. **Conclusion:** To conclude, an online learning package regarding nursing competencies can improve knowledge in paediatric critical care nursing. This will affect the quality of care and patients' safety.

Keywords: Online Learning Package; Paediatric Intensive Care Unit; Simulation of Nursing Paediatric Critical Care

INTRODUCTION

In response to the growing demand for more flexible, accessible, and technology-integrated education, many educational institutions have transitioned from traditional on-site teaching to online learning. This shift aims to overcome limitations related to time, location, and resource availability, thereby enhancing learning opportunities for diverse groups of learners (Mishra, Gupta & Shree, 2020). According to the UNESCO report, higher education institutions were closed in 185 countries as of April 2020, affecting more than 1,000 million learners worldwide (Marinoni, Van't Land & Jensen, 2020). As a result, academics around the world are rapidly changing their teaching materials and methodologies in ways that are suitable for online learning (Dwivedi *et al.*, 2020).

Nursing education management requires different branches of science and technology knowledge to be applied in nursing courses; therefore, a variety of simulation-based teaching methods have been adopted in teaching and learning courses, which enable nursing students to have confidence and gain professional skills in nursing (Maraphen & Boonkoum, 2020). Simulation-based education provides learners with the opportunity to practice skills in real-life situations. It is a virtual reality method to test learners' knowledge and skill levels by placing them in scenarios where they can actively learn and solve problems. This learning platform enhances learners' self-confidence in analytical thinking and ability to solve problems; moreover, it demonstrates appropriate nursing skills which can be used as measurement tools, learning objectives, and

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goals, increase efficiency towards patient care and reduce errors (Khumsuk & Ninphan, 2021; Lateef, 2010).

Newly graduated professional nurses may experience anxiety and stress from their roles and responsibilities shift as a nursing student to a professional nurse. They are often expected in their knowledge, ability and skills to perform tasks obtained from schools and practices; however, graduated nurses have not had enough practical experience as well as analytical thinking and planning, leading them to feel insecure and lack confidence at work, which has an enormous impact on their nursing work. However, the success and failure of an individual's career depend on their ability to adapt himself/herself to given roles and responsibilities. If a person is unable to adapt to his/her professional practice, it will result in discomfort and boredom at work physically, mentally and socially, resulting in a lack of determination to work (Schaufeli & Salanova, 2013). In order for nurses with a bachelor's degree in nursing to have quality nursing practice and readiness to meet operational needs, personal and professional development with knowledge and skills for professional practice must be prepared, and it is very necessary to obtain prior to working.

To continually develop professional knowledge and skills of nursing practice corresponding to the Department of Nursing Education, the Nursing Council has determined the central competency of the nursing education curriculum from bachelor's degrees, master's degrees, and doctorates, as well as specialised nursing training courses and certificate-level advanced nursing courses in order to determine the ladder of professional advancement, which is the path to maintaining experienced medical professionals and quality of nursing services in the nursing profession (Price & Reichert, 2017). Professional nurses with more than three years of experience in the Paediatric Intensive Care Unit (PICU) are required to attend a training course in paediatric intensive care nursing. However, due to workforce shortages and the high demand for nursing care in hospitals, particularly in critical care settings, many nurses are unable to attend the required training courses as they must prioritise patient care and staffing needs. Therefore, professional nurses who have more than 3 years of work experience but have not received the training in paediatric intensive care nursing can continue to develop knowledge and professional skills through online learning packages using simulation of nursing paediatric critical care, in which this educational platform is an up-to-date learning technology.

Paediatric critical care nursing provides care for specific patients. The ward takes care of infants and children with complicated symptoms or in crisis. It requires nurses with specific knowledge and practice skills in paediatrics (Meghani & Lalani, 2014). Therefore, the researcher had reviewed literature on the mortality rates of the first five diseases in the paediatric care unit at University Hospital in North-eastern region of Thailand before creating online learning packages using simulations of nursing competencies for paediatric critical care. Two online learning packages for online learning using simulation of nursing paediatric critical care were developed. Each package consisted of 2 lessons, with a total of 4 lessons, including knowledge and skill topics regarding paediatric critical care nursing on hypoxaemia, acute respiratory failure, abnormal circulatory systems, and cardiopulmonary resuscitation in cardiac arrest.

Nurses were provided with online learning packages through the Google Classroom platform. This online learning approach was developed in response to the evolving trends in digital education, where flexible and accessible learning methods are increasingly essential. The use of such platforms aligns with modern educational practices that promote self-paced, technology-enhanced learning widely adopted across healthcare education. The packages aimed to develop learners' skills in line with the holistic competency approach of paediatric critical care nursing, structured under Bloom's digital taxonomy. The video presentation was created using a simulation of the nursing competency in paediatric critical care. Nurses could take lessons as many times as they want until they feel confident and able to put them into practice. In addition, this simulation-based learning was prepared for the practice of professional nurses in real situations, which affects the quality of health services to provide safe and complication-free care to paediatric patients.

Objectives

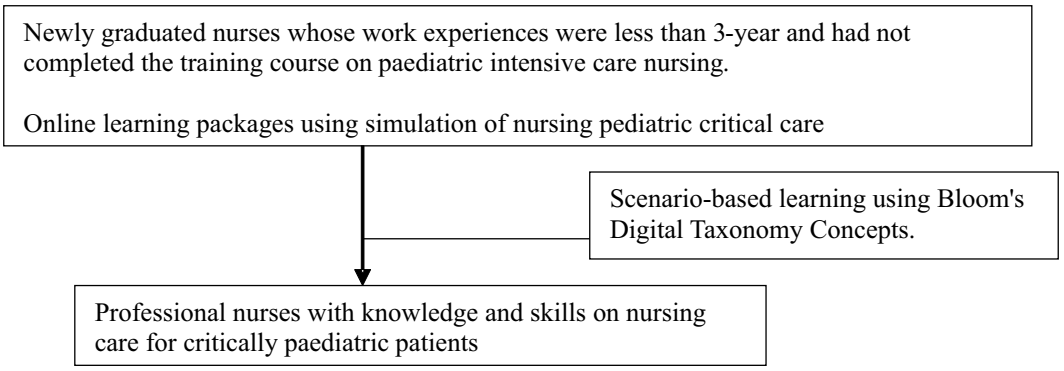
To compare the knowledge scores before and after receiving the online learning packages using a simulation of nursing paediatric critical care.

Research Hypothesis

There will be a significant difference in knowledge scores between the pre-test (T0) and post-test (T1)

following the implementation of an online learning package incorporating paediatric critical care nursing simulation.

Conceptual Framework



METHODOLOGY

This was a quasi-experimental study, a one-group pre-post-test design. The samples in this study were professional nurses working in the Paediatric Intensive Care Unit (PICU) at University Hospital in the North-eastern Region of Thailand. The inclusion criteria were 1) Nurses with working experience at PICU of less than 3 years and who have not completed the training course on paediatric critical care nursing; 2) Nurses who have devices such as computers, mobile phones, and/or other communication devices with an internet signal that can be used to access online learning and respond to pre-post-test surveys. Nurses who were transferred between departments during the research were excluded from the study.

Sample size was calculated using G* Power version 3.1 (Faul *et al*., 2007). Test family was defined as F tests, and the statistical analysis used to analyse data was One-way ANOVA. Repeated measures within factors and set the parameters to calculate the sample size were as follows:

1. Cohen's influence size was set at a high level, which was equal to 0.40 (Faul, *et al*., 2007).
2. Significance level was equal to 0.05
3. The power of test was equal to 0.8
4. The number for testing group was equal to 1
5. The number of times to evaluate the results was equal to 3 times.
6. The size of the relationship between the result values in each assessment was equal to 0.3.
7. The researcher assumed that the variance of the differences between repeated measures would be equal (sphericity was not violated); therefore, no correction for variance differences was required. As such, the non-sphericity correction factor (ε) in the G*Power program was set to 1.00. Based on this configuration, the calculated total sample size for the study was 16 participants. However, during the data collection phase, two participants submitted requests to transfer to another agency and were consequently excluded. Thus, the final sample size included 14 participants who completed the study. All participants were thoroughly informed about the study's objectives, potential benefits, and relevant details using clear and accessible language. Participants were also informed of their rights, including the right to privacy and the freedom to decline or withdraw from the study at any time without any consequences to their employment. Furthermore, all data collected were treated with strict confidentiality, and no identifying information was used in any reports or publications.

Research Instruments

An interview questionnaire was used as a research tool to collect data, which consisted of 2 parts: Part 1:

General information, including gender, age, working experience, education, and specialised training, and Part 2: Knowledge assessment test of online learning packages using simulation of nursing paediatric critical care. Educational video consisted of content structure for each lesson, teaching demonstrations, assessment tests, and evaluation criteria. Online learning packages consisted of 2 sets of online learning packages; each set has 2 lessons as follows.

Online Learning Package 1: Nursing paediatric critical care for infants and children with respiratory disease consisted of 2 lessons:

Lesson 1.1: Paediatric Critical Care for infants and children with hypoxia

Lesson 1.2: Paediatric Critical Care for infants and children with acute respiratory failure

Online Learning Package 2: Nursing paediatric critical care for infants and children with cardiovascular disease

Lesson 2.1: Nursing Paediatric Critical Care for Infants and Children with Abnormal Circulatory Systems

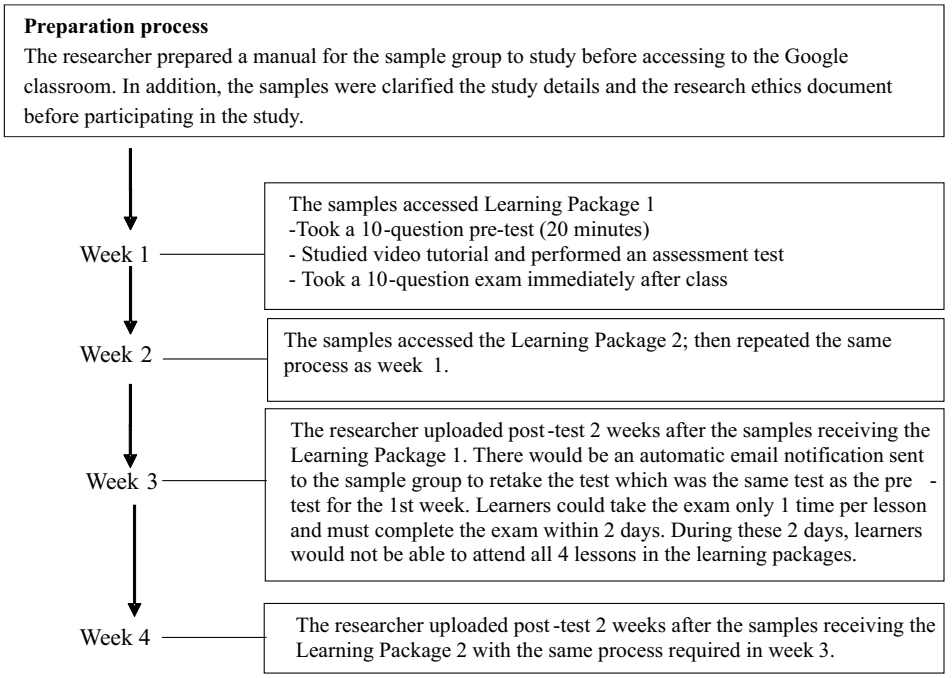
Lesson 2.2: Nursing Paediatric Critical Care for infants and children with cardiopulmonary resuscitation in cardiac arrest

Teaching video materials were created using a simulation of nursing paediatric critical care scenarios and consisted of 3 steps: Pre-brief: the preliminary steps which explained the detailed information; Scenario: practical steps in simulated situations; and Debrief: a step in which learners evaluated their results after learning from the instructional video from each lesson. The researcher utilised a high-performance robot (Paediatric HAL® S3005 - Wireless and Tetherless, Five-Year-Old Patient Simulator) to demonstrate the use of medical equipment for practice and practical skills in a simulated environment, as it would occur in the ward. They were required to assess, make decisions, and perform clinical interventions in real time. The key features employed during the simulation included performing spontaneous blinking, eye movement, and facial expressions to simulate patient responsiveness and distress. To demonstrate the breathing patterns, including normal, distressed, or absent respiration, synchronised with thoracic movements, and demonstrate the adventitious lung sounds, which are critical for teaching respiratory assessment skills in children. For the cardiovascular assessment procedure such as palpable pulses, and vital sign fluctuations to reflect changes in the child's condition based on learners' interventions. The real-time monitoring and feedback through integrated software from Paediatric HAL® S3005 allows facilitators to adjust scenarios dynamically and track learners' performance. Furthermore, it was utilised to deliver high-fidelity simulation scenarios that bridged theoretical knowledge with clinical practice. This advanced manikin is capable of replicating a wide range of paediatric physiological responses and clinical signs such as hypoxia, cardiac arrhythmia, and cardiac arrest, thereby providing a realistic and immersive learning environment.

Reliability and Validity of the Instruments

The content validity of the online learning packages was verified by three experts in the field of nursing and paediatric critical care, including a paediatrician specialising in medical education, a paediatric nursing instructor, and the head of the paediatric intensive care unit. The assessment test was checked using the index of congruence (Index of item objective congruence: IOC) with criteria to consider selecting valid questions, an IOC value ranging from 0.5-1.0 (Kao, Wang & Liao, 2016). The IOC values for each lesson were as follows: for paediatric critical care nursing for infants and children with hypoxia, the IOC was 0.73; for acute respiratory failure, the IOC was 0.93; for an abnormal circulatory system, the IOC was 0.9; and for cardiopulmonary resuscitation in cardiac arrest, the IOC was 0.83. The total value of all 4 assessment tests, IOC was 0.85. The trustworthiness of the online learning package's utilisation was supported by the consistent and measurable improvement in participants' knowledge scores across all assessment points. Furthermore, the structure of the package delivered through a widely accessible platform (Google Classroom), reinforced by simulation-based scenarios and assessed using a validated knowledge test, ensured that the learning experience was both standardised and traceable, minimising the likelihood of non-participation or superficial engagement.

Data Collection



Data Analysis

1. For the analysis of general characteristics information of the samples, continuous data such as age and working experience were presented as mean and standard deviation. A group data such as gender and work experience (<1 year, >1 year, > 3 years), the data was presented in frequency and percentage.

2. For the comparison of knowledge scores before and after receiving the Online Learning Packages: the researcher performed the comparison of knowledge scores in a total of three periods including: Pretest which was before receiving the online learning packages; Post-test which was immediately after receiving the online learning packages; and the follow-up period, 2 weeks after receiving the online learning packages. The researcher compared the scores in 2 ways using one-way repeated measure ANOVA.

The analysis employed a one-way repeated measures ANOVA with Bonferroni correction to compare the mean knowledge scores across three time points for each learning unit. Assumption checks were conducted to ensure the appropriateness of the statistical method.

For the overall scores of Learning Unit 1 (combined scores from Lesson 1 and 2) and for Lesson 2, the assumption of sphericity was met, as indicated by non-significant Mauchly's test results. However, for Lesson 1, the assumption of sphericity was violated. Therefore, the Greenhouse-Geisser correction was applied ($\varepsilon = 0.636$) to adjust the degrees of freedom, ensuring the validity of the *p*-values.

The results revealed statistically significant differences in mean knowledge scores across time points for all three comparisons (Learning Unit 1), with *p*-values < 0.001 in each case. These findings indicate that at least one pair of time points showed a significant difference in knowledge scores at the 0.05 significance level.

Ethical Consideration

This study received ethical approval from the Human Research Ethics Committee of Khon Kaen University, Thailand with reference number HE641594 on 4th February, 2022.

RESULTS

General characteristics information showed that all of the samples that participated in the study were female. Majority of them were aged between 21-25 years old (50.0%). The mean age of the samples was 27.5 years (SD = 4.1). The total number of 8 samples had less than 3 years of working experience in PICU (One sample was 34 years old and had transferred from another unit, which was from a general ward). The total of 6 samples had

working experience at PICU of more than 3 years, with an average working experience of 4.2 years (SD=3.7). All of them obtained the highest level of education as Bachelor of Nursing Science and have not received any specific medical training, as shown in Table 1.

Table 1: General Characteristics Information

General Characteristics Information	Number	(Percentage)
Female	14	(100.0)
Age		
21 – 25 Year	7	(50.0)
26 – 30 Year	4	(28.6)
31 – 35 Year	3	(21.4)
Mean (Standard Deviation)	27.5	(4.1)
(Max= 35, Min=22)		
Working Experience in PICU		
Less than 3 years	8	(57.1)
More than 3 years	6	(42.9)
Mean (Standard deviation)	4.2	(3.7)
(Max= 13 Years, Min=6 Months)		
Highest Level of Education		
Bachelor's Degree of Nursing	14	(100.0)
Specialized Training	0	(0)

The comparison of mean knowledge scores toward online learning packages using simulation of nursing paediatric critically care is shown as follows:

The mean knowledge score for online learning packages 1 at the pretest (T0), immediately after receiving learning packages (T1), and the 2-week follow-up period (T2) was equal to 12.1, 19.5, and 16.1 respectively. The result of comparing the means of knowledge scores for each period by pairs found that the mean knowledge scores of (T0) were different from (T1) and (T2). And the knowledge score of (T1) and (T2) was different. The mean difference was 3.4 points.

Lesson 1: The mean knowledge scores of (T0), (T1) and (T2) were 6.3, 9.7, and 8.4 respectively. The result of comparing the means of knowledge scores for each period by pairs found that the mean knowledge scores of (T0) were different from (T1) and (T2). And the knowledge score of (T1) and (T2) was different. The mean difference was 1.3 points.

Lesson 2: The mean knowledge scores for (T0), (T1) and (T2) were 5.9, 9.8, and 7.6 respectively. The result of comparing the means of knowledge scores for each period by pairs found that the mean knowledge scores of (T0) were different from (T1) and (T2). And the mean knowledge score of (T1) and (T2) was different. The mean difference was 2.1 as shown in Table 2 and figure 1.

Table 2: Comparison of Nursing Knowledge Score on Online Learning Package 1 (n=14)

Estimated Time	Max	Min	Mean	(SD)	Time (*p*-value)	Paired Comparison[1]			
						Pair Testing	MD	(95% CI)	*p*-value
Online Learning Package 1 Paediatric critical care for an infants and children with respiratory disease									
Pretest (T0)	16	9	12.1	(1.8)	< 0.001	T0 T1	7.4	5.9 to 8.8)	<0.001
Post-test 1 (T1)	20	18	19.5	(0.7)		T0 T2	3.9	(1.7 to 6.2)	0.001
Post-test 2 (T2)	19 ±	12	16.1	(2.1)		T1 T2	3.4	(1.7 to 5.1)	<0.001
Paediatric Critical Care for infants and children with hypoxia									
Pretest (T0)	8	5	6.3	(1.1)	<0.001[2]	T0 T1	3.4	(2.8 to 4.1)	<0.001
Post-test 1 (T1)	10	9	9.7	(0.5)		T0 T2	2.1	(0.9 to 3.4)	0.001
Post-test 2 (T2)	10	6	8.4	(1.0)		T1 T2	1.3	(0.4 to 2.2)	0.005
Paediatric Critical Care for infants and children with acute respiratory failure									
Pretest (T0)	8	3	5.9	(1.4)	< 0.001	T0 T1	3.9	(2.8 to 5.1)	< 0.001
Post-test 1 (T1)	10	8	9.8	(0.4)		T0 T2	1.8	(0.3 to 3.3)	0.018
Post-test 2 (T2)	9	5	7.6	(1.5)		T1 T2	2.1	(0.9 to 3.4)	<0.001

[1]Bonferroni, [2]Greenhouse-Geisser Correction
Greenhouse-Geisser Correction, MD: (mean difference), 95% CI: 95% confidence interval of mean difference

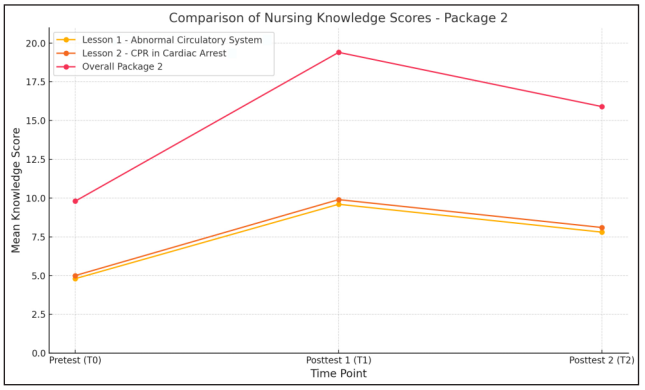


Figure 1: Comparison of Nursing Knowledge Score on Online Learning Package 1

For the comparison in mean knowledge scores of the Online Learning Package 2, the mean knowledge scores of (T0), (T1) and (T2) were 9.8, 19.4, and 15.9 respectively. The result of comparing the means of knowledge scores for each time period by pairs found that the mean knowledge scores of (T0) were different from (T1) and (T2). And the knowledge score of (T1) and (T2) was different. The mean difference was 3.4.

Lesson 1: The mean knowledge scores of (T0), (T1) and (T2) were 4.8, 9.6, and 7.8 respectively. The result of comparing the means of knowledge scores for each time period by pairs found that the mean knowledge scores of (T0) were different from (T1) and (T2). And the knowledge score of (T1) and (T2) was different. The mean difference was 1.3 points.

Lesson 2: The mean knowledge scores of (T0), (T1) and (T2) were 5.0, 9.9, and 8.1 respectively. The result of comparing the means of knowledge scores for each time period by pairs found that the mean knowledge scores of (T0) were different from (T1) and (T2). And the knowledge score of (T1) and (T2) was different. The mean difference was 2.1 as shown in Table 3 and Figure 2.

Table 3: Comparison of Nursing Knowledge Score on Online Learning Package 2 (n=14)

Estimated time	Max	Min	Mean	(SD)	Time (*p*-value)	Paired Comparison[1]			
						Pair Testing	MD	(95% CI)	*p*-value
Online Learning Package 2 - Nursing paediatric critical care for infants and children with cardiovascular disease									
Pretest (T0)	15	5	9.8	(2.7)	< 0.001	T0 T1	7.4	(5.9 to 8.8)	< 0.001
Post-test 1 (T1)	20	18	19.4	(0.8)		T0 T2	3.9	(1.7 to 6.2)	0.001
Post-test 2 (T2)	19	12	15.9	(2.0)		T1 T2	3.4	(1.7 to 5.1)	< 0.001
Paediatric Critical Care for infants and children with abnormal circulatory system									
Pretest (T0)	7	3	4.8	(1.3)	<0.001	T0 T1	3.4	(2.8 to 4.1)	< 0.001
Post-test 1 (T1)	10	8	9.6	(0.6)		T0 T2	2.1	(0.9 to 3.4)	0.001
Post-test 2 (T2)	9	6	7.8	(0.9)		T1 T2	1.3	(0.4 to 2.2)	0.005
Paediatric Critical Care for infants and children with cardiopulmonary resuscitation in cardiac arrest									
Pretest (T0)	8	1	5.0	(1.9)	< 0.001	T0 T1	3.9	(2.8 to 5.1)	< 0.001
Post-test 1 (T1)	10	9	9.9	(0.4)		T0 T2	1.8	(0.3 to 3.3)	0.018
Post-test 2 (T2)	10	6	8.1	(1.3)		T1 T2	2.1	(0.9 to 3.4)	<0.001

[1]*Bonferroni, Greenhouse-Geisser Correction, MD: (mean difference), 95% CI: 95% confidence interval of mean difference*

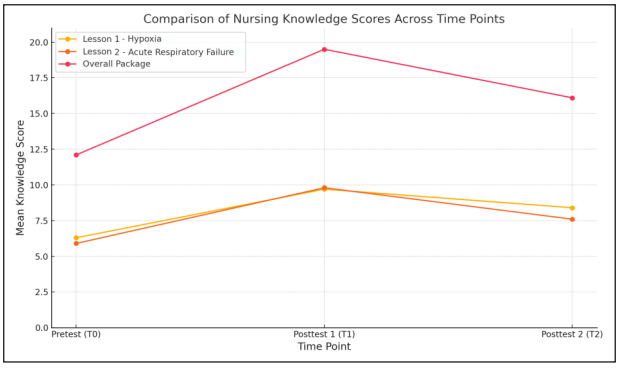


Figure 2: Comparison of Nursing Knowledge Score on Online Learning Package 2

DISCUSSION

The development and implementation of online learning packages using simulation based on Bloom's digital taxonomy significantly enhanced participants' knowledge and skills in paediatric critical care nursing. The integration of cognitive, affective, and psychomotor domains promoted holistic learning outcomes, while high-fidelity simulations provided realistic practice environments without compromising patient safety. High-fidelity simulations, in particular, offer learners a realistic, immersive environment to practice complex clinical scenarios without endangering patient safety (Cant & Cooper, 2017). This method not only improves clinical competencies but also enhances learner confidence, engagement, and satisfaction (Padilha *et al.*, 2019). This instructional approach not only strengthened clinical competencies but also boosted learner confidence and satisfaction. Ultimately, these online learning interventions contribute to the ongoing development of nursing professionals and the delivery of safe, high-quality paediatric critical care.

This study contributes to the global advancement of paediatric critical care nursing by demonstrating that simulation-based online learning is an effective and scalable strategy for developing clinical competencies among novice nurses. Particularly in regions with limited access to specialised in-person training, virtual simulation provides a practical and accessible alternative to traditional pedagogies (Foronda *et al*., 2020). The integration of high-fidelity virtual simulation into continuing nursing education has the potential to standardise and elevate training quality in both resource-constrained and high-demand healthcare environments, thereby supporting safer and more effective paediatric care (Cant & Cooper, 2017; Padilha *et al*., 2019). Future research should explore the adaptability of this approach across diverse healthcare systems, including its impact on skill retention, patient outcomes, and cost-effectiveness, to inform international nursing education standards.

After accessing the learning materials via the Google Classroom platform, participants reported improved nursing knowledge, practical skills, team communication, and confidence in applying these skills in real-life clinical settings. These findings are consistent with the study by Khonboon and Deeaom (2021), who applied Bloom's taxonomy to enhance the learning outcomes of nursing students in maternal-infant and midwifery nursing. Their results also highlighted a strong emphasis on the affective domain, followed by the cognitive and psychomotor domains, contributing to improved academic performance. This study employed high-fidelity simulation videos as supplementary learning tools. These simulations bridged theory with practice by creating realistic clinical scenarios using computer-controlled manikins. The manikins simulated human functions such as blinking, thoracic movement, heart and breath sounds, pulses, and vital signs, which stimulated learner engagement and enhanced practical readiness. This aligns with the findings of Jamjang *et al*. (2021), who demonstrated that virtual simulation significantly improved learners' problem-solving abilities and confidence in clinical practice.

Furthermore, previous research by Tutticci (2016) found that learners expressed high satisfaction with online simulation-based learning, considering it an effective and engaging method for nursing education. Nursing is a profession that demands continuous learning and upskilling to maintain quality healthcare delivery. Lifelong learning, particularly in the context of emerging technologies and new knowledge, is essential for professional growth and competency (Huggins, 2004).

To advance the understanding and effectiveness of simulation-based learning, particularly virtual simulation in nursing education, future research should strategically address several critical areas. First, studies should aim to evaluate higher levels of clinical competence by focusing on the "does" level of Miller's pyramid. Specifically, there is a need to examine whether clinical reasoning skills developed through virtual simulations translate into improved performance in actual clinical practice (Sim *et al*., 2022). Additionally, consistent with the findings of Wittig *et al*. (2025), future investigations should explore the conditions before and after training that facilitate the transfer of teamwork competencies to the clinical setting. Furthermore, it is essential to assess the cost-effectiveness of these preparatory and follow-up conditions and determine their impact on the overall economic value of simulation-based training, particularly for Nontechnical Skills (NTS) and interprofessional teamwork. Furthermore, the integration of cutting-edge technologies such as artificial intelligence offers promising avenues to personalise learning experiences and optimise educational outcomes, thereby transforming nursing education (Martinez-Ortigosa, 2023). These advancements could contribute significantly to establishing global standards and best practices in nursing education, ultimately enhancing healthcare quality and patient safety worldwide.

Limitation

This study provides a foundational basis for the development of comprehensive online modules that integrate theoretical knowledge with practical skills in paediatric critical care nursing. While the use of a within-subject (pre–post) design enhances internal validity by allowing for direct comparison of participants' performance over time, certain methodological and contextual limitations must be acknowledged. These include the small sample size, potential sources of bias, and limited generalisability of the findings, which may restrict the broader applicability of the results. Future research with larger and more diverse samples is recommended to validate and extend these preliminary findings.

CONCLUSION

The online learning packages incorporating simulation for paediatric critical care nursing were meticulously designed using Bloom's digital taxonomy, addressing the cognitive, affective, and psychomotor domains. The cognitive domain delivered in-depth theoretical knowledge necessary for managing critically ill infants and children, reinforcing essential nursing competencies. The affective domain targeted the development of appropriate attitudes and emotional responsiveness, fostering a compassionate and holistic approach to patient care. Meanwhile, the psychomotor domain emphasised the acquisition and demonstration of practical skills, ensuring that learners could perform critical procedures accurately and deliver high-quality, safe care in real-time clinical scenarios. However future research should also evaluate learning outcomes to determine the effectiveness.

Conflict of Interest

The authors declare that they have no competing interests.

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REFERENCES

Cant, R. P., & Cooper, S. J. (2017). The value of simulation-based learning in pre-licensure nurse education: A state-of-the-art review and meta-analysis. *Nurse Education in Practice, 27*, 45-62. https://doi.org/10.1016/j.nepr.2017.08.001

Dwivedi, Y. K., Hughes, D. L., Coombs, C., Constantiou, I., Duan, Y., Edwards, J. S., ... & Upadhyay, N. (2020). Impact of COVID-19 pandemic on information management research and practice: Transforming education, work and life. *International Journal of Information Management, 55*. https://doi.org/10.1016/j.ijinfomgt. 2020.102211

Faul, F., Erdfelder, E., Lang, A. G., & Buchner, A. (2007). G* Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods, 39*(2), 175-191. https://doi.org/10.3758/BF03193146

Foronda, C. L., Fernandez-Burgos, M., Nadeau, C., Kelley, C. N., & Henry, M. N. (2020). Virtual simulation in nursing education: A systematic review spanning 1996 to 2018. *Simulation in Healthcare, 15*(1), 46-54. https://doi.org/10.1097/SIH.0000000000000411

Huggins, K. (2004). Lifelong learning—the key to competence in the intensive care unit. *Intensive and Critical Care Nursing, 20*(1), 38-44. https://doi.org/10.1016/j.iccn.2003.10.001

Jamjang, S., Atthamatakul, W., Nilliaum, R., & Wongyara, N. (2021). The effects of simulation-based learning on problem-solving ability and self-confidence in nursing care for patients with health problems among nursing students (In Thai). *Journal of Prachomklao College of Nursing, Phetchaburi Province, 4*(3), 178–194. Retrieved from: https://he01.tci-thaijo.org/index.php/pck/article/view/249420. Accessed on 14th June, 2023.

Kao, P. F., Wang, Y. H., & Liao, H. C. (2016). Construction and validation of an analytic critical thinking scoring rubric for healthcare students and providers. *Journal of Medical Education, 20*(4), 308-320. https://doi.org/10.6145/jme201631

Khonboon, R., & Deeaom, A. (2021). The guidelines on development of learning achievement of nursing students in maternal-newborn and midwifery nursing practice I, Buriram Rajabhat University. *Research and Development Health System Journal, 14*(3), 207–208. Retrieved from: https://he02.tci-thaijo.org/index.php/RDHSJ/article/view/254125. Accessed on 8th August, 2023.

Khumsuk, W., Nillapun, M. (2021). Simulation-Based Learning (In Thai). *Journal of Council of Community Public Health, 3*(1), 1-11. Retrieved from: https://search.tci-thailand.org/article.html?b3BlbkFydGljbGUmaWQ9NjUzMDU3. Accessed on 8th August, 2023.

Lateef, F. (2010). Simulation-based learning: Just like the real thing. *Journal of Emergencies, Trauma, and Shock, 3*(4), 348-352. https://doi.org/10.4103/0974-2700.70743

Maraphen, R., & Boonkoum, W. (2020). *Development of Learning Instructional Model by Using Standardized Patient in Simulation Base in Community Health Nursing* (Doctoral dissertation, Silpakorn University). Retrieved from: http://ithesis-ir.su.ac.th/dspace/handle/123456789/2751 Accessed on 8th August, 2023.

Marinoni, G., Van't Land, H., & Jensen, T. (2020). The impact of Covid-19 on higher education around the world. *IAU Global Survey Report, 23*(1), 1-17. Retrieved from: http://viduketha.nsf.gov.lk:8585/COVID19_Articles/GRA/The%20impact%20of%20Covid-19%20on%20higher%20569%20iau_covid19_and_he_survey_report_final_may_2020.pdf. Accessed on 18th August, 2023.

Martinez-Ortigosa, A., Martinez-Granados, A., Gil-Hernández, E., Rodriguez-Arrastia, M., Ropero-Padilla, C., & Roman, P. (2023). Applications of artificial intelligence in nursing care: A systematic review. *Journal of Nursing Management, 2023*(1). https://doi.org/10.1155/2023/3219127

Meghani, S. T., & Lalani, N. S. (2014). The journey of educational training from competency to proficiency of Pediatric Intensive Care Unit Nurses (PICU). *Pediatrics & Therapeutics, 4*(209), 2161-0665. https://doi.org/10.4172/2161-0665.1000209

Mishra, L., Gupta, T., & Shree, A. (2020). Online teaching-learning in higher education during lockdown period of COVID-19 pandemic. *International Journal of Educational Research Open, 1*. https://doi.org/10.1016/j.ijedro.2020.100012

Padilha, J. M., Machado, P. P., Ribeiro, A., Ramos, J., & Costa, P. (2019). Clinical virtual simulation in nursing education: Randomized controlled trial. *Journal of Medical Internet Research, 21*(3). https://doi.org/10.2196/11529

Price, S., & Reichert, C. (2017). The importance of continuing professional development to career satisfaction and patient care: meeting the needs of novices to mid-to late-career nurses throughout their career span. *Administrative Sciences, 7*(2). https://doi.org/10.3390/admsci7020017

Schaufeli, W. B., & Salanova, M. A. R. I. S. A. (2013). Burnout, boredom and engagement in the workplace. *An Introduction to Contemporary Work Psychology*, 291-320. https://doi.org/10.1002/9781394259564.ch12

Sim, J. J. M., Rusli, K. D. B., Seah, B., Levett-Jones, T., Lau, Y., & Liaw, S. Y. (2022). Virtual simulation to enhance clinical reasoning in nursing: A systematic review and meta-analysis. *Clinical Simulation in Nursing, 69*, 26–39. https://doi.org/10.1016/j.ecns.2022.05.006

Tutticci, N., Coyer, F., Lewis, P. A., & Ryan, M. (2016). High-fidelity simulation: Descriptive analysis of student learning styles. *Clinical Simulation in Nursing, 12*(11), 511-521. Retrieved from: https://www.nursingsimulation.org/article/S1876-1399(16)30053-6/abstract. Accessed on 6th August, 2024.

Wittig, J., Krogh, K., Blanchard, E. E., Xing, K., Kushner, J., Bichmann, A., Flin, R., Brazil, V., Goldhaber-Fiebert, S. N., Paige, J., & Lauridsen, K. G. (2025). A systematic review on conditions before and after training of teamwork competencies and the effect on transfer of skills to the clinical workplace. Simulation in Healthcare: *The Journal of the Society for Simulation in Healthcare, 20*(2), 111–117. https://doi.org/10.1097/SIH.0000000000000809