การพัฒนาสื่อเทคโนโลยีความเป็นจริงเสริม เรื่อง การให้ยาในเด็กสำหรับนักศึกษาพยาบาล
Development of Augmented Reality Technology Media on Pediatric Medication Administration for Nursing Students

นิพนธ์ต้นฉบับ

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Original Article

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บทคัดย่อ

วัตถุประสงค์: เพื่อพัฒนาและทดสอบประสิทธิผลของการให้ความรู้เรื่องการให้ยาในเด็กผ่านสื่อเทคโนโลยีฯ และทดสอบความพึงพอใจต่อการใช้สื่อเทคโนโลยีฯ **วิธีการศึกษา:** การวิจัยและพัฒนามีตัวอย่างเป็นนักศึกษาพยาบาลชั้นปีที่ 3 จำนวน 70 คนที่เลือกแบบเจาะจง ในภาคการศึกษา 3/2565 มหาวิทยาลัยราชภัฏสุราษฎร์ธานี ที่สอนแบบปกติร่วมกับสื่อเทคโนโลยีฯ เครื่องมือวิจัย คือ 1) สื่อการเรียนรู้ด้วยเทคโนโลยีความเป็นจริงเสริมทักษะการให้ยาในเด็ก 3 ทักษะ (การให้ยากิน การให้ยาพ่น และการให้ยาฉีดขนาดต่ำ) 2) แบบประเมินความรู้และทักษะการให้ยา และ 3) แบบประเมินความพึงพอใจหลังการใช้สื่อเทคโนโลยีฯ เปรียบเทียบคะแนนทักษะแต่ละทักษะก่อนและหลังการเรียนรู้ด้วย paired t test **ผลการศึกษา:** หลังการเรียนรู้เรื่องการให้ยาในเด็กผ่านสื่อเทคโนโลยีความเป็นจริงเสริม พบว่าคะแนนเฉลี่ยทักษะการให้ยาเพิ่มขึ้นทั้ง 3 ทักษะอย่างมีนัยสำคัญทางสถิติทั้งหมด (P-value < 0.001) โดยทักษะการให้ยากินมีคะแนนเพิ่มขึ้นมากที่สุด (ร้อยละ 4.77) ทักษะที่คะแนนเพิ่มขึ้นน้อยที่สุด คือ ทักษะการให้ยาฉีดขนาดต่ำ (ร้อยละ 2.23) หลังการเรียนรู้ พบความพึงพอใจต่อการใช้สื่อเทคโนโลยีฯโดยรวมอยู่ในระดับดี (ค่าเฉลี่ย 4.41 คะแนนเต็ม 5 คะแนน) **สรุป:** เทคโนโลยีสื่อความจริงเสริมเพื่อการเรียนรู้รู้เรื่องการให้ยาในเด็กทำให้คะแนนทักษะการให้ยาเพิ่มขึ้น อาจนำไปใช้และวิจัยพัฒนาเพิ่มได้

Keywords: สื่อเทคโนโลยีความเป็นจริงเสริม; การให้ยาในเด็ก; นักศึกษา; การพยาบาล

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Abstract

Objectives: To develop and test the augmented reality technology media for self-directed learning and determine satisfaction with the media. **Method:** This research and development study was conducted with 70 participants who were third-year nursing students in the 3/2022 academic semester at Surat Thani Rajabhat University, selected by purposive sampling. Traditional teaching methods were combined with augmented reality technology media which included skills of administrations of oral medications, nebulization medications, and small-dose intravenous medications. Skills were assessed using the assessment form for medication administration. Satisfaction was assessed after learning. Scores of each of 3 skills were compared using paired t test. **Results:** After learning, scores of each of 3 skills increased significantly from before learning (P-value < 0.001 for all). The highest increase was oral medication administration skill (4.77% improvement), while the smallest gain was for small dose intravenous administration (2.23%). After learning, overall satisfaction with the developed media was high (mean = 4.41 out of 5 points). **Conclusion:** The augmented reality technology media improved scores of pediatric drug administration skills. The media could be used and further tested.

Keywords: augmented reality; technology media; pediatric medication administration; students, nursing

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Introduction

Nursing education curricula encompass both theoretical and practical components, with the practical component focusing on the application of theoretical knowledge in nursing practice. Clinical teaching is a fundamental element of nursing education, as it plays a pivotal role in developing nursing students' practical skills prior to their engagement in actual clinical practice on hospital wards [1]To ensure that patients receive safe and rights-based nursing care, medication administration is a critical nursing procedure,[2,3,4]with various medications necessitating distinct administration techniques. Pediatric medication administration, in particular, demands meticulous attention to detail, especially in dose calculations, and requires specialized techniques distinct from those used in adult medication administration. Medication errors in pediatric patients can have life-threatening consequences.[5]

Pediatric medication administration constitutes a fundamental responsibility of pediatric nurses to ensure that children receive medications in alignment with physicians' treatment plans in a safe and precise manner. This role is critical for pediatric nurses[5-6]at Suratthani Rajabhat University, second-year nursing students acquire essential clinical competencies in medication administration, gaining

experience with adult patients during their basic nursing practicum (NURNS0 2). Subsequently, third-year nursing students engage in the pediatric and adolescent nursing practicum (NURNS2 4), where they practice with pediatric patients. Pediatric wards differ significantly from adult wards in terms of patients' age and disease profiles, necessitating distinct approaches to medication administration. Therefore, mastering pediatric medication administration is an essential clinical competence that all students must perform correctly and safely.

The current instructional approach employs clinical teaching, allowing students to gain hands-on experience in preparing and administering pediatric medications during at least one morning shift. Students are responsible for preparing and storing medication equipment, preparing medications, and providing care to patients before, during, and after medication administration. Prior to clinical practice, a one-hour session is dedicated to teaching pediatric medication preparation and administration. This session primarily employs lecture and demonstration methods in classrooms and practice labs. Typically, each instructor, responsible for students, demonstrates the procedure. Students then perform a return demonstration, followed by individualized feedback and additional guidance from the instructor.

However, challenges such as large class sizes, students' lack of prior pediatric care experience, varying learning abilities, and time constraints hinder adequate review and practice within the allotted class time. Consequently, teaching in short periods to large groups may be insufficient given the diverse learning potentials and the required learning times of students. According to clinical teaching experience and student reflections, students often experience stress and anxiety regarding pediatric medication administration, leading to a lack of confidence in patient care. Thus, it is necessary to adjust teaching strategies beyond clinical preparation alone to reduce anxiety and enhance student competence. This includes supporting self-directed learning and increasing learning resources to improve knowledge and safety in medication administration.

Augmented reality (AR) technology integrates the real world with the virtual world through mobile devices such as smartphones, computers, or tablets[7] AR multimedia can enhance students' interests and improve learning comprehension by presenting lesson content in a manner closely resembling actual classroom instruction.[8] It fosters self-directed learning, enabling students to learn and review independently, thereby increasing confidence and ensuring correct nursing practices. [9]

Khan et al. (2019),[10] Kairu (2021),[11] and Sari and Rahmani (2024)[12] collectively address critical issues in educational theory and practice, emphasizing the importance of motivation, cognitive processes, and reinforcement strategies in enhancing learning outcomes. Khan et al.[10] explored the impact of augmented reality (AR) on the learning motivation of undergraduate health science students, employing intrinsic motivation theory and the ARCS model (Attention, Relevance, Confidence, Satisfaction) as a framework. Their findings indicated a significant increase in student motivation, particularly in attention, satisfaction, and confidence, while noting a statistically insignificant decline in relevance. Kairu's investigation into AR further underscored its potential to strengthen various cognitive skills, including problem-solving, critical thinking, and information retention, ultimately demonstrating that AR integration can enhance cognitive thinking and improve overall learning outcomes. Meanwhile, Sari and Rahmani's [12] research, grounded in Skinner's behaviorist theory, revealed how positive reinforcement strategies can boost students' confidence, encourage active participation, and facilitate language acquisition in English learning. They concluded that effectively implementing these reinforcement techniques can lead to significantly more favorable educational outcomes. Together, these studies highlight the interplay between motivation, cognitive development, and reinforcement in fostering effective learning environments.

Recognizing the significance of AR technology, the research team aimed to develop AR technology media focusing on pediatric medication administration for nursing students. This initiative sought to provide an additional learning channel to supplement clinical teaching, allowing students to interact with the material, review it as needed, and learn at their own pace. Such an approach would facilitate comfortable studying tailored to individual abilities, enabling students to monitor their learning progress, and fostering continuous self-development. Consequently, this would increase confidence in pediatric nursing practices within pediatric wards. The anticipated outcomes of this study included enhanced pediatric nursing practice teaching, increased use of AR technological media in education, support

for student self-directed learning, and informed development of teaching methods for pediatric nursing skills in the future.

This study aimed to the effectiveness of AR technology media in teaching pediatric medication administration to nursing students and determine nursing students' satisfaction with AR technology media. It was hypothesized that skill scores of administrations of 1) oral medications, 2) nebulization medications, and 3) small-dose intravenous medication after the learning would be higher than those before the learning.

Conceptually, this research integrated foundational concepts from three learning theories: Cognitive Learning Theory,[13] Keller's Motivation Theory[14] utilizing the ARCS Motivation Model (Attention, Relevance, Confidence, Satisfaction), and Skinner's Operant Conditioning Theory.[15] According to Cognitive Learning Theory[13], learning is an internal process that occurs within each learner based on their abilities. This concept guided the design of the AR media, aiming to stimulate the learner's five senses through reading, listening, and interaction with the lesson content. Learners process information and connect it with prior knowledge, storing it in memory. Frequent review of lessons as needed facilitates long-term retention, enhancing knowledge retention.

Keller's Motivation Theory[14] posits that learners become engaged when they find the lessons interesting (Attention) and relevant to them (Relevance). This engagement leads to a belief in the lesson's accuracy, fostering confidence (Confidence) and satisfaction in learning (Satisfaction).

Additionally, Skinner's Operant Conditioning Theory [15] emphasizes the importance of positive reinforcement in learning. This principle was integrated into the AR technology media, which included end-of-lesson tests, allowing learners to immediately assess their learning outcomes and receive positive reinforcement.

Thus, the researchers developed the AR technology media to enhance learners' engagement and satisfaction. By enabling repeated review of the AR lessons, learners could build confidence before practicing nursing in pediatric wards, ultimately improving their pediatric medication administration skills.

Methods

In this research and development study, we developed the augmented reality technology media on pediatric medication administration for nursing students and tested its effectiveness. The study population consisted of 104 third-year nursing students at Suratthani Rajabhat University. The study sample comprised 70 third-year nursing students enrolled in the Pediatric and Adolescent Nursing Practicum (NURNS24) course during the academic semester 3/2022. These students were used to test the effectiveness of the AR technology media for pediatric medication administration and assess satisfaction with the AR technology media in the development phase.

Participants were chosen for purposive sampling based on the following inclusion criteria: enrolled as third-year nursing students at Suratthani Rajabhat University during semester 3/2022; registered for the Pediatric and Adolescent Nursing Practicum (NURNS24) course; proficient in speaking, reading, writing, and communicating in Thai; owning a smartphone or tablet compatible with Android or iOS; and willing to participate in the research project. The exclusion criteria, those who are not registered for the Pediatric and Adolescent Nursing Practicum (NURNS24) course and who are unwilling to participate in this project. The remaining 34 individuals were used for testing the reliability of a research instrument.

Research procedure

Phase 1: Development of AR technology media to promote learning about pediatric medication administration

1. Review of relevant literature and research. The AR learning media was developed based on Cognitive Learning Theory, Keller's ARCS Model of Motivation (Attention, Relevance, Confidence, Satisfaction), and Skinner's Operant Conditioning Theory. The content included Topic 1-Principles of pediatric medication administration, Topic 2-Equipment preparation and medication preparation steps, Topic 3-Calculation and routes of pediatric medication administration, and Topic 4-Providing medication instructions to parents/guardians

2. Development of AR technology for medication administration for nursing students using the application "Spatial." This involved creating AR technology media through the website https://www.spatial.io/, which could display content via the application on both iOS and Android mobile devices. The necessary equipment and tools for creating this media included: printed materials to be converted into AR, such as photographs and 3D drawings in digital file formats; files to be incorporated into the printed media, such as image

files, 3D drawing files, and video files; a smartphone; and a computer.

3. Creation of draft questionnaires. Draft questionnaires were created to assess three skills: oral medication administration (Kappa coefficient = 0.75), nebulizer medication administration (Kappa coefficient = 0.75), and small-dose intravenous medication administration (Kappa coefficient = 0.65).

Phase 2: To evaluate the effectiveness of AR technology media on pediatric medication administration for nursing students, focusing on both pediatric medication administration skills and satisfaction.

1. The researchers administered a pre-test to evaluate pediatric medication administration skills before utilizing the AR technology media, in preparation for the Pediatric and Adolescent Nursing Practicum.

2. The AR technology media was implemented for student use, requiring iOS or Android smartphones. This media included instructions and end-of-lesson comprehension tests for immediate self-assessment.

3. The researcher conducted a post-test to assess pediatric medication administration skills upon completion of the Pediatric and Adolescent Nursing Practicum.

4. The researcher administered the second questionnaire, designed to evaluate participants' satisfaction with the use of AR technology media on pediatric medication administration. To ensure clarity and comprehension, the researcher carefully explained the online questionnaire process, addressing any participant inquiries until they demonstrated a clear understanding of the instructions. Once assured of their readiness, the researcher provided participants with a QR code, guiding them to use their smartphones to scan the code and access the questionnaire via Google Forms.

Data collection instruments

Data were collected over a four-month period, specifically from March to June 2023. This involved two distinct time points: a pre-test administered in March prior to the implementation of the intervention, and a post-test conducted in June following the intervention. Instructors collected all data. The participant completed the online questionnaire to prevent response bias.

Research instruments

Three types of research instruments were deployed: A personal information record for students comprised three items, including details such as gender, age, and average academic performance.

2) An assessment of skills in medication administration comprised evaluations of three distinct competencies: oral medication administration (13 items, total score range: 0-26), nebulization medication administration (15 items, total score range: 0-30), and small-dose intravenous medication administration (24 items, total score range: 0-48). Each competency was evaluated using a 3-point rating scale, where a score of 2 indicated correct performance, 1 denoted partial correctness, and 0 represented incorrect or unperformed actions. Both raw scores and standardized scores (on a 0-100 scale) were presented to elucidate the overall assessment criteria and percentage scores.

3) A satisfaction assessment regarding the use of AR technology media for pediatric medication administration consisted of 10 items evaluated using a 5-point Likert scale, whereby a score of 1 represented the lowest level of satisfaction, while a score of 5 denoted the highest level of satisfaction. An average score ranging from 4.51 to 5.00 indicates a very high level of satisfaction with the use of AR media. An average score from 3.51 to 4.50 signifies a high level of satisfaction. An average score between 2.51 and 3.50 reflects a moderate level of satisfaction. An average score ranging from 2.01 to 2.50 indicates a low level of satisfaction. Finally, an average score from 1.00 to 2.00 represents the lowest level of satisfaction with the use of AR media.

Instrument quality assurance

Content validity was used to determine the questionnaire's validity. The AR media and questionnaires were reviewed by three experts, including a pediatric and adolescent nursing specialist, an AR digital technology specialist, and a research instrument development specialist. The Index of Item-Objective Congruence (IOC) was calculated, with all items in the three questionnaires achieving IOC values between 0.50 and 1.00.

The three questionnaires were tested for inter-rater reliability with a sample of 34 participants similar to the target group. The result yielded Cohen's Kappa coefficients as follows: oral medication administration (0.83), nebulization medication administration (0.72), and small-dose intravenous medication administration (0.70).

Protection of Participants' Rights

This research was approved by the Human Research Ethics Committee of Suratthani Rajabhat University (Ethical SRU-EC 2023/045). Informed consent was obtained from each participant. Participation in the study was anonymous and voluntary.

Data Analysis

The researchers analyzed the collected data using the SPSS statistical software. An analysis of personal data and satisfaction with the use of AR technology media for pediatric medication administration was conducted using descriptive statistics, including frequency, percentage, mean, and standard deviation. The effectiveness of AR technology media for pediatric medication administration was analyzed by comparing the mean scores of a single dependent group using the paired t test with statistical significance set at the 0.05 level.

Results

The results are presented in two phases. In phase 1, the developed AR technology media covered four key topics of 1) principles of pediatric medication administration, 2) equipment preparation and medication preparation steps, 3) calculation and routes of pediatric medication administration, and 4) providing medication instructions to parents/ guardians. The augmented reality media could be accessed via the web link https://www.shorturl.asia/Gng8U or by scanning the code with

the Spatial AR application (as illustrated in Figure 1).

Figure 1 QR code for AR technology media on pediatric medication administration.

Effectiveness of the AR technology media on pediatric medication administration for nursing students is as follows. The majority of participants were women (98.57%). Most had a cumulative Grade Point Average (GPA) of 3.01 to 3.50 (70.00%) (Table 1).

Table 1 Demographic characteristics (N = 70).

Demographic characteristics	N	%
Gender		
Women	69	98.57
Men	1	1.43
Cumulative GPA		
2.51 - 3.00	9	12.56
3.01 - 3.50	49	70.00
3.51 - 4.00	12	17.14

After learning from the AR technology media, the most substantial improvement was observed in oral medication administration, with an increase of 4.77% (mean difference of 4.77 out of 100 points), followed by nebulization (an increase of 4.62%), and the administration of small-dose intravenous medication (an increase of 2.23%). All improvements were statistically significant (P-value < 0.001 for all) (Table 2).

Table 2 Comparisons of mean scores for medication administration skills before-after using the media (N = 70).

Variable	Pre-test		Post-test		Mean difference	Paired t-test	P-value
	Mean	S.D.	Mean	S.D.			
Oral medication	72.96	3.08	77.74	3.16	4.77	11.11	< 0.001
Nebulization medication	70.07	3.87	74.69	3.34	4.62	10.23	< 0.001
Administration of small-dose intravenous medication	66.65	0.97	68.88	1.30	2.23	12.74	< 0.001

Table 3 demonstrates that overall satisfaction with the developed media among third- year nursing students at Suratthani Rajabhat University was rated positively (mean = 4.41, S.D. = 0.69). The highest mean satisfaction scores were recorded for two specific items: students' ability to review lessons independently (mean = 4.46, S.D. = 0.61) and the increased confidence in practice following exposure to the media (mean = 4.46, S.D. = 0.70).

Table 3 Satisfaction with augmented reality technology media for pediatric medication administration (N = 70).

Question	Mean	S.D.	Level
1. The media is interesting, modern, and different from regular learning	4.49	0.53	Good
2. The media can be used to prepare for clinical practice	4.35	0.74	Good
3. The content presented is easy to understand	4.40	0.67	Good
4. The duration is appropriate for the content	4.30	0.82	Good
5. The virtual images and content are appropriate	4.43	0.62	Good
6. The virtual images are clear	4.40	0.67	Good
7. The content sequence is appropriate	4.39	0.71	Good
8. The media is suitable for self-review of lessons	4.46	0.61	Good
9. The media is suitable for use in teaching	4.40	0.75	Good
10. After viewing the media, students feel more confident in their practice	4.46	0.70	Good
Total	**4.41**	**0.69**	Good

Discussions and Conclusion

This research utilized a research and development design to develop AR technology media for self-directed learning and to evaluate nursing students' skills in pediatric medication administration through AR technology. The AR technology media on pediatric medication, developed for nursing students in this research, encompasses key aspects of pediatric medication administration. It addresses the fundamental principles of medication administration in children, the preparation of necessary equipment and medications, accurate dosage calculation, and various techniques for pediatric drug delivery. Additionally, it includes guidance for educating parents on administering medications to their children. The content is systematically divided into distinct sections, each comprising comprehensive information paired with practical exercises to reinforce learning.

The investigation into nursing students' pediatric medication administration skills revealed that, following teacher-led instruction combined with AR technology media, there was an increase in mean scores across all three skill areas. Specifically, oral medication administration skills demonstrated the most significant improvement, with an increase of 4.77%. Conversely, the smallest improvement was observed in small-dose intravenous medication administration, with an increase of 2.23%. All skill areas exhibited statistically significant improvements post-instruction, with p-values less than 0.001. This aligns with research on the development of educational media for nursing AR technology in the Philippines and Thailand.[16] The findings indicate that the application of AR technology in instructional settings significantly enhances nursing students' comprehension of medical equipment, such as ventilators and electrocardiogram machines, and improves their proficiency in English communication with foreign patients. These results are consistent with studies on the impact of virtual reality (VR) media on 21st-century learning skills and satisfaction with virtual learning environments.[17]

The use of Skinner's Operant Conditioning Theory [15] in this study is evident in how AR technology provides immediate feedback to nursing students. According to Skinner, learning is enhanced when behaviors are reinforced through consequences, and in this case, AR media acts as positive reinforcement. Nursing students receive real-time feedback while practicing pediatric medication administration, reinforcing correct steps and encouraging the repetition of desirable behaviors [15]. This is particularly evident in the significant improvement of oral medication administration skills, where students likely experienced more opportunities for reinforcement compared to the smaller improvement observed in intravenous medication administration, which may require more nuanced feedback.

Cognitive Learning Theory[13] further explains the effectiveness of AR media by emphasizing the role of mental processes in learning. This theory suggests that learners actively process information, store it, and retrieve it when needed. In this study, AR media broke down the pediatric medication content into systematic sections, combining theoretical knowledge with practical exercises, which enhanced cognitive processing. The interactive nature of AR technology allowed students to apply learned concepts to real-life scenarios, fostering deeper understanding and improving retention. This is consistent with cognitive learning theories that highlight the importance of meaningful organization of content and active engagement in learning.[13] The combination of structured knowledge with interactive exercises helped nursing students develop essential skills, bridging the gap between theoretical knowledge and practical application.

Keller's ARCS Motivation Model [14] emphasizes Attention, Relevance, Confidence, and Satisfaction as key factors in maintaining learners' motivation. The AR media developed in this study successfully captured students' attention through its interactive and immersive nature, making the learning process engaging and motivating. The content was highly relevant to the student's future nursing practice, particularly in pediatric medication administration, ensuring that the media addressed real-world problems they would encounter. As students practiced using AR technology, their confidence in administering pediatric medications grew, reflected in the statistically significant improvements across all skill areas. The student's high satisfaction with the AR media, as indicated by the positive feedback and increased confidence in practice, aligns with the final component of Keller's model, satisfaction.[14] This motivational framework underscores the importance of designing educational tools that not only teach but also engage and motivate learners to excel.

Cognitive Learning Theory[13] in AR education underscores the substantial impact AR has on enhancing student motivation and engagement. According to Keller's ARCS Model [14], which emphasizes the importance of attention,

relevance, confidence, and satisfaction, AR effectively captivates learners through its interactive and immersive experiences. This engagement not only captures learners' attention but also delivers satisfying outcomes, thereby fostering deeper involvement in the educational process. Furthermore, Skinner's Operant Conditioning [15] theory underscores the vital role of reinforcement and immediate feedback in the learning environment. AR systems are capable of providing instantaneous responses to learners' actions, thereby reinforcing positive behaviors and contributing to improved learning outcomes. This immediate feedback loop allows students to comprehend the consequences of their actions, encouraging further engagement with the material. Lastly, Cognitive Learning Theory is effectively employed within AR contexts to stimulate cognitive processes. By immersing learners in interactive and contextualized scenarios, AR promotes critical thinking and facilitates a deeper understanding of complex concepts. This alignment with cognitive principles not only supports active learning but also enhances learners' abilities to construct knowledge in a meaningful way.

The findings showed that the overall satisfaction with the AR media developed for third-year nursing students at Suratthani Rajabhat University was rated as good (Mean = 4.41, SD = 0.69). Specifically, two aspects received the highest average satisfaction scores: the ability of students to independently review lessons (Mean = 4.46, SD = 0.61) and the increased confidence in practice after using the media (Mean = 4.46, SD = 0.70). These results aligned with the study's objectives and the intended purpose of the media, as students highlighted the media's capacity for repeated review and its facilitation of practical application.[18]

In terms of other aspects of satisfaction, the media was highly rated for its utility in preparing for clinical practice and its suitability for instructional purposes. These findings are consistent with those of Chiewsothorn et al. (2021),[19] who investigated the impact of virtual reality media on 21st-century learning skills and satisfaction. Their study found that overall satisfaction with virtual learning media was good (Mean = 4.45, SD = 0.20), with the highest satisfaction scores attributed to easy access to lessons and frequent self-review (Mean = 4.67, SD = 0.53). Additionally, Lamchang et al. (2019)[20] examined the development of multimedia for pediatric medication administration and found that nursing students expressed high satisfaction with the multimedia content. The majority of students rated their satisfaction as high or very high (46.7% and 50.0%, respectively). This suggests that the multimedia content effectively supports self-directed learning beyond classroom instruction, thereby enhancing students' knowledge and their ability to apply it in pediatric nursing practice.

In conclusion, this research aimed to contribute to academic advancement and align with the evolving paradigms of 21st-century nursing education. By integrating augmented reality (AR) technology into the pedagogical approach for pediatric medication administration an area that demanded exceptional precision, meticulous attention, and specialized techniques distinct from those employed in adult care, the study enhanced the learning experience. It fostered greater student engagement and facilitates autonomous, continuous learning. Moreover, this innovative approach strengthens the efficacy of pediatric nursing education, promoting the application of theoretical knowledge in clinical practice and ultimately enhancing the accuracy and safety of pediatric patient care.

This study has certain strengths. The AR technology media on pediatric medication provides students with the opportunity for self-directed learning that extends beyond the traditional classroom environment. This application facilitates the acquisition of knowledge regarding pediatric medication management, enabling students to apply this knowledge effectively in nursing practice when administering medications to children, thus significantly reducing the incidence of medication errors in pediatric patients. Additionally, these AR technology media should be utilized as a review tool for newly graduated nurses to ensure the safe and competent administration of medications to children.

This study has certain limitations. The design of the AR technology media on pediatric medication administration cannot determine how many times a nursing student has used the program or for how long. This is because the data processing results in a cumulative sum for all users of the program. Lastly, the quasi-experimental design makes it has certain probability of bias. Future control study is needed.

It is recommended to further develop and support a range of AR technology media to prepare students effectively for their practical training. Future research should test the effectiveness of AR technology media with third-year nursing students from other nursing colleges or universities to validate the results across different institutions. The efficiency of AR

technology media should be evaluated in a broader context to ensure the generalizability of the findings. Further studies should explore various learning outcomes related to AR technology, such as knowledge acquisition. Research should investigate the integration of AR technology with other teaching methods to develop comprehensive teaching and learning models. Additionally, AR technology media on pediatric medication administration could be beneficial and widely used to deliver training content in other areas for pediatric nurses.

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