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The Effect of Practice Satisfaction and Practice Immersion on the Problem-Solving Ability of Nursing Students Who Experience Case-Based Extended Reality (XR) Content Learning

Jong Lan Lee[1], **Sun Jung Park**[2*]

[1]Department of Nursing, Suwon Women's University, Suwon, Republic of Korea.
[2]Department of Nursing, Sahmyook Health University, Seoul, Republic of Korea; bun8973@naver.com (S.J.P.).

Abstract. This study aims to understand the effect of practice satisfaction and practice commitment on the problem-solving abilities of nursing students who have experienced learning through case-based extended reality (XR) content. Methods: A descriptive study design was used. The participants were 150 nursing students from various universities in Korea. Data were collected using self-reported questionnaires through a survey. The questionnaire was administered after implementing learner-based case-based extended reality (XR) content. Data were analyzed using multiple linear regression. Multiple linear regression analysis was conducted on the data to examine the effect of learner-based learning through XR content on the nursing students' practice immersion and satisfaction and their impact on the problem-solving abilities. The results showed that practice immersion ($t=4.082$, $p<.001$) had a significant positive effect on problem-solving abilities. XR-based learning effectively enhances the immersion of students, thereby improving their problem-solving abilities. Therefore, developing and implementing educational programs based on XR content would be beneficial to students.

Keywords: Content, Problem-solving, Nursing, Student, Effect.

1. INTRODUCTION

1.1. Significance of Research

The wave of the Fourth Industrial Revolution is rapidly spreading to the field of education, leading to the implementation of various ICT-based programs (Nesenbergs et al., 2021). In particular, education using virtual reality (VR) allows learners to gain diverse educational experiences by indirectly engaging in activities within a virtually designed environment that simulates reality. This is especially useful for education and training that would otherwise be dangerous or costly to experience directly, freeing learners from temporal and spatial constraints (Nam et al., 2020). The continued advancement of immersive content technology is expected to bring about transformative changes in the future educational environment(Nesenbergs et al., 2021).

In addition, there is growing interest in the metaverse within the field of education, including technologies such as Augmented Reality (AR), Virtual Reality (VR), and Extended Reality (XR) (Nam et al., 2020). This growing interest has been further heightened by the onset of COVID-19, which restricted face-to-face interactions. To address the limitations of reduced interaction and meet the demand for in-person activities (Nam et al., 2020), there has been an increase in attempts to conduct activities such as experiential learning, career exploration, exhibitions, and presentations within metaverse spaces. Extended Reality (XR) is a technology that bridges the virtual and real worlds using Head-Mounted Display (HMD) devices. It allows learners to interact with virtual objects and other users' avatars within a real-world-based environment. This approach enhances learner interest and immersion while offering personalized experiences (Nam et al., 2020). As a result, XR is considered a promising technology for delivering highly immersive and realistic learning experiences. The virtual environments created through XR facilitate interactions among learners, between instructors and learners, and between learners and content, enhancing engagement and immersion in learning (Schutte et al., 2022), and are expected to be widely applicable in various educational contexts.

Studies examining the impact of virtual reality-based practice education on nursing students' practical skills have found that training with headsets significantly improved their self-efficacy in learning (Kim & Park, 2014). Similarly, using 360-degree videos of hospital environments enhanced nursing students' knowledge, satisfaction with education, and academic performance (Kim et al., 2019). Virtual simulation software (vSim for Nursing, Laerdal Medical & Wolters Kluwer) used in medical-surgical virtual reality simulation training has been shown to improve nursing students' ability to perform nursing processes (Kim & Kim, 2016). Virtual reality simulation training using the pediatric nursing module of the vSim for Nursing software has been shown to enhance nursing students' critical thinking, clinical performance, and satisfaction with practice (Kim & Kim, 2022). Similarly, practice education utilizing scenario-based admission management virtual reality with mobile devices improved students' engagement, confidence, and overall learning satisfaction (Kim, 2021).

Practice education using virtual reality has been found to improve nursing students' knowledge, skills, and attitudes, driven by increased learning satisfaction, confidence, engagement, and achievement (Shorey & Ng, 2020). As such, this study aims to investigate the relationships among practice satisfaction, practice immersion, and problem-solving abilities in nursing students who have undergone case-based extended reality (XR) content education. The findings aim to serve as foundational evidence for the development of educational strategies to enhance problem-solving competencies.

* Correspondence: bun8973@naver.com

1.2. Research Purpose

This study aims to examine the impact of practice satisfaction and practice immersion on the problem-solving abilities of nursing students who have experienced case-based extended reality (XR) content education.

2. RESEARCH METHODOLOGY

2.1. Research Design

This study is a descriptive research investigation designed to examine the practice satisfaction, practice immersion, and problem-solving abilities of nursing students who have experienced case-based extended reality (XR) content education and to identify the relationships among these variables.

2.2. Case-Based XR Content Learning

Case-based XR content learning involves the use of the "HoloPatient" program, developed by VEP4U, which leverages mixed reality (MR) technology to deliver virtual patient simulations for nursing education. This program allows students to safely explore and practice various scenarios that are difficult to encounter in real clinical settings, enhancing their learning experience (Son, Kang, & Gagne, 2023). Students used the preeclampsia nursing module while wearing HoloLens and GUN-Glove devices to engage in the simulation.

2.3. Research Participants

The participants in this study were fourth-year nursing students from a nursing program in S province who had completed maternal nursing practice education. The study focused on students who had engaged in case-based XR content learning related to preeclampsia during their maternal nursing practice. Only students who clearly understood the study's purpose and objectives and voluntarily consented to participate were included. The sample size for this study was calculated using the G-Power 3.1.9 program. For multiple regression analysis, the parameters were set as follows: significance level (α) = .05, medium effect size (d = .15), power = .95, and seven predictor variables (gender, school satisfaction, nursing program satisfaction, clinical practice satisfaction, practice satisfaction, practice immersion, and problem-solving ability). Based on these settings, the minimum required sample size was determined to be 150 participants. Considering a dropout rate of 10%, data were collected from 165 participants.

2.4. Research Instruments

2.4.1. Practice Satisfaction

In this study, practice satisfaction was measured using a modified version of the learning satisfaction tool originally developed by Yoo (2001) for nursing students and later revised by Chang & Park (2017). The tool was adapted by removing items related to satisfaction with instructors and replacing the term 'learning' with 'practice' to better align with the study's focus. The revised tool was validated for content validity by a panel of experts, consisting of three nursing professors and two education professors, who assessed the evaluation items and criteria. The tool consisted of 17 items rated on a 5-point Likert scale, with scores ranging from 1 ('Strongly Disagree') to 5 ('Strongly Agree') for each item. The total score ranged from 17 to 85, with higher scores indicating greater practice satisfaction. In Chang & Park's (2017) study, the reliability of the tool was demonstrated with a Cronbach's α of .86, while Yoo's (2001) study reported a Cronbach's α of .94. In the present study, the tool's reliability was exceptionally high, with a Cronbach's α of .96.

2.4.2. Practice Immersion

In this study, practice immersion was measured using the Flow Short Scale developed by Engeser & Rheinberg (2008), which was translated and adapted for the context of practice immersion specifically for this research. Practice immersion was assessed to measure the expected level of immersion experienced by nursing students during case-based extended reality (XR) content education. The translation of the practice immersion tool in this study followed a two-step process: the original English tool was initially translated into Korean, and then a bilingual expert fluent in both Korean and English conducted a back-translation into English. The content validity of this tool was evaluated by a panel of experts, including two nursing professors, one education professor, and one English professor with over 15 years of experience. The item-level Content Validity Index (CVI) for all items was above .80. Engeser and Rheinberg (2008) originally developed the Flow Short Scale with 13 items using a 7-point Likert scale. However, in this study, the scale was modified to a 5-point Likert scale while retaining the original 13 items. The tool consists of items assessing the learner's immersion experience, categorized into three subdomains: perceived difficulty (3 items), perceived competence in performance (6 items), and behavioral engagement (4 items). Items 1 to 10 are rated on a 5-point Likert scale, with scores ranging from 1 ('Not at all') to 5 ('Very much'). Items 11 to 13 are scored using a 5-point semantic differential scale. The total score ranges from 13 to 65, with higher scores indicating greater practice immersion. In the study by Engeser and Rheinberg (2008), the tool's reliability was reported with a Cronbach's α of .92, while in the present study, the Cronbach's α was .90.

2.4.3. Problem-Solving Ability

The problem-solving ability tool used in this study was adapted from the problem-solving ability measurement tool for college students and adults, developed by Lee et al. (2003) as part of their life skills assessment. This tool

evaluates the representative competency of resolving issues and improving current situations during case-based extended reality (XR) content education. It comprises five key elements: problem clarification, cause analysis, alternative development, planning and execution, and performance evaluation, with a total of 45 items. The items are rated on a 5-point scale, with higher scores indicating greater problem-solving ability. The reliability of the tool was reported as Cronbach's $\alpha = .94$ in the study by Lee et al. (2003), and in the present study, it also demonstrated a Cronbach's α of .94.

2.4.4. General Characteristics

The tool for assessing general characteristics collected data on participants' age, gender, satisfaction with school life, satisfaction with the nursing program, satisfaction with clinical practice, and academic performance.

5. DATA COLLECTION METHODS

Data for this study were collected from June 1 to June 30, 2024, targeting fourth-year nursing students enrolled in a university located in Seoul, South Korea. Data on participants' general characteristics, practice satisfaction, practice immersion, and problem-solving abilities were gathered through a structured, self-administered questionnaire. Prior to data collection, the purpose and methodology of the study were presented to the department chair, and formal approval was obtained. Participants were provided with detailed information regarding the study's objectives, procedures, and confidentiality measures. Data were collected only from those who voluntarily agreed to participate and provided written informed consent after a thorough understanding of the study. A total of 165 questionnaires were collected; however, 15 were excluded due to incomplete or inaccurate responses. As a result, 150 valid responses were used for the final analysis.

6. DATA ANALYSIS METHODS

The collected data were analyzed using SPSS/WIN 23.0 software, and the analysis methods are as follows:

1) The general characteristics of the participants, as well as the levels of practice satisfaction, practice immersion, and problem-solving abilities, were analyzed using frequency, percentage, mean, and standard deviation.

2) The relationships between practice satisfaction, practice immersion, and problem-solving abilities were analyzed using Pearson correlation coefficients.

3) To examine differences in practice satisfaction, practice immersion, and problem-solving abilities based on participants' characteristics, Independent t-tests and One-way ANOVA were performed. Post-hoc comparisons were conducted using the Scheffé test. Additionally, because the groups by academic performance did not meet the assumption of normality, the Kruskal-Wallis non-parametric test was applied.

4) The factors influencing participants' problem-solving abilities were analyzed using multiple regression analysis.

7. ETHICAL CONSIDERATIONS

Before commencing the study, the researcher thoroughly explained the purpose and procedures of the research to the participants and emphasized that the decision to participate was entirely at the discretion of the participants. Additionally, participants were informed that their confidentiality would be strictly maintained, and they were assured that they could withdraw from the study at any time, should they wish to do so. To prevent any potential infringement on autonomy due to hierarchical influence, the researcher, rather than the course instructor, provided an explanation of the study and conducted the data collection. Participants' personal information was handled by removing all identifying details and assigning new serial numbers to ensure confidentiality. Participants who agreed to participate were fully informed about the collection of personal data and the study activities before providing written consent. All participants who took part in the study received a small token of appreciation.

8. RESEARCH RESULTS

8.1. General Characteristics of Participants

To examine the impact of case-based XR content learning on practice satisfaction, practice immersion, and problem-solving abilities among nursing students, the general characteristics of the participants were analyzed. In terms of gender, there were 33 male students (22.0%) and 117 female students (78.0%). School life satisfaction was reported as follows: 105 students (70.0%) were dissatisfied, 34 students (22.7%) were neutral, and 11 students (7.3%) were satisfied. Nursing program satisfaction showed that 85 students (56.7%) were dissatisfied, 50 students (33.3%) were neutral, and 15 students (10.0%) were satisfied. Clinical practice satisfaction was reported as 102 students (68.5%) dissatisfied, 37 students (24.8%) neutral, and 10 students (6.7%) satisfied. In terms of academic performance, 77 students (51.3%) had a GPA between 3.5 and 4.0 (good), 42 students (28.0%) had a GPA between 3.0 and 3.5 (average), 18 students (12.0%) had a GPA above 4.0 (excellent), 11 students (7.3%) had a GPA between 2.5 and 3.0 (below average), and 2 students (1.3%) had a GPA below 2.5 (very poor). Regarding age, 104 students (69.3%) were between 21 and 23 years old, 28 students (18.7%) were 24 or older, and 18 students (12.0%) were 20 or younger (Table 1).

Table 1: General Characteristics of the Participants (N=150).

Characteristics		N	%
Gender	Male	33	22.0
	Female	117	78.0
Satisfaction with school life	Dissatisfaction	105	70.0
	Commonly	34	22.7
	Satisfaction	11	7.3
Satisfaction with nursing program	Dissatisfaction	85	56.7
	Commonly	50	33.3
	Satisfaction	15	10.0
Clinical practice satisfaction	Dissatisfaction	102	68.5
	Commonly	37	24.8
	Satisfaction	10	6.7
Academic Performance	Best(4.0<)	18	12.0
	Award(3.5-3.9)	77	51.3
	Middle(3.0-3.4)	42	28.0
	Under(2.5-2.9)	11	7.3
	Lower(<2.5)	2	1.3
Age	20	18	12.0
	21~23	104	69.3
	24<	28	18.7

8.2. Practice Satisfaction, Practice Immersion, and Problem-Solving Ability of Nursing Students

The descriptive statistics for practice immersion, practice satisfaction, and problem-solving ability of nursing students who experienced case-based XR content learning are as follows: Practice immersion, measured with 13 items, ranged from a minimum of 21 points to a maximum of 62 points, with an average score of 48.95. Practice satisfaction, assessed with 16 items, ranged from a minimum of 45 points to a maximum of 80 points, with an average score of 63.23. Finally, problem-solving ability, measured with 45 items, ranged from a minimum of 120 points to a maximum of 173 points, with an average score of 147.92 (Table 2).

Table 2: Degree of Practice Immersion,Practice Satisfaction:

Problem-Solving Ability				(N=150)
	Min.	**Max.**	**M**	**SD**
Practice Immersion	21.00	62.00	48.95	6.20
Practice Satisfaction	45.00	80.00	63.23	8.10
Problem-Solving Ability	120.00	173.00	147.92	11.01

8.3. Differences in Practice Satisfaction, Practice Immersion, and Problem-Solving Ability Based on General Characteristics of Nursing Students

The results of the statistical tests examining differences based on the participants' general characteristics showed that practice immersion was significantly different based on school life satisfaction, practice satisfaction was significantly different based on nursing program satisfaction, and practice satisfaction also showed significant differences based on age. To examine the differences between groups, Scheffé's post-hoc analysis revealed significant differences in practice immersion based on school life satisfaction, with differences observed between the dissatisfied, neutral, and satisfied groups. Additionally, for age, significant differences were found between the groups of 20 years or younger, 21–23 years, and 24 years or older (Table 3).

Table 3: Differences depending on characteristics of survey subjects (N=150).

Characteristics	Categories	n	Practice Immersion					Practice Satisfaction					Problem-Solving Ability			
			Mean	SD	t/F/X^2	*p*		Mean	SD	t/F/X^2	*p*		Mean	SD	t/F/X^2	*p*
Gender	Male	33	50.00	5.11	1.09	0.27		60.61	9.11	-2.13	0.03		149.30	10.55	0.818	0.41
	Female	117	48.66	6.46				63.97	7.67				147.53	11.15		
Satisfaction with school life	Dissatisfaction	105	49.74	6.07	3.50	0.03	a>b,c	62.52	8.60	2.32	0.10		148.09	10.70	0.191	0.82
	Commonly	34	46.56	5.96				63.91	6.58				147.00	12.21		
	Satisfaction	11	48.82	6.76				67.82	5.91				149.09	10.87		
Satisfaction with nursing program	Dissatisfaction	85	48.21	6.75	1.41	0.24		64.67	8.31	3.21	0.04		148.21	10.98	0.105	0.90
	Commonly	50	49.88	5.17				61.30	7.31				147.33	11.43		
	Satisfaction	15	50.07	5.81				61.47	8.22				148.20	10.35		
Clinical practice satisfaction	Dissatisfaction	102	49.07	6.14	0.25	0.77		62.39	7.89	2.44	0.09		148.06	10.99	2.567	0.08
	Commonly	37	48.24	6.34				64.22	8.57				145.65	11.13		
	Satisfaction	10	49.20	5.85				67.80	7.60				154.40	9.22		
Academic Performance	Best(4.0<)	18	48.89	5.16	5.37*	0.25		65.17	9.17	7.75*	0.10		150.94	9.68	7.095*	0.13
	Award(3.5-3.9)	77	48.31	5.82				63.64	7.89				148.86	10.69		
	Middle(3.0-3.4)	42	49.36	7.57				63.17	8.32				144.51	11.69		
	Under(2.5-2.9)	11	51.82	4.64				57.55	5.68				149.73	11.71		
	Lower(<2.5)	2	50.00	0.00				62.50	3.54				146.00	5.66		
Age	20	18	47.44	8.67	2.40	0.09		68.78	7.77	5.44	0.001	a>b,c	149.11	9.44	0.139	0.87
	21~23	104	48.63	5.74				62.77	7.86				147.65	11.79		
	24<	28	51.11	5.69				61.36	7.95				148.13	9.00		

Note: * Chi-square statistic

* Correspondence: bun8973@naver.com

9. CORRELATION BETWEEN PRACTICE IMMERSION, PRACTICE SATISFACTION, AND PROBLEM-SOLVING ABILITY OF NURSING STUDENTS

To examine the correlations among practice immersion, practice satisfaction, and problem-solving ability in nursing students who experienced case-based XR content learning, Pearson correlation analysis was conducted. The results showed that there was no significant correlation between practice immersion and practice satisfaction ($r = -.06$, $p = .40$). However, a significant positive correlation was found between practice immersion and problem-solving ability ($r = .318$, $p < .001$) (Table 4).

Table 4: Correlation analysis.

			(N=150)
	Practice Immersion	**Practice Satisfaction**	**Problem-Solving Ability**
Practice Immersion	1		
Practice Satisfaction	-.06(.40)	1	
Problem-Solving Ability	.31(<.01)	.01(.95)	1
Pearson's correlation coefficient r(p)			

10. FACTORS INFLUENCING THE PROBLEM-SOLVING ABILITY OF NURSING STUDENTS

To examine the impact of practice immersion and practice satisfaction on problem-solving ability in nursing students who experienced case-based XR content learning, multiple regression analysis was conducted. First, multicollinearity among the independent variables was checked by calculating the tolerance limit and the Variance Inflation Factor (VIF). The results showed that the tolerance limit was greater than 0.1, and the range of the Variance Inflation Factor (VIF) was 1.005, which is below the threshold of 10, indicating no issues with multicollinearity. Additionally, the Durbin-Watson value was 2.20, which is close to 2, suggesting no autocorrelation in the error terms. Residual analysis confirmed that linearity, normality, and homoscedasticity assumptions were met. Therefore, the regression model was found to be significant ($F = 8.33$, $p = .001$), with an explanatory power of 10%.

The results of the multiple regression analysis examining the impact of practice immersion and practice satisfaction on problem-solving ability in nursing students who experienced case-based XR content learning showed that practice immersion ($t = 4.0$, $p < .001$) had a significant positive effect on problem-solving ability (Table 5).

Table 5: Impact on problem solving ability.

					(N= 150)	
	B	**SE[1]**	**β**	**t**	***p***	**VIF[2]**
A constant	117.83	9.941		11.85	<.001	
Practice Immersion	0.56	0.13	0.32	4.08	<.001	1.005
Practice Satisfaction	0.03	0.10	0.02	0.33	0.73	1.005
R^2=.102, adj R^{23}=.090, F(p)=8.334(<.001), D-W=2.206						

11. DISCUSSION

This study attempted multiple regression analysis to examine the impact of practice satisfaction and practice mmersion on the problem-solving ability of nursing students who experienced case-based XR content learning.

In this study, the practice immersion, practice satisfaction, and problem-solving ability of nursing students participating in XR-based practice were investigated, yielding generally positive results. For practice immersion, the average score was 48.95 (with a minimum of 21 points and a maximum of 62 points). This score indicates a moderate level, suggesting that students are relatively well-engaged in the XR-based practice. According to Kim & Park (2014), higher levels of practice immersion are associated with improved learning outcomes and clinical performance, which supports the findings of this study. The practice satisfaction score was 63.23 (with a minimum of 45 points and a maximum of 80 points), which is above average, indicating that students were generally satisfied with the XR-based practice. This finding is consistent with the results of Lee et al. (2023), supporting the idea that practice satisfaction positively influences learning motivation and self-efficacy. The problem-solving ability score was 147.92 (with a minimum of 120 points and a maximum of 173 points), indicating a high level of problem-solving ability. According to Kim & Kim (2016), problem-solving ability is one of the core competencies for nurses and plays a crucial role in adapting to and performing in clinical settings, which aligns with the findings of this study. Based on these findings, this study suggests that nursing practice using XR technology can positively impact nursing students' practice immersion, practice satisfaction, and problem-solving abilities. Future research, including the development of additional studies and educational programs, will be necessary to maximize the educational effects

* Correspondence: bun8973@naver.com

of XR technology.

The study found that there were differences in practice satisfaction based on age among the general characteristics of the participants. Specifically, differences were observed between the groups of 20 years or younger, 21–23 years, and 24 years or older. This finding contrasts with the results of Lee & Baek (2023), whose study did not report such age-related differences in practice satisfaction. In the present study, a tendency was observed where younger students reported higher levels of practice satisfaction, whereas Lee & Baek (2023) found that older students had higher levels of practice satisfaction. Therefore, future research should explore whether age influences practice satisfaction among a broader range of nursing students to better understand this relationship. Additionally, there is a need to explore various approaches based on age groups to enhance practice satisfaction among nursing students. Specifically, it is important to provide more support and guidance to younger students to help improve their practice satisfaction.

In this study, the correlation between practice immersion and practice satisfaction was found to be non-significant. This suggests that practice immersion does not necessarily lead to higher practice satisfaction. Park & Yoon (2023) reported that immersion in a virtual reality (VR)-based learning environment does not always correlate with learner satisfaction. This suggests that even with high levels of immersion, personal expectations and environmental factors can influence the learner's overall satisfaction. On the other hand, a significant positive correlation was found between practice immersion and problem-solving ability. This suggests that learners with higher levels of immersion are likely to have improved problem-solving skills. These results are consistent with the findings of Lee et al. (2023), who reported that XR-based education increases learner immersion, which in turn enhances problem-solving abilities. This suggests that extended reality (XR) education allows learners to experience real-world problem situations and encourages them to make various attempts to resolve these issues, thereby strengthening their problem-solving abilities. While XR-based learning has a positive impact on improving nursing students' problem-solving abilities, it was found to have no direct correlation with practice satisfaction. This suggests that while XR-based learning is effective in cultivating skills necessary for real-world practice, it may have limitations in enhancing learners' subjective satisfaction. Therefore, to maximize the effectiveness of XR-based learning, strategies to foster learning immersion should be combined with additional support and improvements aimed at enhancing learner satisfaction. Based on these findings, program developers should focus on enhancing students' immersion when introducing XR-based learning. At the same time, it is essential to establish an educational environment and support system that also considers students' satisfaction. In fact, by providing personalized educational programs that reflect learners' individual characteristics and expectations, the overall learning experience can be enhanced.

The finding that practice immersion has a significant impact on problem-solving ability is consistent with the results of Kim & Kim (2021) who reported that learners with higher levels of immersion put more effort into solving the given problems, which in turn enhances their problem-solving abilities. This suggests that as immersion increases, learners become more actively engaged in the learning process and are more likely to try various approaches to solving the given problems, ultimately leading to an improvement in their problem-solving abilities. On the other hand, the finding that practice satisfaction does not have a significant impact on problem-solving ability may be somewhat unexpected. However, similar results have been observed in previous studies as well. According to the study by Park & Yoon (2023), even when learners have high satisfaction, it may not be directly related to improvements in problem-solving ability. Satisfaction can be influenced by various factors such as the learning environment, support systems, and individual expectations, and these factors may not directly impact the enhancement of the learner's problem-solving skills. The explanatory power of the regression model was found to be 10%, indicating that the impact of practice immersion and practice satisfaction on problem-solving ability is relatively low. Therefore, future research should consider including other important variables that may influence problem-solving ability and expand the sample size to include participants from diverse backgrounds.

12. CONCLUSION AND SUGGESTIONS

This study demonstrates that practice immersion and practice satisfaction in nursing students who experienced case-based extended reality (XR) content learning have an impact on their problem-solving abilities. This suggests that XR-based learning can effectively enhance learners' immersion, which in turn can improve their problem-solving abilities. However, since practice satisfaction was found to have no significant impact on problem-solving ability, it suggests that the relationship between satisfaction and problem-solving ability may be influenced by more complex factors. Therefore, when developing educational programs, strategies to enhance learners' immersion should be combined with various educational approaches that can improve problem-solving abilities. Since this study was conducted with nursing students from only one university, its findings may not apply to all nursing students. To make the results more widely applicable, future research should involve nursing students from different universities or regions, which would help increase the ability to generalize the findings to a broader population. In this study, there may be various mediating variables affecting the relationship between practice satisfaction and problem-solving ability, but these were not fully considered. Therefore, future research should analyze the relationship by taking into account a broader range of variables. Since the quality of XR content and the learning environment may not have been consistently provided to all learners, future research should focus on addressing technical issues and establishing support systems to enhance the learning experience. Future research should focus on maximizing the effectiveness of XR-based learning in nursing education and exploring ways to enhance learners' problem-solving abilities.

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REFERENCES

Chang, E., & Park, S. (2017). Effects of self-evaluation using smartphone recording on nursing students' competency in nursing skills, satisfaction, and learning motivations: Focusing on Foley catheterization. Journal of Academy of Fundamentals of Nursing, 24(2), 118–127. https://doi.org/10.7739/jkafn.2017.24.2.118

Engeser, S., & Rheinberg, F. (2008). Flow, performance and moderators of challenge-skill balance. Motivation and Emotion, 32(3), 158–172. https://doi.org/10.1007/s11031-008-9102-4

Hwang, Y., Jeong, J., & Jeong, Y. M. (2023). A study on the feasibility of introducing XR in nursing education core fundamental nursing skills. Journal of Digital Contents Society, 24(4), 775–783. https://doi.org/10.9728/dcs.2023.24.4.775

Kaplan, A. D., Cruit, J., Endsley, M., Beers, S. M., Sawyer, B. D., & Hancock, P. (2021). The effects of virtual reality, augmented reality, and mixed reality as training enhancement methods: A meta-analysis. Human Factors, 63(4), 706–726. https://doi.org/10.1177/0018720820904229

Kim, H. Y. (2021). A study on the interaction of extended reality through analysis of extended augmented reality art. Cartoon Animation Research, 64, 643–672. https://doi.org/10.3390/app12031241

Kim, J. Y., Kim, H. O., & Lee, M. H. (2019). Academic achievement of nursing college students according to academic self-efficacy: The mediating effect of major satisfaction. Child Health Nursing Research, 25(2), 205–213. https://doi.org/10.4094/chnr.2019.25.2.205

Kim, M. G., & Kim, H. W. (2021). The effects of classes using virtual reality simulations of the hospital environment on knowledge of the hospital environment, academic self-efficacy, learning flow, educational satisfaction and academic achievement in nursing students. Journal of Korean Academy of Fundamentals of Nursing, 28(4), 520–529. https://doi.org/10.7739/jkafn.2021.28.4.520

Kim, S., & Kim, M. J. (2022). Effect of learner-centered virtual reality simulation education. Journal of Digital Convergence, 20(4), 705–713. https://doi.org/10.14400/JDC.2022.20.4.705

Kim, S. H., & Park, S. Y. (2014). Factors influencing on learning flow of nursing students. Journal of the Korea Academia-Industrial Cooperation Society, 15(3), 1557–1565. https://doi.org/10.5762/KAIS.2014.15.3.1557

Kim, Y. H., & Kim, Y. A. (2016). The influence of academic self-efficacy, and critical thinking disposition on problem-solving ability of nursing students. Journal of the Korea Academia-Industrial Cooperation Society, 17(9), 589–598. https://doi.org/10.5762/KAIS.2016.17.9.589

Kim, Y. J. (2021). Development and application of scenario-based admission management VR contents for nursing students. Journal of the Korea Society of Computer I nformation, 26(1), 209–216. https://doi.org/10.9708/jksci.2021.26.01.209

Ko, J. Y., & Jung, A. R. (2021). Augmented reality-based surgical nursing practice application development and evaluation. Journal of Convergence for Information Technology, 11(2), 47–56. https://doi.org/10.22156/CS4SMB.2021.11.02.047

Lee, E., & Baek, G. (2023). Development and effects of a virtual reality simulation nursing education program combined with clinical practice based on an information processing model. Computers, Informatics, Nursing, 41, 1016–1025. https://doi.org/10.1097/CIN.0000000000001051

Lee, H., Kim, C., Kim, H., Kim, J., & Kang, M. (2023). Improving active collaborative clinical learning through a mobile application for undergraduate nursing students. Computers, Informatics, Nursing, 41, 309–315. https://doi.org/10.1097/CIN.0000000000000918

Lee, S. J., Chang, Y. K., Lee, H. N., & Park, K. Y. (2003). A study of the development of life-skills; communication, problem solving, and self-directed learning (Report No.: RR2003-15-3). Korean Educational Development Institute. https://www.kedi.re.kr/khome/main/research/selectPubForm.do?plNum0=3847

Nam, C. M., Kim, C. W., Hong, K., Cho, C., & Hong, J. (2020). A study on the learner characteristics in virtual reality by a school level curriculum. Journal of The Korean Association of Information Education, 24(1), 71–78. https://doi.org/10.14352/jkaie.2020.24.1.71

Nesenbergs, K., Abolins, V., Ormanis, J., & Mednis, A. (2021). Use of augmented and virtual reality in remote higher education: A systematic umbrella review. Education Sciences, 11(1), 8. https://doi.org/10.3390/educsci11010008

Park, S., & Yoon, H. G. (2023). Effect of virtual-reality simulation of indwelling catheterization on nursing students' skills, confidence, and satisfaction. Clinical Simulation in Nursing, 80, 46–54. https://doi.org/10.1016/j.ecns.2023.05.001

Schutte, D. L., Kisting, M., Warren, C., & Stoneman, M. (2022). Linking hospitals to communities through evidence-based practice. Clinical Nurse Specialist, 36(5), 249–253. https://doi.org/10.1097/NUR.0000000000000695

Shorey, S., & Ng, E. D. (2020). The use of virtual reality simulation among nursing students and registered nurses: A systematic review. Nurse Education Today, 98, 104662. https://doi.org/10.1016/j.nedt.2020.104662

Son, Y., Kang, H. S., & De Gagne, J. C. (2023). Nursing students' experience of using HoloPatient during the coronavirus disease 2019 pandemic: A qualitative descriptive study. Clinical Simulation in Nursing, 80, 9–16. https://doi.org/10.1016/j.ecns.2023.03.007

Yoo, M. S. (2001). The effectiveness of standardized patient managed instruction for a fundamental nursing course. Journal of Korean Academic Society of Nursing Education, 7(1), 94–112.

Yoon, D. J., & Jeong, H. C. (2021). The effect of extra-corporeal membrane oxygenation preparation education using augmented reality on performance ability, performance confidence, and educational satisfaction of clinical nurses. Journal of Korea Society for Simulation in Nursing, 9(2), 61–71. https://doi.org/10.17333/JKSSN.2021.9.2.61