The Mediating Effect of Problem-Solving Ability on the Relationship between Digital Literacy and Clinical Performance Ability in Nursing Students

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Abstract

This study was to identify the mediating effect of problem solving ability (PSA) on the relationship between digital literacy (DL) and clinical performance ability (CPA) in nursing students and to provide supplementary materials for developing educational programs that can bring positive changes in clinical performance by understanding the influence of these variables. The subjects were 235 nursing students conveniently sampled from a university located in W city, Gangwon-do. The results showed that problem solving ability partially mediated the relationship between subjects' digital literacy and clinical performance ability. It indicated that the three core variables - digital literacy, problem solving ability, and clinical performance ability - were all significantly and positively correlated with one another. In-depth research is continuously needed to analyze various variables affecting the clinical performance ability of nursing students and the effects of education to improve digital literacy and problem solving ability.

Keywords: *Ursing Students, Digital Literacy, Problem Solving Ability, Clinical Performance Ability.*

Introduction

The modern medical environment is characterized by the rapid development of digital technologies such as big data analysis, artificial intelligence (AI) and telemedicine, and a surge in medical information, adding complexity to the roles and responsibilities of nurses. Amidst these changes, the clinical performance ability of nursing students is increasingly emphasized as a core competency for ensuring patient safety and the quality of nursing care. According to a study by [1], clinical performance ability is defined as the ability to skillfully perform nursing duties through sufficient knowledge, judgment, skills, and attitudes regarding the needs of patients in nursing practice. This study aims to provide supplementary materials for the development of educational programs that can bring positive changes to this clinical performance ability. Digital literacy can be defined as a core competency for constructing new knowledge and communicating with others by utilizing digital resources, moving beyond simply handling devices. This comprehensive process includes critically understanding vast amounts of information, integrating and analyzing it for specific purposes, and evaluating its value. The Korean Accreditation Board of Nursing Education also emphasizes information communication and health medical technology competencies, and informatics education within nursing colleges is expanding [2]. Digital literacy competency helps nursing students efficiently process and utilize information to perform effective decision-making, problem solving, and evidence-based practice. Previous studies have reported that digital literacy enhances confidence in clinical performance ability [3] and has a significant correlation with actual clinical performance ability. Problem solving ability is defined as the ability to recognize and clarify problems arising in various clinical situations, explore causes and alternatives, plan and execute them, and systematically evaluate the results. Studies by [4] and [5] confirmed that digital literacy is a major factor positively influencing problem solving ability, and a significant positive correlation was found between the two variables. Previous studies have explored the individual relationships between digital literacy, problem solving ability, and clinical performance ability, or the relationships between some variables. For example, [4] analyzed the effects of digital literacy on problem solving ability, and [1] analyzed the effects of digital literacy on clinical performance ability. However, there is a lack of in-depth analysis on the mediating role of problem solving ability in the process by which digital literacy affects clinical performance ability. Therefore, educational strategies

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aimed at improving the clinical performance of nursing students should integratively enhance both digital literacy and problem solving abilities.

Methods

Study Subjects

Participants were recruited from a university in W city, Gangwon-do, using convenience sampling. After providing informed consent, which explained the study's purpose and guaranteed anonymity, an initial sample of 242 nursing students was obtained. Data was collected via self-administered questionnaires from April 1 to April 23, 2025. Seven questionnaires were excluded due to incomplete responses, resulting in a final sample of 235 for analysis. A prior power analysis using G*Power 3.1 indicated that a minimum of 117 participants were required to achieve a power .95 at a significance level .05 for a medium effect size. Thus, the final sample size was deemed adequate for the planned statistical analysis.

Research Tools

Digital literacy was measured using the instrument developed by Shim and Lee [6]. This instrument consists of 18 items across four subscales: ICT basic competency, SNS utilization and collaboration ability, basic work utilization ability, and SW-centered social adaptation ability. All items are rated on a 5-point Likert scale, with higher scores indicating greater digital literacy, and the scale demonstrated excellent internal consistency in this study (Cronbach's α = .96), consistent with previous findings (α = .95) by Kim and Na [4].

Clinical performance ability was assessed using the 19-item instrument from the study by Koo [7]. The instrument covers six domains: nursing process, nursing intervention, psychosocial nursing, patient education, physical assessment and patient monitoring, and basic nursing. All items are rated on a 5-point Likert scale. A higher scores reflecting a higher level of clinical performance ability. The Cronbach's α for the scale was .89 in the present study, while Koo [7] reported a reliability of .96.

Problem solving ability was measured using the instrument from the study by Koo [7]. This 30-item instrument is rated on a 5-point Likert scale and comprises five subscales with six items each: problem clarification, seeking solutions, decision-making, implementing solutions, and evaluation and reflection. Higher scores indicate greater problem solving ability. The scale showed high internal consistency in this study with a Cronbach's α of .92. The Cronbach's α reported in the study by Koo [7] was .06.

Analysis Methods

The collected data were analyzed using the SPSS 25.0 statistical program, and the statistical significance level was set at .05. Differences in general characteristics, digital literacy, clinical performance ability, and problem solving ability were analyzed using t-test and ANOVA, with Dunnett T3 for post-hoc testing.

It examined the correlations among the variables – digital literacy, clinical performance ability, and problem solving ability – using Pearson's correlation coefficients. Hierarchical regression analysis was conducted to determine the effects on the subjects' clinical performance ability. To examine the mediating effects of problem solving ability on the relationship between digital literacy and clinical performance ability, the mediating effects verification procedure proposed by Baron and Kenny [8] was used, and statistical significance was tested using the Sobel test.

Results

Descriptive Statistics for Participant Characteristics and Study Variables

Regarding the general characteristics of the subjects, 79.2% were female students, the average age was 21.6 years. and 30.5% were 2nd-grade students, 46.2% had 'medium' academic performance, and 60.2% reported 'average' interpersonal relationships (Table 1). The mean score for digital literacy was 3.60 out of 5, for problem solving ability was 3.74 out of 5, and for clinical performance ability was 3.62 out of 5 (Table 2).

Differences in Clinical Performance Ability according to Participant Characteristics

There was a significant difference in clinical performance ability according to grade. Fourth-grade students had higher clinical performance ability than first-grade students (p=.012) (Table 1).

Table 1. Difference of Clinical Performance Ability by Participant Characteristics(N=235)

Characteristic	Categories	n (%)	Clinical Performance Ability		
			M±SD	t/F(p)	Dunnet t T3
Gender	Male	49(20.8)	3.39± .61	-2.66 (.009)	
	Female	187(79.2)	3.66± .77		
Age			21.6±1.03		
Grade	1 Grade[a]	41(17.4)	3.50± .48	3.70 (.012)	d>a
	2 Grade[b]	72(30.5)	3.68± .75		
	3 Grade[c]	67(28.4)	3.79± .66		
	4 Grade[d]	56(23.7)	3.96± .67		
Academic Performance	High	55(23.3)	3.84± .72	1.62 (.200)	
	Medium	109(46.2)	3.66± .75		
	Low	72(30.5)	3.81± .61		
Relationship	Good	35(14.8)	3.84± .83	.409 (.665)	
	Usually	142(60.2)	3.72± .67		
	Bad	59(25.0)	3.75± .71		

Table 2. Degree of Digital Literacy, Problem Solution Ability and Clinical Performance Ability (N=235)

Variables	M±SD	Range	Reference range
Digital literacy	3.60±.05	2.39~4.89	1~5
Problem solution ability	3.74±.05	2.48~4.87	1~5
Clinical performance ability	3.62±.04	2.26~6.32	1~5

Correlations among Digital Literacy, Problem solving Ability, and Clinical Performance Ability of Subjects

The subjects' digital literacy showed a significant positive correlation with problem solving ability (r=.75, p<.001) and clinical performance ability (r=.74, p<.001). A significant positive relationship was also identified between problem solving ability and clinical performance ability (r=.72, p<.001) (Table 3).

Table 3. Correlation among Digital Literacy, Problem Solution Ability, Clinical Performance Ability(N=235)

	Digital Literacy	Problem Solution Ability	Clinical Performance Ability
Digital Literacy	1		
Problem Solution Ability	.75 (<.001)	1	
Clinical Performance Ability	.74 (<.001)	.72 (<.001)	1

Effects of Subjects' Digital Literacy and Problem Solving Ability on Clinical Performance Ability

Hierarchical regression analysis was conducted to analyze the factors affecting the subjects' clinical performance ability, as shown in Table 4. In step 1, control variables (general characteristic variables) were entered. In step 2, digital literacy was entered, and in step 3, problem solving ability was entered. General characteristics such as gender, grade, academic performance, and interpersonal relationships were dummy coded. The control variables entered in step 1 were not significant. In step 2, after controlling control variables, the inclusion of digital literacy showed a significant effect on clinical performance ability (β=.76, p<.001), and the explained variance in step 2 (R²=.58) increased by 56% compared to step 1. In step 3, after controlling control variables, the inclusion of both digital literacy and

problem solving ability showed that digital literacy (β=.48, p<.001) and problem solving ability (β=.38, p<.001) had a significant influence on clinical performance ability. The explained variance in step 3 (R^2=.64) increased by 6% compared to step 2, indicating that digital literacy and problem solving ability explained approximately 64% of the variance in clinical performance ability. To check for multicollinearity between variables, the tolerance was above 0.1, and all Variance Inflation Factor (VIF) values ranged from 1.0 - 2.3, which are less than 10, confirming no multicollinearity issues. The Durbin-Watson value for this study was 1.947, indicating no problems with autocorrelation of errors.

Table 4. The Effects of DL, PSA on CPA(N=235)

Variables	Model1			Model2			Model2		
	B	β	p	B	β	p	B	β	p
Gender	-.15	-.09	.194	.09	.05	.258	.10	.06	.158
Grade	-.12	-.08	.249	-.18	-.11	.011	-.19	-.12	.004
Academic perf.	.10	.06	.379	.17	.10	.023	.15	.09	.032
Relationship	.15	.08	.257	-.01	-.01	.879	.03	.02	.699
DLA				.71	.76	<.001	.44	.48	<.001
PSA							.49	.38	<.001
R^2		.02			.58			.64	
Adj R^2		.01			.57			.63	
F		1.29			62.21 (<.001)			66.60 (<.001)	
Durbin-Watson								1.95	

DL: Digital Literacy, PSA: Problem-Solution Ability, CPA: Clinical Performance Ability, Academic perf.: Academic Performance

Mediating Role of Problem Solving Ability in the Relationship Between Digital Literacy and Clinical Performance Ability

Mediation effect analysis was conducted to determine whether problem solving ability mediated the relationship between subjects' digital literacy and clinical performance ability. The significance of the mediating effect was verified using Sobel's Z-test, and the result (Sobel's Z = 5.80, p<.001) was significant as it exceeded the threshold of ±1.96. Regression analysis to determine the effect of subjects' digital literacy on clinical performance ability was observed that the Variance Inflation Factor (VIF) ranged from 1.02 to 2.39, below the criterion of 10.0, and tolerance values were above the criterion of 0.1, indicating no multicollinearity. Furthermore, the Durbin-Watson statistics were 1.95, close to the criterion of 2.0, making the regression model suitable. The results of the mediation analysis are summarized in Table 5. In Step 1, the effect of subjects' digital literacy on problem solving ability was statistically significant (β=.75, p<.001). In Step 2, the effect of subjects' digital literacy on clinical performance ability was also statistically significant (β=.74, p<.001). In Step 3, when subjects' digital literacy and the mediating variable, problem solving ability, were simultaneously entered, both digital literacy and problem solving ability had a significant effect on clinical performance ability (β=.42, p<.001). Comparing the regression coefficients, the B value of .74 in Step 2 was greater than the B

value of .42 for DL in Step 3, confirming a partial mediating effect. The R-squared values, indicating explanatory power, were 56.7% in Step 1, 54.8% in Step 2, and 61.1% in Step 3.

Table 4. Mediating Effect of PSA between DL and CPA (N=235)

Variables	B	SE	β	$t(p)$	Adj R^2	F	Sobel Test $z(p)$
Step 1. DL → PSA	.53	.03	.75	17.52(<.001)	.57	306.88(<.001)	
Step 2. DL → CPA	.68	.04	.74	16.84(<.001)	.55	283.54(<.001)	
Step 3. DL → CPA	.42	.06	.45	7.30(<.001)	.61	182.65(<.001)	
PSA → CPA	.49	.08	.38	6.13(<.001)			5.80(<.001)

Discussion

This study aims to elucidate the pathway by which digital literacy influences clinical performance in nursing students, positing problem solving ability as a key mediator. Nursing students' digital literacy and problem solving ability were found to be significantly and positively correlated (r=.75, p<.001). This finding supports the work of [4], which also identified a significant positive correlation (r=.651, p<.001) between digital literacy and problem solving ability in nursing students. Notably, the present study found an even stronger relationship (r=.75, p<.001), reinforcing the idea that digital skills are fundamental to developing effective problem solving strategies. Digital literacy also confirmed a significant positive correlation with clinical performance ability (r=.74, p<.001). This finding is consistent with the study by Lee et al. [1], which also reported a significant positive correlation between nursing students' digital literacy and their clinical performance ability (r=.52, p<.001). Problem solving ability showed a significant positive correlation with clinical performance ability (r=.72, p<.001). This suggests that students with high problem solving ability can effectively cope with complex and diverse problems encountered in the clinical field, thereby demonstrating excellent clinical performance ability. [4] indirectly supports the results of this study by mentioning that problem solving ability improves nurses' clinical performance ability and affects the improvement of nursing work performance. Problem solving ability was found to partially mediate the relationship between nursing students' digital literacy and clinical performance ability. In other words, digital literacy has both a direct positive effect on clinical performance ability and an indirect effect by enhancing problem solving ability. In other words, nursing students with high digital literacy competency can enhance their problem solving ability by effectively utilizing and analyzing information in problem situations, and this improved problem solving ability, in turn, leads to an improvement in clinical performance ability. This study builds upon previous findings, such as [4]'s work linking digital literacy to problem solving and [1]'s research connecting it to clinical performance. However, our key contribution is the empirical verification of problem solving ability as a mediator. By demonstrating this specific pathway, our results offer a more nuanced mechanical understanding of how digital literacy translates into enhanced clinical performance in nursing students.

In this study, digital literacy and problem solving ability were found to explain approximately 61% of clinical performance ability, indicating that these variables are important predictors of clinical performance ability. Synthesizing the above research results, an integrated educational strategy that can cultivate problem solving ability along with strengthening digital literacy competency is necessary to effectively enhance the clinical performance ability of nursing students. This aligns with the suggestion by [4] that digital information search, evaluation, and utilization skills can be integratively cultivated to improve problem solving ability. Furthermore, [1] also emphasized the development of educational programs that cultivate digital literacy and communication skills to improve clinical performance ability.

Conclusion and Suggestions

This study investigated the effect of digital literacy on nursing students' clinical performance, focusing on the mediating role of problem solving ability to inform strategies for improvement. The findings confirmed significant positive correlations among all three variables. The key result was the identification of problem solving ability partially mediated the relationship between digital literacy and clinical performance. Therefore, this study suggests that enhancing students' clinical capabilities requires the development and application of educational programs that simultaneously foster both digital literacy and problem solving skills.

Acknowledgement

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