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Structural Relationship among Learning Motivation, Learning Confidence, Critical Thinking Skill and Problem-Solving Ability, Using Digital Textbooks

Ji-Woo Han[1]

[*1]*Professor, Nursing of Department, Kyungdong University, Korea*
laurabest@kduniv.ac.kr

Abstract

This study aimed to provide basic data for enhancing the structural relationship among learning motivation, learning confidence, critical thinking skill and problem-solving ability in junior high school students and factors influencing problem-solving ability, by closely examining them. To this end, it investigated the causality among variables, for 390 junior high school students in Gangwondo, based on the outcomes of a questionnaire survey conducted to verify the effectiveness of digital textbooks. Although learning motivation did not have a significant effect on critical thinking skill, learning confidence had a direct effect on it. In addition, learning motivation, learning confidence and critical thinking skill had direct effects on problem-solving ability. In order to enhance problem-solving ability, therefore, We may be necessary to make efforts to support learning capabilities and provide opportunities for them to experience rich learning and resources.

Keywords: *Learning Motivation, Learning confidence, Critical Thinking Skill, Problem-Solving Ability, Digital Textbook*

1. Introduction

At the educational field, in the 21th century, digital textbooks are used as learning materials, along with the development of information and communication technology. A variety of educational contents for digital textbooks have been used: multimedia materials, use of supplemental learning and transfer of knowledge.

The use of digital textbooks acts as a very important factor for learners' satisfaction with learning. Most functions of digital textbooks, such as 'multimedia', 'interactive animations' and 'cyber homework' and 'hyperlink' are learners-centered and active learning, which increase learners' learning motivation, by affecting their interest [1-4]. In addition, Digital textbooks can more strongly promote learners' learning motivation, than does the existing paper textbooks. Learners' spontaneous learning motivation can leaning to learning confidence with which learners can directly control their learning, develop strategies, maintain motivation and achieve successful learning. In particular, the class type of the 21th century version of digital textbooks most often appears as discussion/debate-based learning which is associated with several activities such as criticism

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Corresponding Author: laurabest@kduniv.ac.kr
Tel: +82-033-738-1433, Fax: +82-033-738-1209
Professor, Nursing of Department, Kyungdong University, Korea

and analysis based on thinking skill through communication ability [5]. Use of digital textbooks are thus thought to be very important for learners' learning motivation, confidence effective for learning and critical thinking skill to enhance various problem-solving abilities.

This study, therefore, attempts to provide basic data for developing strategies and programs used to examine the structural relationship among learning motivation, learning confidence, critical thinking skill and problem-solving ability and provide basic data for developing strategies and programs for enhancing problem-solving ability, so it sets following hypotheses.

[Hypothesis 1] the subjects' learning motivation and confidence may have effects on critical thinking skill.

[Hypothesis 2] the subjects' learning motivation and confidence, and critical thinking skill may have effects on problem-solving ability.

2. Methods

2.1 Study design and model

This is a descriptive research study acquired online raw data from the verification of digital textbooks' effectiveness, which was conducted by Korea Education and Research Information Service (KERIS), for junior high school students in 2019, and analyzed them by only selecting junior high school students as the subjects and adjusting them for the study purpose. Then, it designed a model, as shown in Figure 1, to examine the relationship among learning motivation and confidence, and critical thinking skill in junior high school students.

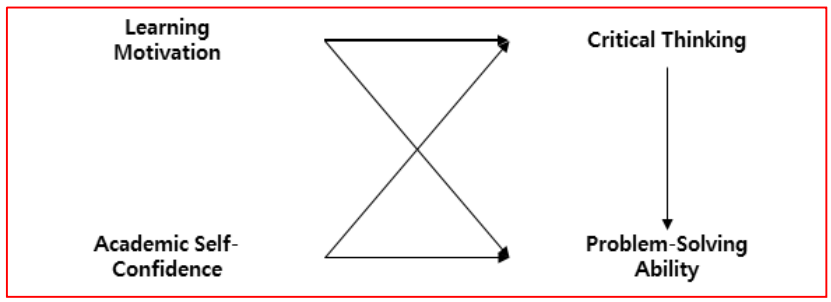

Figure 1. Research model

2.2 Subjects

This study targeted eight junior high schools located in Gangwondo, which was designated as schools that lead the use of digital textbooks, by KERIS, for two years, from 2018 to 2019. Only 1st graders who underwent the science class using digital textbooks in their junior high schools, for two hours a week, at the first semester in 2019 were extracted as the subjects, and 390 students who responded to questionnaires adjusted for the study purpose were finally selected. Most of selected junior high schools used table PC and the class with the principle of one device per a person was operated.

2.3 Research tools

The learning motivation is the behavior for achieving desirable learning goals and the psychology for maintaining the behavior. The learning confidence is a feeling of learning processes and results. The critical thinking skill is ability to resolve a variety problems, in terms of both usual and innovative measures. The problem-solving ability is for solving various problems. All data developed to verify the effectiveness of digital textbooks were used in [6]. The responses to questions were evaluated, based on the Likert 5-point scale ranging from 1='never' to 5='strongly agree'. Higher the scores, stronger the learning motivation. In this study,

the learning motivation is Cronbach's α=.898. The learning confidence Cronbach's α=.940. The critical thinking skill is Cronbach's α=.803. The problem-solving ability is Cronbach's α=.850.

2.4 Analysis methods

This study used SPSS 25 and AMOS 25 as statistical methods. In order to examine the normality of each measurement variable, this study conducted a descriptive statistical analysis, by using the SPSS program and verified averages, standard deviations, skewness and kurtosis of variables. An exploratory factor analysis (EFA) was used to find that the construct validity of measuring tools is higher than .50. For the test of multivariate normality, data with the absolute value of skewness less than 3 and the absolute value of kurtosis less than 10 were adopted. By using AMOS, CFA was conducted, TLI, CFI and RMSEA and path-coefficients were examined for the fitness of a model. The fitness was evaluated as good, if TLI and CFI was higher than .90 and RMSEA was less than .05 (the range from .05 to.10 was acceptable). The fitness of a model was tested by using structural equation modeling (SEM).

3. Results

3.1 Descriptive statistics and mean difference analysis of measured variables

In order to verify the multivariate normal distribution of measured variables, averages, standard deviations, skewness and kurtosis were examined. The results show that the absolute value of skewness was less than 3 and that of kurtosis was less than 10, so the normal distribution condition of measured variables was met [7], so the multivariate normal distribution was satisfied, in the test of a structural equation model in this study. Variance Inflation Factor (VIF) was measured to show that all factors were less than 10, so there was no multicollinearity among variables and all factors have significant correlations with each other, with the significant level =.05.

3.2 Correlation matrix for measured variables

This study measured the correlation matrix for measured variables, and the findings are shown in Table 1. All variables have significant correlations with each other with the significant level = .05. Learning motivation has positive correlations with learning confidence (r=.746), critical thinking skill (r=.393), problem-solving ability (r=.328), and learning confidence has positive correlations with critical thinking skill(r=.469), and critical thinking skill has a positive correlation with problem-solving ability (r=.660).

Table 1. Correlation matrix for measured variables

Measured variables	1	2	3	4
1. Academic motivation	1			
2. Academic self-confidence	.746***	1		
3. Critical thinking	.393***	.469***	1	
4. Problem-solving ability	.328***	.265***	.660***	1

***p<.001

3.3 Confirmatory factor analysis of measured variables

The confirmatory factor analysis is to examine the relationship between potential and measured variables and verify whether they are suitable for this study. For the fitness of data, X^2, TLI, CFI, RMSEA were used, and the findings show that both TLI and CFI as measured variables' fitness for potential variables were higher than .90 and RMSEA ranges form .05-.10, which were acceptable, so the fitness of a measured model for this study was verified.

3.4 Verification of fitness of measured model

The fitness of the measured model was estimated with maximum likelihood estimation, before the verification of the possibility and fitness of the structure regression model, as shown in Table 2. As the fitness index of an initial model, each index of TLI, CFI and RMSEA was .889, .909 and .113, and therefore, could not satisfy acceptance criteria, so measured variables with were removed in order of their explanatory power, based on the criterion of SMC. The fitness was enhanced after setting covariance, by removing two measured variables of problem-solving ability and using modified indices. The findings showed that X^2=296.47, df=70, TLI=940, CFI=.953 and RMSEA=.091(.05-.10), and that the measured model the has acceptable fitness.

Table 2. Structural equation model analysis

Variables	χ2	df	p	TLI	CFI	RMSEA
Measurement model	585.67	98	.000	.889	.909	.113
Adjustment model	296.47	70	.000	.940	.953	.091 (.05~.10)

3.5 Test of structural model and analysis of path coefficients

The parameters of the structure regression model, estimated by this study which aims to examine factors influencing problem-solving ability are shown in Figure 2.

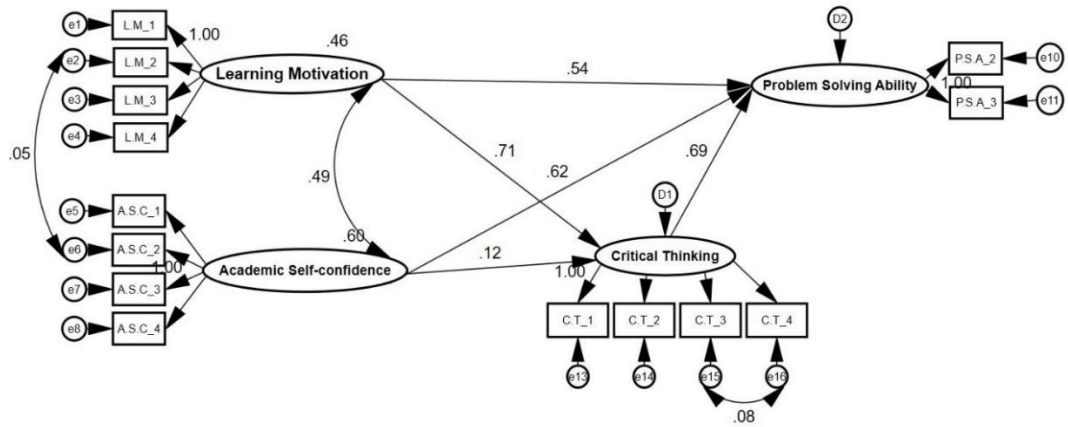

Figure 2. Estimation of standardized parameters for SEM

The path coefficients representing the relationship between potential variables were examined based on confirmatory factory analysis. The resulting B, β, S.E and C.R were shown in Table 3. Although learning confidence did not have an effect on critical thinking skill, learning motivation has a positive effect on critical thinking skill (β=.66, p<.001), with the significant level = .05. Learning confidence (β=.61, p<.001), critical thinking skill (β=.64, p<.001) and learning motivation (β=.64, p<.001) have positive effects on problem-solving ability with the significant level =.05.

Table 3. Path coefficient of variables

Path	B	β	S.E.	C.R.
Critical thinking ← Academic self-confidence	.12	.12	.172	-.671
Critical thinking ← Learning motivation	.71	.66***	.202	3.494

Problem-solving ability	← Academic self-confidence	.62	.61***	.163	3.780
Problem-solving ability	← Critical thinking	.69	.64***	.073	9.370
Problem-solving ability	← Learning motivation	.54	.47**	.200	2.691

**p<.01, ***p<.001

4. Discussion

This study analyzed the causal structure among learning motivation and confidence, critical thinking skill and problem-solving ability, using digital textbooks. This analysis demonstrated that the fitness index of the measured model met the condition and the estimation possibility of the model was verified, so the fitness of the structure model was estimated by the maximum likelihood estimation. Consequently, the fitness index of the structure model was thus found to meet the criterion of fitness. Although learning motivation has a significant effect on critical thinking skill (β=.66, p<.001), learning confidence does not. This is consistent with previous studies stressing the important of learning motivation for enhancing critical thinking skill, if learners' motivational characteristics are considered. Learning motivation as the process which puts a high value on learning activity and connects confidence with continuous intention to participate in learning may enhance high-level cognitive abilities such as critical thinking skill [14, 20]. Effects of learning motivation and confidence, and critical thinking skill on problem-solving ability were tested to show that each effect of learning motivation and confidence, and critical thinking skill on critical thinking skill is as follows: β=.47(p<.001), β=.61(p<.001) and β=.64(p<.001). The result is similar to the previous study [15] examining the correlation between factors influencing problem-solving ability and learning motivation and confidence, and consistent with the another study [16] investigating the effects of learning confidence and critical thinking skill. With enhanced learning motivation, students can concentrate efforts and interest on their schoolwork [17], and learning efficiency and critical thinking tendency can allow students to attempt to solve problems, through access to problems, collection of information and use of resources [18-19]. This means that some strategies would be required to foster talents who can solve new problems with which they will be confronted in the 21th century, and that it is necessary to make efforts to support learners' capabilities and provide opportunities for them to be exposed to affluent learning experiences and resources.

5. Conclusion

This study has an implication, in that it provides basic data for seeking measures to enhance problem-solving ability, by understanding the causal relationship among junior high school students' learning motivation and confidence, critical thinking skill, and problem-solving ability. Learning motivation has positive correlations with learning confidence, critical thinking skill and problem-solving ability. Learning confidence has positive correlations with critical thinking skill and critical thinking skill has a positive correlation with problem-solving ability.

The findings show that although learning motivation has a significant effect on critical thinking skill, learning confidence does not. In addition, the problem-solving ability can be enhanced, as learning motivation and confidence and critical thinking skill are improved. An intervention strategy for increasing learning motivation and confidence, as well as critical thinking skill is required to enhance problem-solving ability.

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