

<https://doi.org/10.33472/AFJBS.6.9.2024.3830-3840>



African Journal of Biological Sciences

Journal homepage: <http://www.afjbs.com>



Research Paper

Open Access

Mediating Effect of Learning Flow in the Relationship between Learning Motivation and Academic Achievement of Nursing Students

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Volume 6, Issue 9, 2024

Received: 09 March 2024

Accepted: 10 April 2024

Published: 20 May 2024

[doi:10.33472/AFJBS.6.9.2024.3830-3840](https://doi.org/10.33472/AFJBS.6.9.2024.3830-3840)

Abstract

This study applied AI-based adaptive learning education to nursing students to investigate the mediating effect of learning flow in the relationship between learning motivation and academic achievement of AI-based adaptive learning education in university classes. For this purpose, the effectiveness of AI-based customized learning training was verified for 197 learners who participated in basic mathematics classes among nursing students at University B in Region C. As a result of the study, it was confirmed that AI-based adaptive learning education has a mediating effect of academic immersion in the relationship between learning motivation and academic achievement. Satisfaction results: In terms of students' overall satisfaction with the use of the system, understanding was the highest, and for learning-related satisfaction, expertise and reliability were the highest. This will be an effective way for nursing students to learn because AI-based adaptive learning education improves academic achievement by increasing learning motivation and learning immersion. This study can be used as basic data for operating artificial intelligence-based adaptive learning education. In the future, we propose strategic research on how to verify the effectiveness of using various variables in AI-based adaptive learning and how to utilize the analyzed data.

Keywords: Artificial intelligence (AI), AI-Based Adaptive Learning, Learning Motivation, Learning Flow, Academic Achievement

1. Introduction

The development of new industries and new technologies has recently brought about new changes in the educational field. Artificial Intelligence (AI) is the technological foundation of the 5th Industrial Revolution and is leading innovation and change in the educational field. The development of new industries and new technologies has recently brought about new changes in the educational field. Artificial Intelligence (AI) is the technological foundation of the 5th Industrial Revolution and is leading innovation and change in the educational field. AI-based adaptive learning can enhance students' academic abilities and improve academic achievement through content and classes that reflect students' needs according to individual abilities [1]. AI adaptive learning education is a method of providing customized learning that meets the needs of each learner[2], and provides learning speed and path adjusted according to the learning level and speed of each learner. Additionally, the learning effect can be maximized by allowing weak areas to be learned repeatedly [3]. However, since students with low self-directed learning ability lack the motivation to participate on their own, it is expected that if appropriate teaching and learning is applied, it will contribute to achieving the educational goals of learners at each level.

Recently, many universities in Korea are raising issues such as a decline in the basic academic ability of new students and an increasing learning gap [1,4]. Accordingly, universities are seeking various ways to improve students' insufficient basic academic skills and increase their adaptation to university life and academic retention rates [5,6]. As part of this, many universities in the United States are trying to expand operations by introducing AI-based adaptive learning systems [7,8]. However, domestic universities are complaining of difficulties in operating AI-based systems due to economic and time difficulties in building and using them in actual classes. The Asian Education Association has proposed the High Touch High Tech (HTHT) AI-based adaptive learning education model and is attempting it in various liberal arts and major fields, including basic academic skills [9]. This is a system that utilizes big data and AI-based adaptive learning system to diagnose the level of prior knowledge of each student and provide immediate feedback to students and professors. Additionally, this is a learner-centered prescriptive teaching and learning method that connects face-to-face and non-face-to-face classes. In Korea, there are still not many AI-based education systems developed focusing on university education, and they are being developed focusing on basic subjects. AI-based adaptive learning focuses on basic education areas such as basic English, mathematics, and science, where it is relatively easy to apply artificial intelligence technology due to the nature of the curriculum and has a high impact on educational effectiveness [10]. As artificial intelligence (AI)-based education expands due to the increased use of edtech, interest in and practical use of AI-based adaptive learning systems will increase at many domestic universities. In order to obtain effective results using an AI-based system, it is first necessary to understand how to use AI-based adaptive learning, and lesson planning and operation that can maximize system utilization are very important.

The ARCS model developed by Keller started from Tolman & Lewin's 'Expectancy-Value Theory', which designs motivational aspects of the learning environment to induce and sustain learning motivation [11]. When an individual has a positive expectation of success and the activity is connected to values that satisfy the individual's needs, the individual is motivated to continue participating in the activity [12]. According to Keller, the characteristics that integrate concepts related to various variables that affect the formation of human motivation [13] are largely divided into four elements: Attention, Relevance, Confidence, and Satisfaction.

Attention is the first factor in learning motivation. Attention captures and focuses the learner's attention for learning to occur. To maintain attention, you must continuously arouse attention, arouse curiosity, and provide learning stimulation. Relevance refers to a positive perception based on how the presented content relates to one's personal interests or goals. Confidence refers to a subjective belief in the perception of one's own abilities. Satisfaction plays a role in sustaining the learner's motivation until the end. The ARCS(Attention, Relevance, Confidence, Satisfaction) model has shown in previous studies that learning motivation has a significant impact on behavioral commitment, learning flow, and academic achievement [14-16]. Learning Flow gives learners a sense of happiness in learning [17] and has been shown to have the effect of organizational immersion in the workplace [18]. It was said that Learning Flow affects academic achievement in restaurant cooking-related education and online education [19, 20].

However, the theoretical basis for learner motivation according to artificial intelligence (AI)-based adaptive learning education for nursing students is ambiguous. Recently, it appears that no systematic research on learners' motivation has been presented in artificial intelligence (AI)-based adaptive learning education. Therefore, this study seeks to determine how learning flow is related to learning motivation and academic achievement in artificial intelligence (AI)-based adaptive learning education for nursing students.

The purpose of this study is to determine the effect on academic achievement by introducing AI-based adaptive learning into classes.

1) Identify the subject's general characteristics, learning motivation, learning flow, and academic achievement.

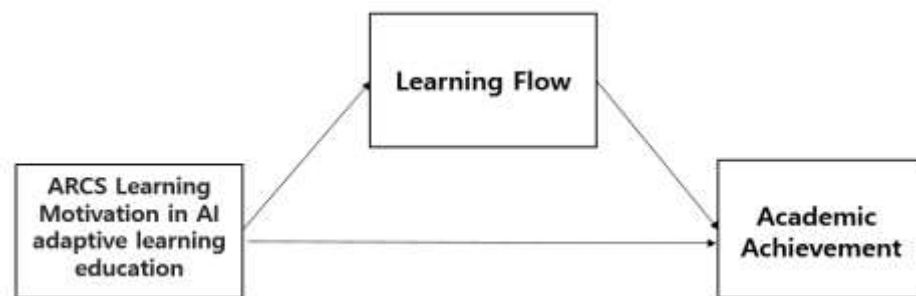
2) Determine the subject's satisfaction level with AI-based adaptive learning education.

3) AI-based adaptive learning education identifies the mediating effect of learning flow in the relationship between the subject's learning motivation and academic achievement.

2. Materials and Methods

2.1. Research Design

This study established a structural relationship in which learning motivation in AI



adaptive learning education causes learning flow and has a significant impact on academic achievement. By revealing the causal relationship between them, we attempted to present a framework of learning motivation theory for AI adaptive learning education, and the research model based on this is shown in [Figure 1].

Figure 1. This is a figure. Schemes follow the same formatting

2.2. Research Tools

2.2.1. Learning Motivation

In this study, based on the ARCS learning motivation theory [11], the tool that Lee Mi-ran [16] derived evaluation items of attention, relevance, confidence, and satisfaction was modified and used. The survey consisted of a total of 24 items, and all items used a 5-point Likert scale with 1 being 'not at all' and 5 being 'very much'. A higher score means higher learning motivation. Reliability at the time of research and development was Cronbach's $\alpha=.93$. In this study, reliability was found to be Cronbach's $\alpha=.99$.

2.2.2. Learning Flow

The measurement tool for learners' learning flow was derived from Csikszentmihalyi [21], Park Dong-cheol, et al. [22], and the questionnaire consisted of a total of 6 items, and all items were measured using a 5-point Likert scale. A higher score means higher learning immersion. Cronbach's alpha at the time of research and development was .93, and in this study, Cronbach's alpha was .93.

2.2.3. Academic Achievement

The measurement tool for academic achievement was the Ary, Jacobs, & Razavieh [23] questionnaire modified and improved by Lee Mi-ran [16]. The survey questions consisted of a total of 6 items, and all items were measured using a 5-point Likert scale. A

higher score means higher academic achievement. Cronbach's alpha at the time of research and development was .93, and in this study, Cronbach's alpha was .96.

2.3. Data Collection

In this study, we attempted to analyze the mediating effect of learning flow in the relationship between ARCS learning motivation theory and academic achievement among nursing students in AI-based adaptive learning education. This research study distributed a total of 200 questionnaires from June 12, 2023 to June 30, 2023, and after removing questionnaires with insincere or inappropriate responses, 197 copies were used in the final analysis. The anonymity of the data was guaranteed by requiring the online questionnaire to be filled out in a self-reported form after checking consent to participate in the study. For the ethical protection of research subjects, the purpose, necessity, and process of the study were explained to the subjects before data collection, and they were informed that they could withdraw at any time if they did not wish to do so while completing the questionnaire. A consent form for participation in the study was obtained, including that it would not be used for any purpose other than research and that personal information would be kept confidential.

2.4. Data Analysis

The data collected in this survey was analyzed using SPSS 23.0 for windows statistical program, and each analysis method is as follows.

1) The general characteristics, learning motivation, learning flow, and academic achievement of nursing students were calculated as frequency, percentage, mean, and standard deviation.

2) Subjects' satisfaction with AI-based adaptive learning education was calculated as frequency, percentage, mean, and standard deviation.

3) The mediation regression analysis of learning motivation, learning flow, and academic achievement of subjects of AI-based adaptive learning education was conducted according to Baron and Kenny [24]. First, regression analysis of the effect of the independent variable on the mediator, second, regression analysis of the effect of the independent variable on the dependent variable, third, when the independent variable and the mediator are input at the same time and control each other's influence, This is a regression analysis of the effect on the dependent variable. In order for a mediation effect to be established, both the first and second regression analyzes must have a significant effect, and the size of the effect of the independent variable on the dependent variable in the third regression analysis must be reduced compared to the second regression analysis. At this time, if the relationship between the independent variable and the dependent variable is still significant, it is determined that there is a partial mediation effect, and if it is not significant, it is determined that there is a full mediation effect. The significance of the mediation effect was verified with the Sobel test.

3. Results

1 General characteristics

The average age of the subjects was 21.1 years, there were 156 women (79.2%), which was more than the men (41 (20.8%)), and the most middle-ranked students were 106 (53.8%). When selecting a major, 191 (97.0%) students chose the nursing major of their own volition, and 167 (84.8%) students had no experience in taking AI-based courses (Table 1). The level of learning motivation, learning flow, and academic achievement is shown in Table 2. The motivation for learning was highest in confidence($4.00 \pm .75$), followed by satisfaction($3.99 \pm .75$), attention($3.97 \pm .75$), and relevance($3.96 \pm .78$). Learning

flow was $3.82 \pm .73$ and academic achievement was $3.84 \pm .76$.

Table 1. Results of general characteristics

Variables		N(%), M±SD
Age	≤ 20	152(77.2)
	21-30	30(15.2)
	> 30	15(7.6)
Sex	Male	41(20.8)
	Female	156(79.2)
Grades	Low	88(44.7)
	Middle	106(53.8)
	High	3(1.5)
Willingness when choosing a major	No	6(3.0)
	Yes	191(97.0)
Experience of AI-based adaptive learning	No	167(84.8)
	Yes	30(15.2)

Table 2. Learning Motivation, Learning Flow , Academic Achievement level

Variables	Category	N(%), M±SD
Learning Motivation	Attention	$3.97 \pm .75$
	Relevance	$3.96 \pm .78$
	Confidence	$4.00 \pm .75$
	Satisfaction	$3.99 \pm .75$
Learning Flow		$3.82 \pm .73$
Academic Achievement		$3.84 \pm .76$

2 *Satisfaction with AI-based adaptive learning education*

Table 3 shows the satisfaction results after operating AI-based adaptive learning education. As a result of investigating students' opinions on the use of the AI-based adaptive learning system, understanding($3.91 \pm .73$) and learning progress($3.91 \pm .74$) were

the highest in students' satisfaction with the system use. Satisfaction with AI-based adaptive learning was highest for Professionalism(3.90±.74) and Customizing(3.90±.72), followed by convenience (3.89±.70), reliability (3.89±.77), and intention to use (3.88±.76) appeared in that order. The results of analyzing the problems related to the use of AI-based systems showed that 'anxiety about grades' was the most common with 66 people(33.5%), followed by 'Topic Learning Problem Difficulty' with 43 people (21.8%) and 'Learning topics that require mastery' was followed by 35 people(17.8%).

Table 3. AI-based adaptive learning satisfaction

Variables	Category	N(%)	M±SD
System Satisfaction	Learning help		3.88±.76
	Understanding		3.91±.73
	Interesting	3.86±.76	3.89±.68
	Learning progress	3.91±.74	
	Learning support	3.89±.68	
Learning related satisfaction	Learning effect	3.85±.73	
	Convenience	3.89±.70	
	Customizing	3.90±.72	3.88±.70
	Professionalism	3.90±.74	
	Reliability	3.89±.77	
	Intention to use	3.88±.76	
Problems	Unpredictable learning time	17(8.6)	
	Learning topics that require mastery	35(17.8)	
	A different class	15(7.6)	
	Topic Learning Problem Difficulty	43(21.8)	
	Anxiety about grades	66(33.5)	
	etc	21(10.7)	

3 The mediating effect of learning flow on the relationship between learning motivation and academic achievement in AI-based adaptive learning education.

The results of confirming the mediating effect of learning flow in the relationship between the subject's learning motivation and academic achievement are shown in <Table 4>. Before confirming the mediating effect, the tolerance limit and variance inflation factor were checked to diagnose multicollinearity between independent variables. As a result, the tolerance limit was 0.34 to 0.88, which is more than 0.1, and the variance inflation factor(VIF) range was 1.00 to 1.13, which was less than 10. It was small and showed no multicollinearity. The autocorrelation of the dependent variable showed a Durbin-Watson value of 2.01, confirming that it was independent without autocorrelation. The normality test of the residuals was statistically significant(Z=2.00, p=.000), indicating that the regression model was appropriate. The independent variable, learning motivation, was confirmed as a significant influencing factor on the mediating variable($\beta=.878$, $p<.001$), learning flow, and was confirmed as a significant influencing factor on the dependent variable, academic achievement($\beta=.907$, $p<.001$).

As a result of adding learning motivation and learning flow simultaneously, learning flow, which is a mediating variable, was a significant influence factor on academic achievement($\beta=.628$, $p<.001$), and learning motivation also had a significant effect($\beta=.318$, $p<.001$). It was judged that learning flow played a partial mediating role, as the influence was reduced compared to when input alone. As a result of the Sobel test, the partial mediating effect of learning flow in the relationship between learning motivation and academic achievement was statistically significant(Z=3.29, $p<.001$) (Table 4).

Table 4. Mediating Effect of Learning Flow in the Relationship between Learning Motivation and Academic Achievement

Variables	B	SE	β	t(p)	R2	F(p)
1. Learning Motivation → Learning Flow	0.864	0.034	0.878	25.627 (.000)	0.771	656.75 (.000)
2. Learning Flow → Academic Achievement	0.944	0.031	0.907	30.112 (.000)	0.823	906.76 (.000)
3. Learning Motivation, Learning Flow → Academic Achievement	0.325 0.654	0.06 0.061	0.318 0.628	5.398 10.673 (.000)	0.846	533.36 (.000)

Sobel test: Z=3.29 (p <.001)

4. Discussion

This study was conducted to prepare a plan for future expansion of the system based on the case of a university that operated an AI-based adaptive learning system. To this end, we operated AI-based adaptive learning for basic mathematics subjects and then identified the mediating effect of learning flow in the relationship between learning motivation and academic achievement. In addition, in order to collect opinions on the system, the learners' satisfaction with the system, satisfaction with learning activities, and opinions on problems were identified. A comprehensive discussion of the analysis results is as follows.

As a result of analyzing learning motivation, learning flow, and academic achievement after AI-based adaptive learning training, self-confidence was the highest among learning motivation. Additionally, learning flow and academic achievement were also high. It was found that there was a significant relationship between learning motivation and learning flow through AI-based adaptive learning. This result was consistent with the results of ARCS learning motivation theory, which proved to be an effective variable for learning flow through various previous studies. Deukman Kim [15] revealed that the ARCS learning motivation model shows that three of the four variables of ARCS learning motivation in lifelong vocational education - attention, relevance, confidence, and satisfaction - have a significant impact on learning flow. Lee Mi-ran [16] and Dong-cheol Park et al. [22] found that the ARCS learning motivation theory showed that the four sub-variables of the ARCS learning motivation model, attention, relevance, confidence, and satisfaction, had a significant impact on NCS-based learners' learning immersion. This has been studied. Hong Yu-na [25] was able to confirm that learning motivation affects learning immersion in art museum career education for teenagers, and Choi Woo-seong and Woo Yeo-reum [26] in English education for college students majoring in tourism.

In addition, it was found that there was a significant relationship between learning flow and academic achievement through AI-based adaptive learning. This result is consistent with previous studies that reported a positive correlation between learning flow and academic achievement. Learning flow not only reduces study time and promotes active participation in learning activities, but also has a positive effect on academics, improving academic achievement. Students who are immersed in the learning process are said to experience positive emotions such as curiosity, interest, and passion generated while learning, take on more difficult tasks than before, and show great effort and high concentration for academic achievement [16]. Kyeong-Hwa Jeong [19] stated that in food service education, if students are encouraged to be interested in their studies by giving them a positive perception and helping them experience success, the degree of learning immersion will increase and have a significant impact on academic achievement. Seongmu Bae [27], Ara Jo, and Seokjun Noh [20] stated that in university distance education, learners' learning attitude did not have a significant effect on academic achievement, but learning flow and academic achievement had a significant positive correlation. Through this study, it was confirmed that it had a significant impact on learning immersion and academic achievement. In the case of Korean students, it was said that the effect of intrinsic motivation was greater than that of instrumental motivation and had a significant impact on academic achievement [28]. Accordingly, AI-based adaptive learning can provide customized content according to the learner's level, so it is believed that it can contribute to improving academic achievement by providing students with internal learning motivation and promoting learning flow. However, students diagnosed with a low level of prior learning may feel burdened by the large amount of learning to be done and may express difficulties in the learning process. Therefore, rather than relying entirely on AI-based customized learning systems in relation to controlling students' learning volume, instructors are required to reflect students' situations [29, 30] and use the system flexibly in terms of difficulty level, topic selection, and problem progression method. In addition, instructors need to carefully consider strategies to actively and continuously encourage learner participation by adjusting the amount of class content covered by the system and the level of system utilization so that the repetitive problem-

solving learning method can achieve positive effects.

In terms of system satisfaction, satisfaction with understanding and learning process progress was high, and in learning activities, satisfaction scores were high in reliability and expertise. This is believed to be the result of good feedback based on diagnostic evaluation in the system. On the other hand, the convenience of the system and the interest of learning activities were low, which means that the system needs to be supplemented so that students can immediately learn the concepts of problems they got wrong. In addition, in order to induce adaptive learning, comparative analysis of systems and understanding of suitability for the university environment are necessary, as in the case of application in the United States [7, 31]. AI-based adaptive learning appears to have suffered from anxiety about grades, difficulty of learning questions for each week, and the need to complete classes within a set period of time for each week. The type and difficulty level of content provided by the AI-based customized learning system does not vary depending on the student level, and it does not provide immediate feedback on topics and solutions. Accordingly, if you rely solely on AI-based customized systems for learning, academic achievement may not be as high as instructors expect [8]. These results mean that, considering that AI-based systems consist of learning content centered on learning to master basic concepts, separate teaching and learning is needed for application of concepts or in-depth learning. Therefore, it is necessary to design and operate classes that link the system with teaching and learning activities in the classroom to understand the content characteristics of the AI-based system in advance and achieve realistic class goals. Accordingly, strategies for data utilization on how to effectively utilize students' learning process and result data provided by AI-based personalized learning in classroom classes should also be considered.

5. Conclusions

This study analyzed the effects of applying AI-based adaptive learning at University B and proposed implications for considering the expansion of AI-based customized learning in the future based on the results. Through AI-based adaptive learning, the results showed that the learner's learning motivation had a positive effect on learning flow and academic achievement, and the results showed that learning flow had a positive effect on academic achievement. Therefore, AI-based adaptive learning was found to increase academic achievement as the learner's learning motivation and learning flow increased. This confirmed that learners' learning flow was an important factor in academic achievement. Although this result is an example from a single university, it can be considered meaningful for the expansion of AI-based adaptive learning at a time when universities are currently showing high interest in the use of AI-based systems and are making efforts to practically introduce them. The results of this study can be used as basic data if an AI-based adaptive learning system is to be introduced in the future for the purpose of solving the problems of university education provided by student level and increasing learning effectiveness. Based on the above results, the following suggestions are made.

As this study confirms the effect of using an AI-based customized system in a specific subject at one university, it is necessary to expand the operation of the AI-based adaptive learning system and analyze the effect of applying it to various subjects. In addition, we would like to verify the learning effectiveness of AI-based adaptive learning in universities by reflecting various variables and propose follow-up research on the development of an effective teaching and learning model using AI-based adaptive learning education.

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