Applying Artificial Intelligence-Based Adaptive Learning on Mathematical Attitudes and Self-Directed Learning

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AI-adaptive learning is an educational method that provides customized learning that meets the needs of each learner, but there are few AI-based education systems developed around university education in Korea. Hence, this study applied the AI-based adaptive learning system to basic mathematics subjects to investigate the mathematical attitude and self-directed learning ability of the AI-based customized learning system in university classes. The survey data consisting of a single group pre-post experimental design for 177 students who participated in basic math courses among first-year students at B community college in C region from March to June 2023 were analyzed.

As a result of the study, the use of AI-based adaptive learning system improved students' mathematical attitude and self-directed learning ability. The level of understanding was the highest in students' overall satisfaction with the use of the system, and professionalism and reliability were the highest in learning-related satisfaction. Although this study was designed only in a specific population, the results suggest that AI adaptive learning can be an effective way to motivate and strengthen knowledge by improving self-directed learning capabilities and mathematical attitudes.

Keywords: Artificial intelligence(AI), AI-Based Adaptive Learning, Mathematical Attitudes, Nursing students, Self-Directed Learning.

1. Introduction

New technology development and online education methods have brought about new changes. These developments have also caused new changes in education. One of these developments that is leading innovation and change in various areas of society as a technological foundation of the 5th Industrial Revolution is Artificial Intelligence (AI), which is said to be the coexistence of humans and machines by adding a human element to the results of the 4th Industrial Revolution[1]. In the field of education, personalized learning provided by AI is also attracting attention and expectations as a way to accelerate innovation in teaching and learning methods. Artificial intelligence-based adaptive learning, which has recently been used, is a way to solve learning difficulties that arise in learning, such as students' learning motivation,

level, various student resource limitations, and background. Interest in AI-based adaptive learning is growing because it has the advantage of improving students' learning performance and self-directed learning ability through content and lessons tailored to each student's needs and abilities. The growing interest in AI-based adaptive learning is the advantage of improving students' learning performance and self-directed learning skills through content and classes tailored to individual students' needs and abilities [2]. AI-adaptive learning is an educational method that provides customized learning that meets the needs of each learner [3]. It also and maximizes the learning effect by adjusting the learning path and speed according to the learning speed and level of each learner and allowing repeated learning of vulnerable parts [4]. In particular, students with low self-directed learning ability can achieve can achieve their learning goals if appropriate teaching-learning is applied. However, students with low self-directed learning skills lack the motivation to participate, so if appropriate teaching-learning is applied, it is expected to contribute to the efficient achievement of various learners' learning goals.

Recently, due to the decrease in the school-age population and the increase in special admission, excellent learners are entering universities, and the number of admission to colleges for learners with low basic learning skills is increasing. Therefore, in colleges, there is a problem that students' basic education is decreasing and the learning gap is gradually increasing. Recently, many universities in Korea have problems such as a decrease in students' basic education and a gradual increase in the learning gap due to changes in the educational environment, such as various admission screening and a decrease in the school-age population [2,5]. Accordingly, community colleges and universities are seeking ways to respond to these changes in the educational environment, improve students' lack of basic academic skills, and increase the academic retention rate.[6,7]. As part of this, many foreign universities are making efforts to introduce and operate AI-based adaptive learning systems [8,9]. However, domestic universities are very limited due to economic difficulties in building and operating AI-based systems that can be used for actual classes. The Asian Education Association is attempting AI-based customized learning by presenting a High Touch High Tech (HTHT) education model [10]. In general, most adaptive learning systems, including HTHT, use mathematical algorithms to identify students' current levels and recommend appropriate learning methods and paths. The currently developed AI-based customized learning system is also being developed mainly for basic subjects. This HTHT is a learner-centered prescription teaching and learning method that uses intelligent information technology-based adaptive learning systems such as big data and AI to diagnose individual students' prior knowledge levels, provide immediate feedback to students and professors, and fit individual students and groups inside and outside the classroom. There are not many AI-based education systems developed in Korea centered on university education which are being developed around basic subjects, and platforms developed overseas are introduced and applied on a trial basis to some statistics-oriented subjects. AI-based adaptive learning focuses on basic education areas such as basic science, math, and writing, which are relatively easy to apply artificial intelligence technology due to the nature of the curriculum and have a significant influence on educational effects[11,12]. And recently, it has expanded its scope to the fields of history, psychology, economy, art, philosophy, marketing, legume products and animal research [13,14,15,16]. As artificial intelligence (AI)-based education expands due to the increase in the use of Edutech

due to post-COVID-19, interest in and practical use of AI-based adaptive learning systems will increase in many domestic universities.

In order to achieve effective results using AI-based systems, it is first necessary to analyze AI-based system functions and characteristics, and to understand how to effectively utilize the data provided by the system. In addition, it is very important to plan and operate classes that can maximize the effectiveness of system use.

Therefore, this study intends to apply AI-based adaptive basic mathematics to operate it on nursing students and to see changes in their mathematical attitudes. Mathematical attitudes refer to emotions, feelings, and interests that students have during the learning process[17,18]. These also refer to students' learning attitudes, beliefs, and motivations in the learning process [17]. Mathematics attitude is an accurate perception of the mathematics subject itself, the learner, and the situation in which mathematics is learned, and is also the result of a conscious or unconscious individual's evaluation. Therefore, in order to promote mathematical attitudes, it is necessary to motivate students during class [18]. Through this study, customized learning tailored to each individual level was made to enhance motivation for learning mathematics. Through this class, customized learning is conducted at the individual level to promote motivation for mathematics.

Mathematical attitude refers to the values and interest one has toward mathematics, the attitude toward mathematics, and the emotions one has toward mathematics [19] [40]. Mathematical attitudes are influenced by the teacher's teaching and learning methods as well as the individual characteristics of the learner. Therefore, there is a need to pay attention to forming a positive mathematical attitude toward mathematics [17]. In previous studies, GeoGebra, experiential activities, classes using engineering tools, problem-based learning (PBL), and concrete manipulatives were used in mathematics classes and showed results of improving student's attitudes toward the subject [18].

Additionally, self-directed learning means that learners carry out learning on their own [19]. Self-directed learning is an effective educational method in increasing students' confidence and improving their ability for independent learning [20]. In online classes, self-directed learning ability is very important because learning outcomes vary depending on whether the learner takes initiative and actively participates in learning [21]. Looking at previous research on self-directed learning ability, it was found to be positively correlated with nursing students' learning immersion, academic self-efficacy, and academic achievement [22, 47]. It affects self-leadership, adaptation to college life, and psychological well-being[23], and has a desirable effect on academic achievement by increasing learning satisfaction[24] and clinical performance ability[23, 25]. This can be seen as a desirable result of learners autonomously adapting and coping with an environment in which they must participate in classes and learn proactively.

Therefore, this study also aims to find out how the use of AI-based customized systems in classes improves self-directed learning, and to analyze the perception of the participants on the AI-based systems in teaching and learning. It is intended to be a basic data for effective use of AI-based systems in future university classes.

Genrally, this study sought to identify the difference between nursing students' mathematical

attitudes and self-directed learning before and after introducing AI-based adaptive learning into classes. Specifically, it aimed to first, identify the general characteristics of the subject. Second, identify the differences between the general characteristics of the subject, mathematical attitudes, and self-directed learning. Third, identify the difference between the subject's mathematical attitude and self-directed learning before and after AI-based adaptive learning. Fourth, identify the satisfaction level of the participants of AI adaptive learning.

2. RESEARCH METHOD

2.1 Selection of Subjects

For this study, a basic mathematics course that conducts AI adaptive learning at community college B was selected to understand the effect of applying AI-based adaptive learning. The subject was selected as "Basic Mathematics," a basic subject in which AI-based customized learning is currently underway on the HTHT platform.

2.2 AI-Based Customized Learning System Utilization and Class Operation

2.2.1 AI-Based Customized Learning System Utilization

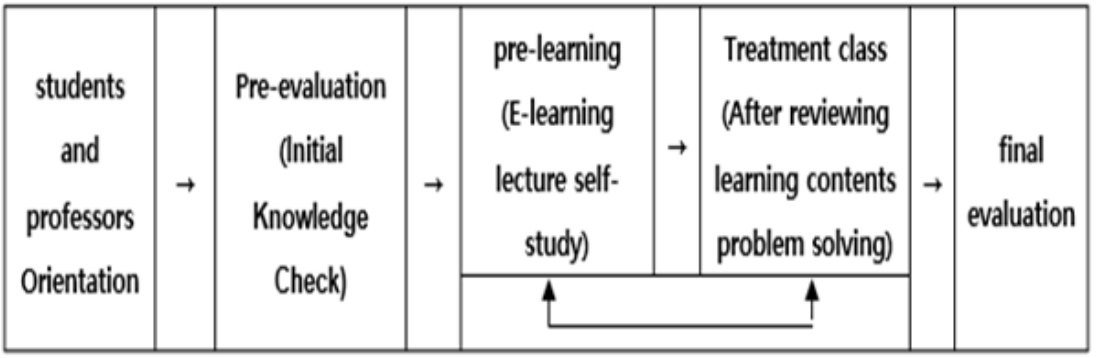
The basic mathematics subject selected as the example of this study used an AI-based customized learning system, an HTHT education model of the Asian Education Association. This system continuously measures learners' knowledge levels by applying artificial intelligence-based technology and recommends individualized learning paths according to the results. HTHT is an activity-based artificial intelligence (AI)-based system that solves problems by topic, and is conducted by identifying the level before learners' participation through an initial Knowledge Check (IKC) and presenting learning problems by path. HTHT's topic is the smallest unit of learning content, and the instructor is supposed to select the topic to be learned, and when the subject is first created, it is supposed to be selected. The instructor can organize the class by selecting the topic method according to the teaching method. The topic method chosen by the instructor is a method that allows the student to learn at any given time of class. Students' learning level methods are divided into 'Learned' and 'Master' (skilled). Learned judges that students learned the concept when they answered the related questions presented in the topic, and the Master judges that they are familiar with the concept when they answer the problem of the concept learned in the Knowledge Check conducted to check the learning status after learning. Treatment evaluation can participate in treatment evaluation after learning for a certain period or more, and can be added if the instructor thinks it is necessary.

2.2.2 AI-Based Customized Learning Class Operation

The class plan and operation of the subject were carried out according to the characteristics of the subject through cooperation between the instructor and the instruction designer, reflecting the learning goals, learner characteristics, educational content, class environment, and evaluation methods of each subject.

The course was a basic mathematics course taken by first-year nursing students at a community college, and the number of students was 177. All parking was operated as an online class, and HTHT was used in the entire class process. The teaching method was conducted by

participating in topic classes after conducting prior learning through HTHT problem solving. HTHT was conducted in a topic method, and 15 topics were organized into 1-2 topics according to the theme of each week. Students were required to watch lecture videos after pre-diagnosis, learn all set topics, and participate in treatment evaluation. In the treatment evaluation, it was designed to conduct problem-solving activities by level based on the learning process and result data. The overall learning process was designed as shown in Figure 1 and classes were conducted at each time.



[Fig. 1] class course

2.3 Research Design

This study is a similar experimental study of a single group pre-post experimental design to apply AI-based adaptive learning to nursing college students and verify its effectiveness.

[Table 1] Research Design

Group	Pre test	Intervention	Post test
Experimental group	E1	X	E2

E1: pre Mathematical Attitudes, Self-Directed Learning

X: AI-based adaptive learning

E2: post Mathematical Attitudes, Self-Directed Learning

2.4 Research Tools

2.4.1 Mathematical Attitude

The mathematical attitude test paper used in this study was a test paper developed by Lee, Kim, Lee, Lee, and Geo [26]. The mathematical attitude test was divided into seven areas: math interest, math learning attitude, value, external motivation, willingness to learn, internal motivation, and efficacy, and for a total of 24 questions. Each question consists of a 4-point Likert scale, and the higher the score, the more positive the mathematical attitude is. At the time of R&D, the reliability was Cronbach's α= .93. In this study, the reliability is Cronbach's α= . 823.

[Table 2] Composition of mathematical attitude survey questions

Category	Number of questions	Cronbach's α
math interest	4	.873
math learning attitude	4	.850
value	4	.861
external motivation	2	.860
willingness to learn	4	.841
internal motivation	2	.848
efficacy	4	.848
Total	24	.823

2.4.2 Self-Directed Learning

Self-directed learning ability was measured using a self-directed learning ability diagnostic tool developed for college students/adults by Lee, Chihui, Chienlin, and Tseng [27]. The self-directed learning ability evaluation questions consisted of 45 questions, and the detailed items consisted of 20 questions of learning plan, 15 questions of learning execution, and 10 questions of learning evaluation. Each question consisted of a 5-point Likert scale, and the higher the score, the higher the self-directed learning ability. At the time of R&D, Cronbach's alpha was .93, and in this study, Cronbach's alpha was .915.

[Table 3] Composition of Self-directed learning ability survey questions

Category	Number of questions	Cronbach's α
learning plan	20	.642
learning execution	15	.767
learning evaluation	10	.778
Total	45	.915

2.4.3. Satisfaction Level

In order to conduct a satisfaction survey on the use of AI-based adaptive learning systems, the overall operation satisfaction and the tool [28] used in AI language learning applications were modified and used according to the pilot operation context of this study. The tool's contents consisted of 18 questions, including the overall learning effect, convenience, personalization, expertise, reliability, and intention to use AI-based customized learning. The 5-point Likert scale, which consists of “Not at all” (1 point) and “Very Yes” (5 points), was used. The higher the score, the higher satisfaction. In the JIN [28] study, Cronbach's alpha was .96, and in this

study, In this study, the satisfaction with system use was .992 for Cronbach's alpha, and the satisfaction with AI-based adaptive learning was .979 for Cronbach's alpha.

[Table 4] Composition of satisfaction level survey questions

Variables	Category	Cronbach's α	
System Satisfaction	Learning help	.915	.992
	Understanding	.932	
	Interesting	.925	
	Learning progress	.897	
	Learning support	.980	
Learning related satisfaction	Learning effect	.982	.979
	Convenience	.983	
	Customizing	.983	
	Professionalism	.982	
	Reliability	.986	
	Intention to use	.983	

2.5 Data Collection

The data collection period of this study was from March 01 to June 12, 2023, and after obtaining permission from the head of the nursing department, the researcher visited in the school person to explain the purpose of the study to the students before and after the class began, provide URLs, and collect data online. In the online questionnaire, the anonymity of the data was guaranteed by checking consent to participate in the study and then filling out the self-reported questionnaire. For the ethical protection of the study subjects, the purpose, necessity, and process of the study was explained to the study subjects before collecting data, and subjects were assured that they can withdraw at any time if not desired while filling out the questionnaire. Further, the consent form includes confidentiality of personal information and will not be used for any purpose other than research.

2.6 Data Analysis

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

1) The general characteristics, mathematical attitudes, self-directed learning, and satisfaction of nursing students were calculated as frequency, percentage, mean and standard deviation.

2) Independent samples t-test and ANOVA & Scheffe, correlation analysis were

conducted for the differences in general characteristics, mathematical attitudes, and self-directed learning of nursing college students.

3) The subject's mathematical attitude and self-directed learning ability before and after AI-based adaptive learning were analyzed using independent sample t-test.

2.7 Ethical Considerations

The purpose and procedure of the study, guarantee of anonymity, and protection of personal information were explained to the research subjects, and new nurses who voluntarily expressed their intention to participate in the research. The research subjects were asked to sign a consent form before the survey was conducted. In addition, it was clearly explained that there would be no disadvantage in grades. even if the participant decided to withdraw from the study at any time.

3. RESULTS

3.1 General Characteristics

The average age of the subjects was 20.8 years old, with 143 women (80.8%) outnumbering 34 men (19.2%). The grades were 99 (55.9%) in the middle, 75 (42.4%) in the bottom, and 3 (1.7%) in the top. When choosing a major, 173 (97.7%) students chose the nursing major of their own volition, and 4 (2.3%) did not, indicating that most students chose the major on their own. and in terms of experience taking AI-based courses, 150 (84.7%) had no experience and 27 (15.3%) had experience, indicating that most students had no experience taking AI-based courses as shown in Table 5.

[Table 5] Characteristics of 177 Korean nursing students

Variables	Category	N(%), M ± SD
Age	20.82 ± 5.89	
Sex	Male	34(19.2%)
	Female	143(80.8%)
Grades	High	3(1.7%)
	Middle	99(55.9%)
	Low	75(42.4%)
Willingness when choosing a major	No	4(2.3%)
	Yes	173(97.7%)
Experience of AI-based adaptive learning	No	150(84.7%)
	Yes	27(15.3%)

3.2 Relationship between General Characteristics and Mathematical Attitudes and Self-Directed Learning

Table 6 shows the results of analyzing mathematical attitudes and self-directed learning before and after AI-based adaptive learning activities. Mathematical attitudes after AI-based adaptive learning activities were statistically significant, with students with excellent grades showing good mathematical attitudes (F=14.555, p=.000). However, it was not significant depending on age, gender, willingness to choose a major, and presence or absence of AI experience(r=-.127, p=.092, t=1.953, p=.052, t=1.603, p=.111, t=.492, p=.623).

Self-directed learning ability after AI-based adaptive learning activities was not statistically significant depending on age, gender, grades, willingness to choose a major, and presence or absence of AI experience(r=.016, p=.832, t=-.630, p=.530, F=.343, p=.710, t=1.127, p=.261, t=1.055, p=.293)

[Table 6] Relationship between General Characteristics and Mathematical Attitudes and Self-Directed Learning in 177 Korean nursing students

Variables	Category	Mathematical Attitudes		Self-Directed Learning	
		M ± SD	t or F/r(p)	M ± SD	t or F/r(p)
age		3.23 ± .63	-.127(.092)	3.89 ± .61	.016(.832)
Sex	Male	3.42 ± .64	1.953(.052)	3.83 ± .70	-.630(.530)
	Female	3.18 ± .62		3.90 ± .59	
Grades	High	4.33 ± .54a	14.555(.000)a>b>c	3.60 ± .53	.343(.710)
	Middle	3.38 ± .55b		3.89 ± .60	
	Low	2.99 ± .63c		3.90 ± .65	
Willingness when choosing a major	No	2.72 ± .64	1.603(.111)	3.90 ± .62	1.127(.261)
	Yes	3.24 ± .63		3.55 ± .43	
AI-based adaptive learning experience	No	3.22 ± .64	.492(.623)	4.01 ± .55	1.055(.293)
	Yes	3.28 ± .59		3.87 ± .62	

3.3 Effects of Mathematical Attitude and Self-Directed Learning before and after AI Adaptive Learning

Table 7 shows the comparison results of mathematical attitudes and self-directed learning ability effects before and after AI-adaptive learning. Mathematical attitude improved significantly after employing AI-adaptive learning activities (3.23 ± .63) than before (2.86 ± .58), showing a statistically significant result (t=5.607, p=.000). Self-directed learning ability was also improved after implementing AI-adaptive learning (3.89 ± .61 points) that before its

implementation (3.74 ± .51 points), showing a statistically significant result (t=-2.484, p=.013).

[Table 7] Comparison of Mathematical Attitudes and Self-Directed Learning before and after AI Adaptive Learning N=177

Variables	Pre(M ± SD)	Post(M ± SD)	t	p
Mathematical Attitudes	2.86 ± .58	3.23 ± .63	5.607	.000
Self-Directed Learning	3.74 ± .51	3.89 ± .61	-2.484	.013

3.4 Learner Satisfaction

Table 8 shows the satisfaction level after AI-based adaptive learning operation. According to a survey of students' opinions on the use of AI-based adaptive learning systems, Overall, students' overall satisfaction with using the system was 3.89 ± .69. Learning help was 3.88±.78, understanding was 3.91±.73, interesting was 3.85±.76, learning progress was 3.90±.75, and learning support was 3.89±.69, with understanding (3.91±.73) being the highest.

Satisfaction with AI-based adaptive learning was 3.87±.71 for learning effect, 3.84±.74 for convenience, 3.89±.74 for professionalism, 3.89±.76 for reliability, and 3.87±.78 for intention to use. This shows that professionalism (3.89±.74) and reliability (3.89±.76) were the highest, while convenience (3.84±.74) seemed to be low.

As a result of analyzing problems related to the use of AI-based systems, 32.8% (58) were most anxious about grades, followed by difficulty in learning problems by parking 22.6% (40), requests for completion of classes within a fixed period by parking 17.5%(31), Unpredictable learning time 8.5%(15), a different class 6.8%

(12), and etc 11.9%(21).

[Table 8] Learner Satisfaction in 177 Korean nursing students

Variables	Category	N(%), M ± SD	
System Satisfaction	Learning help	3.88 ± .78	3.89 ± .69
	Understanding	3.91 ± .73	
	Interesting	3.85 ± .76	
	Learning progress	3.90 ± .75	
	Learning support	3.89 ± .69	
Learning related satisfaction	Learning effect	3.87 ± .71	3.88 ± .77
	Convenience	3.84 ± .74	
	Customizing	3.87 ± .72	

	Professionalism	3.89 ± .74	
	Reliability	3.89 ± .76	
	Intention to use	3.87 ± .78	
Problems	Unpredictable learning time	15	8.5%
	Learning topics that require mastery	31	17.5%
	A different class	12	6.8%
	Topic Learning Problem Difficulty	40	22.6%
	Anxiety about grades	58	32.8%
	etc	21	11.9%

4. DISCUSSION

In this study, an investigation was conducted regarding universities implementing AI-based adaptive learning systems aimed at formulating strategies for future system expansion and operation. Specifically, the effect of employing AI-based adaptive learning activities in basic mathematics subjects on the mathematical attitudes and self-directed learning skills of students was identified. Additionally, the study evaluated student satisfaction with the system, learning activities, and addressed potential issues. The following is a comprehensive discussion of the analysis outcomes, referencing relevant studies.

The analysis of mathematical attitudes and self-directed learning skills before and after AI-based adaptive learning activities revealed a positive correlation between students with strong academic performance and improved mathematical attitudes post-engagement with the AI-based system. A significant enhancement in mathematical attitudes was observed after the learning activities. Mathematical attitudes encompass students' emotional disposition, interests, learning approaches, beliefs, and motivations throughout the learning process. The success of the adaptive learning system was particularly pronounced in subjects characterized by sequential conceptual knowledge [12]. Moreover, studies conducted by Hwang, Shin [32] in general chemistry classes demonstrated an overall improvement in students' conceptual knowledge, reinforcing the potential of AI-based adaptive learning to enhance understanding.

While no significant differences were identified in self-directed learning ability based on factors such as age, gender, grades, major choice, and AI experience following AI-based adaptive learning activities, a statistically significant increase was observed in self-directed learning ability before and after engaging with the AI-based system. This is in line with contemporary trends in nursing education, advocating for autonomous learning through methods such as Problem-based Learning (PBL) and Evidence-based Nursing (EBN) [33]. The study underscores the potential for AI-based customized learning to augment gaps on effective self-directed learning. However, the customization process should consider

variations in students' prior knowledge levels, and adjustments to learning volume, difficulty, topic selection, and problem progression methods are recommended [18,19] [44][45][46].

We support previous research that argues that the reason for the increase in self-directed learning ability is related to the advantage of being able to access and learn from the AI system outside of class hours and regular study habits[34]. In this study, AI learning was applied in class, but let students know that access is possible at other times as well and encouraged additional learning. The AI system has the advantage of being freely accessible anytime, anywhere through a PC or smartphone. The results of this study suggest that periodic learning through learning convenience is helpful for academic achievement.

This means that in order to improve academic performance, it is important for students to have a self-directed attitude to actively solve many customized problems provided by AI rather than passive learning where students simply access programs and fill study time[35]. Learner autonomy, in which the learner actively controls the learning process with a sense of responsibility as the subject of learning, is considered an important attitude in learning basic mathematics. Even in learning, a self-directed attitude in which students solve many problems autonomously and actively is essential for improving scores. AI-based adaptive learning systems can support problem-solving motivation by presenting problems appropriate to the learner's level. In conclusion, students' periodic learning and active problem solving are important in classes using AI, and class design and operation for this are necessary.

Overall, students displayed satisfaction with the AI-based customized learning system. High levels of satisfaction were reported concerning comprehension of the system, progression of the learning process, reliability, and expertise exhibited in learning activities. However, aspects related to system convenience and engagement in learning activities registered comparatively lower satisfaction levels. To address this, the study suggests the implementation of system enhancements to facilitate immediate concept clarification for incorrect answers and to tailor content for diverse learning levels. This aligns with previous research advocating for incorporating a comparative analysis of AI-based systems and suitability within the university environment [8,36,37].

The focus of this study was to investigate the influence of AI-based adaptive learning in basic mathematics education for nursing students. The results revealed that such integration has significant evidence of its potential to enhace students' mathematical attitudes and self-directed learning capabilities.

The findings of this study align with previous research conducted by Smith et al.[37], who noted that personalized learning experiences, tailored to individual students' needs, can significantly improve engagement and motivation. This study concurred with these findings, as students engaging with AI-based adaptive learning demonstrated heightened motivation and engagement in the mathematics learning process. This result substantiates the effectiveness of personalized AI-driven content delivery in enhancing students' attitudes towards the subject matter.

Moreover, the results of this study aligns with the study by Johnson and Lee[38], which emphasized the positive impact of AI-based adaptive learning on self-directed learning abilities. the results of this study. This suggests that the tailored learning paths and immediate

feedback provided by AI systems contribute to fostering students' independence and responsibility for their learning.

The implications of the study findings extend beyond the local context to a global perspective. As universities worldwide grapple with evolving educational paradigms, the integration of AI-based systems, as demonstrated in this study, holds the promise of addressing learning disparities and enhancing academic outcomes. Research by Anderson and Williams[39] supports this notion, highlighting how AI-driven personalized learning can effectively bridge knowledge gaps and optimize learning trajectories. This is particularly significant for institutions catering to a diverse student population, as evidenced by the growing enrollment of students with varying levels of foundational skills[40].

While this study yields promising insights, we acknowledge certain limitations. This research was limited to a specific subject area and student cohort, potentially limiting the generalizability of findings. To address this limitation, future research could draw from the work of Zhang, Chen, and Wang [41], which explored the impact of AI-based systems across multiple disciplines and academic levels. Additionally, an area for future investigation, as suggested by Thompson and Martinez[42], lies in assessing the long-term sustainability of AI-based adaptive learning initiatives, ensuring continued efficacy beyond short-term implementation.

5. CONCLUSION

This study has delved into the dynamic landscape of education, particularly in AI-based adaptive learning, to address evolving challenges and opportunities. The primary objective was to explore the impact of integrating AI-based adaptive learning systems into basic mathematics education for nursing students. This investigation aimed to shed light on the transformation of mathematical attitudes and self-directed learning capabilities because of this integration, while also assessing student satisfaction with the implemented AI-based systems.

The central findings of this study have underscored the significant role that AI-based adaptive learning can play in reshaping students' mathematical attitudes and bolstering their self-directed learning abilities. Through the tailored learning experiences offered by AI systems, students exhibited heightened motivation, engagement, and improved proficiency in mathematics. The results not only support the potential of AI-based adaptive learning to address learning disparities, but also emphasize the importance of personalized educational approaches.

On a broader scale, these findings carry global implications for education systems striving to embrace innovation and adapt to evolving learning paradigms. The successful application of AI-based adaptive learning has the potential to bridge gaps in foundational knowledge and facilitate more effective learning experiences, contributing to enhanced academic retention rates and overall student success.

However, it is important to acknowledge certain limitations of this study. The research was conducted within a specific context and focused on a particular subject area. This context-specific nature could potentially limit the generalizability of the findings to diverse educational settings and disciplines. Additionally, the study's scope predominantly encompassed

mathematical attitudes and self-directed learning capabilities, leaving room for further exploration of the multifaceted impacts of AI-based adaptive learning on broader educational outcomes.

Moving forward, there are promising avenues for future research in this domain. First, conducting similar studies across various subjects and academic levels would offer a more comprehensive understanding of the broader applicability and potential challenges of AI-based adaptive learning systems. Furthermore, exploring the long-term sustainability and scalability of these systems, along with their impact on advanced cognitive skills, could yield valuable insights for educators and policymakers. Additionally, investigating strategies to maximize the synergistic effects of AI-based systems and traditional teaching methodologies remains an area ripe for exploration.

In essence, this study contributes valuable insights to the evolving field of AI-based education, particularly in the context of adaptive learning. By reaffirming the positive influence of AI-based systems on students' attitudes and learning capabilities, the research underlines the potential for personalized education to drive meaningful change in higher education. As institutions worldwide navigate the complexities of modern education, these findings offer a stepping stone towards harnessing the power of AI to shape the future of learning.

The study’s implications are relevant for universities considering the implementation of AI-based adaptive learning systems. While the research was conducted at a specific university, it serves as valuable foundational data for institutions interested in adopting such systems. Further research is encouraged to expand the application of AI-based adaptive learning across various subjects and to develop effective teaching models integrating AI-based systems.

Lastly, AI learning that combines the instructor's student-centered class design and operation is needed, rather than simply learning using an adaptive learning system. This will complement the teaching-learning limitations of AI application and contribute to increasing learning effectiveness. However, what is also essential is the promotion of emotional exchange and learning between instructors and students, which AI cannot replace. This role of the instructor will be the driving force for effective AI learning.

Additionally, students’ satisfaction with the class was determined.

There is a need to improve classes that reflect the lessons learned. Students tended to be generally satisfied with new methods of teaching such as AI application, but requested more systematic operation and evaluation of AI learning. Accordingly, it is advisable to closely analyze students' satisfaction and perceptions in the future and reflect them in class plans.

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