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Research on the development of an AI-based customized learning support model : Focusing on the university class environment

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Abstract

Research Purpose : Based on artificial intelligence, this study considers learners' characteristics, learning content, and individual learning, and analyzes the collected learning data to develop a model that supports customized learning for individual learners.

Research content and method : In order to achieve the research purpose, the literature was analyzed to investigate the structure of customized learning support, learning data analysis, and learning activities, and based on the investigated data, the area and detailed components of the customized learning support model were derived. did. A draft model was constructed through literature analysis, and the first expert Delphi survey was conducted on the draft model with five experts. The model was revised by reflecting the results of the first Delphi, and the validity of the revised model was verified through the second expert Delphi. The model was elaborated through expert Delphi, and the final model was constructed through this.

Conclusion and Recommendation : Through research, customized learning support area, class management system area, and learning analysis data area were formed, and detailed elements were derived for each area. The results of this study provide basic data that can be used as a reference for constructing a customized learning support system based on artificial intelligence, taking into account the university's class environment.

Key Words

AI, Educational use of AI, Customized learning support, Customized learning support model, AI education support

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인공지능 기반 맞춤형 학습 지원 모형 개발 연구 : 대학교 수업 환경을 중심으로

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논문 요약

연구 목적 : 본 연구는 인공지능을 기반으로 하여 학습자들의 특성과 학습 내용, 개인 학습을 고려하고, 수집된 학습 데이터를 분석하여 개별 학습자에게 맞춤형 학습을 지원하는 모형을 개발하는 것이다.

연구 내용 및 방법 : 연구 목적을 성취하기 위해서 문헌을 분석하여 맞춤형 학습지원, 학습 데이터 분석, 학습 활동의 구조를 조사하였고, 조사된 자료를 기반으로 하여 맞춤형 학습 지원 모형의 영역과 세부 구성 요소를 도출하였다. 문헌 분석을 통해서 모형의 초안을 구성하였고, 모형 초안은 전문가 5인을 대상으로 1차 전문가 델파이 조사를 수행하였다. 1차 델파이 결과를 반영하여 모형을 수정하였고, 수정된 모형은 2차 전문가 델파이를 통해서 모형의 타당성을 검증하였다. 전문가 델파이를 통해서 모형을 정교화하였고, 이를 통해서 최종 모형을 구성하였다.

결론 및 제언 : 연구를 통해서 맞춤형 학습지원 영역, 수업 운영 시스템 영역, 학습 분석 데이터 영역을 구성하였고, 각 영역에 세부 요소들을 도출하였다. 본 연구의 결과는 대학의 수업환경을 고려하여 인공지능을 기반으로 맞춤형 학습 지원 시스템을 구성하는데 참고할 수 있는 기초 자료를 제공한 것이다.

《 주제어 》

인공지능, 인공지능의 교육 활용, 맞춤형 학습 지원, 맞춤형 학습 지원 모형, 인공지능 교육 지원

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Ⅰ. Introduction

Considering the digital-based education innovation and AI digital textbook development that are being promoted in response to social changes such as recent digital transformation, society as a whole is entering a digital society based on AI. Accordingly, the Ministry of Education announced the "Digital-based Education Innovation Plan" in February 2023 to realize customized education for everyone using artificial intelligence technology(Ministry of Education, 2023b). In response to social changes such as digital transformation, educational policies that actively utilize digital technology and AI are being promoted. Recently, the amount and type of learning data generated through online education services is increasing, and the technology and artificial intelligence to analyze it are increasing. Digital technologies such as intelligence are developing. Accordingly, the so-called 'intelligent learning service' is becoming possible, where AI that learns from collected data diagnoses individual learners, suggests personalized learning, predicts the learner's academic achievement, and provides feedback. Here, customized learning refers to learning designed to suit each student's learning ability, needs, learning motivation, and interests so that the student's potential can be maximized(Gye, et al., 2018).

As the demand for such customized education has increased at universities, a number of studies have been conducted suggesting the use of learner activity data by considering learner characteristics and distance learning context. Son et al. (2019) presented a customized educational support plan based on learning analysis in online education, and studies conducted with a focus on high school situations include studies by Lee et al.(2020, 2021) and Han et al.(2022). Lee et al. (2020) derived a strategy to support self-regulated learning using activity data collected in the Learning Management System(LMS) of broadcasting middle and high schools. Based on this, Lee et al.(2021) developed a strategy to support learners' self-regulated learning. A dashboard for learners was designed for support. Han et al.(2022) established a machine learning model that predicts learning results and derived a method to provide customized feedback based on the predicted results. However, these studies proposed ways to utilize learning

data, and the absence of relevant data is discussed as a limitation.

The support system currently required in education requires a system that comprehensively supports learning activities in a customized manner, taking into account the learner's characteristics, environment, and progress rate(Lee, 2021). Nevertheless, previous studies are limiting the discussion to one area, such as customized feedback, use of learning analysis data, or content development. Accordingly, this study seeks to develop and propose a model that provides comprehensive customized learning support by considering various factors based on analysis of learning data focusing on learners' classes and learning activities.

Ⅱ. Theoretical background

1. Learning analysis and customized support

Recently, ICT devices have been frequently used in education, and as conditions have been created to collect various learning data, interest in learning analytics has increased significantly. Learning analytics is "the measurement, collection, analysis, and reporting of data about learners and learning situations to understand and optimize learning and the environment in which it occurs." Learning analytics has three main characteristics. First, learning analytics targets massive amounts of 'big data' as a record of learners and learning contexts. Second, learning analysis uses 'data mining techniques' along with inferential statistical techniques to improve the quality of teaching and learning decisions. Third, learning analytics has the ultimate goal of optimizing the learning environment, that is, 'instructional design prescription'. In other words, learning analytics traces the traces and surrounding environmental conditions that occur while a learner learns through a computer or with a computer, so as to find out the path the student has taken and the future direction, so that the remaining course can be completed safely and effectively. It can be compared to a support system that the instructor refers to for guidance(Cho et al., 2019).

Learning analytics can be effective in various aspects. By extracting and analyzing the learner's status information, which is automatically generated during

the learning process through learning analysis, as digital data, individualized learning for learners, individually tailored teaching, development of educational content, improvement of educational policy and curriculum, etc. are possible(Ahn et al., 2016). Presenting learning analysis results to learners or instructors not only promotes social learning, but also suggests related materials to learners, tracks learner behavior, and predicts learner performance. Based on this, learners give up learning midway. It can also be prevented(Jin & Yu, 2015). Another great advantage of learning analytics is that, unlike existing evaluation methods, it can collect and analyze various data about learning in real time without interfering with the learner's activities and provide necessary information to instructors and learners in a timely manner(Cho et al. 2019).

Through learning analysis, the system can provide teachers with recommended feedback so that they can provide the most appropriate feedback, in addition to helping teachers check the learner's status. In a study by Lim and Kim(2017), a dashboard was designed to provide recommended feedback for each learner that teachers can use. A screen containing a comprehensive and summary analysis of the learner's learning status and recommended feedback that the instructor can provide to the learner are also provided to support the instructor's provision of feedback.

2. Domestic and international examples of customized learning support

Overseas cases are as follows. First, ALEKS(Assessment and Learning in Knowledge Spaces) is an artificial intelligence-based customized learning support system developed for K-12 students in the United States. ALEKS was first developed at UC Irvine in 1994 and acquired by McGraw-Hill Education in 2013. At the beginning of the service, only math subjects were supported, but the area of supported subjects was gradually expanded to now cover subjects such as business administration and chemistry. It is actively used in homeschooling as it supports practice problems and lecture materials for each subject. Second, Century is an AI-based customized learning support platform for all school levels, from elementary education to university education, and has the characteristic of pro-

viding an individually customized learning path by analyzing student's misconceptions, strengths, and weaknesses. Century provides English, math, and science education programs, and the questions it provides include a variety of types, so they correspond to the national curriculum and are actively used in schools. In particular, this platform was provided free of charge to schools when schools were closed due to COVID-19, and was utilized by many schools. Third, e-Advisor is an artificial intelligence-based customized learning support platform developed by Arizona State University to support students in achieving their academic and professional goals and provide individualized learning consulting. e-Advisor analyzes each student's grades, tendencies, and learning patterns and provides academic paths and major fields. With the goal of completing the degree program, each student's academic progress is monitored and information on majors and conditions required for degree completion is divided into eight semesters. Fourth, Carta is a learning support platform developed by Stanford University in the U.S. to help students search and check detailed information about various courses and help with course registration and course planning. Cata provides basic schedule information and information for meeting graduation requirements, presents past grade distribution and course order based on grade data for the course, and provides information on what students will do based on course review data from previous students. Supports planning for assignment workload.

Next, domestic cases are as follows. First, Riiid is an artificial intelligence-based English learning AI tutor. It is a learning support system that aims for effective learning by providing customized problems through machine learning based on 450,000 people's learning data and 30 million data. The system collects data sets on the number of questions students answer correctly and the time it takes to solve them, making it possible to diagnose predicted TOEIC scores with 95% accuracy. In particular, based on the learning history, the next learning content is personalized and recommended, and problems and lectures that may be incorrect are personalized and recommended so that the learner can learn weak concepts. The difficulty level of the questions is automatically adjusted to suit the learner's current level and target score. Learners can be recommended

an effective learning path based on the results of the initial diagnostic test, and even during the learning process, the system calculates the learner's level of improvement in real time as an expected value and is provided with the optimal content and learning path. Second, Malvoca is a learning support application that provides English vocabulary education through artificial intelligence-based individually tailored learning. Approximately 3 million cases were collected through various channels such as movies, dramas, YouTube, official English tests, and CSAT, and based on this, artificial intelligence provides example sentences appropriate to the learner's level and measures the level through a test. Depending on the characteristics of machine learning, the learner's level is accurately measured as learning progresses. Third, Snoojini is Seoul National University's learner-customized academic management system developed for the convenience of searching academic information. Snoojini is based on a database containing approximately 300 million pieces of standardized academic information, subject information, and professor information accumulated at Seoul National University, and uses PSD (Psychography, Sociography, Demography) recommendation technology, structured/unstructured big data collection technology, Through machine learning technology, subjects are recommended in real time according to each student's characteristics, and the status of academic completion and graduation requirements is shown. By using Snoozini, students can receive recommendations for courses that may be of interest based on the courses they have taken so far, or customized courses that take into account graduation requirements. They can also easily search for desired courses and professors using keywords. there is. Fourth, 'Korea University AI Senior' is an artificial intelligence-based customized subject recommendation service developd to resolve difficulties faced by students due to limitations in the quantity and quality of information related to course taking. There are two types of recommendation methods: alumni-based and subject-based. Classmate-based recommendations recommend courses taken by students similar to you, and subject-based recommendations recommend courses similar to the courses you have taken. It is easily accessible on mobile devices, so you can use the service without restrictions on time and location. Lastly, Dankook University's 'Dan.i' is

an artificial intelligence-based customized education support service combined with a chatbot that can search and recommend information necessary for university life, such as academic information, subject/non-curriculum information, and employment information. Dankook University began a project to build an artificial intelligence-based customized education support system under the name 'EduAI' in 2017, and developed Dan.i in 2020 to provide websites and mobile applications. We provide services through. In 2021, it was implemented separately into Dan.i, an educational support service for students, and a web-based educational knowledge analysis system desk(D-ESK) service for instructors and staff, and the official service has been in operation since 2022.

Ⅲ. Research Methods

1. Research procedures

The purpose of this study is to construct a customized learning support model based on artificial intelligence to support student learning in universities. To this end, we first reviewed the literature and previous studies to construct a customized learning support model based on artificial intelligence, and the constructed model was reviewed and modified through expert Delphi to construct the final model(see [Figure1]).

[Figure 1] Research Procedures

2. Expert Delphi

This study conducted expert Delphi to validate a customized learning support model based on artificial intelligence. The specific details about this are as follows.

1) Expert Delphi procedure

In the first survey, opinions were collected on the validity of the draft model constructed through literature analysis and previous research exploration and on model improvement. The model was revised through a research team meeting, taking into account the improvement opinions of experts responded to through the questionnaire and the quantitative analysis results of expert Delphi. The revised model was produced through a second survey to collect opinions on the model's validity and improvement. The final model was constructed by considering the opinions of experts who responded to the second survey and the quantitative analysis results of Delphi. This study conducted two rounds of expert Delphi to validate a customized learning support model based on.

2) Expert Delphi target

Five experts were recruited for the Delphi survey of this study. Experts for the Delphi survey were recruited from experts with field experience and related research areas to increase the reliability of the feasibility study. Experts were recruited from universities and engaged in both education and research, and were selected in consideration of their teaching and research experience. The specific details are as shown in 〈Table 1〉 below.

〈Table 1〉 Expert Delphi target

Expert	Agency	Career	Area
A	University	15years	Teaching-Learning
B	University	10years	AI
C	University	8years	Educational Technology
D	Policy Agency	16years	Education policy and school education
E	University	12years	Teaching-Learning

3) Expert Delphi content

The first Delphi survey of this study provided an explanation of the customized learning support model and presented the overall model. Next, five survey questions were constructed to verify the validity of the overall model and one

open-ended question to collect opinions on improvement of the overall model. The survey questions to verify the validity of the overall model and digital capabilities were composed of questions asking experts' opinions on validity, explanatory power, usefulness, universality, and understandability. Looking at this in detail, it is shown in 〈Table 2〉 below.

〈Table 2〉 Contents of expert Delphi survey

Area	Question
Feasibility	The support system presented in the data is a valid principle for implementing customized learning support for learners.
Explanatory power	The support system presented in the material appropriately explains the principles of implementing customized learning support for learners.
Usefulness	The support system presented in the material can be usefully used to support learners' customized learning.
Catholicity	The support system presented in the material can be universally applied to implement customized learning support for learners.
Understanding	The support system presented in the material expresses the principles of implementing customized learning support for learners in an easy-to-understand manner.

4) Expert Delphi quantitative data collection and analysis method

Quantitative data from the expert Delphi were structured so that responses could be made on a 4-point likert scale from 'strongly agree' to 'strongly disagree.' In the case of expert Delphi, content validity(CVR: Content Validity Ratio) is calculated from the frequency of positive and negative responses, so when data are collected on a 5-point likert scale, 1 to 2 are treated as negative responses and 4 to 5 are treated as positive responses. If so, it becomes very difficult to judge whether a 3-point response is positive or negative. Accordingly, when verifying the validity of the model through content validity in the recent expert Delphi, we plan to collect quantitative data so that experts' opinions can be clearly distinguished between positive and negative through a 4-point likert scale. Accordingly, this study also decided on a likert scale of 4 points for collecting quantitative data.

Next, the quantitative data from the expert Delphi is calculated by calculating the mean and standard deviation to check the experts' response tendencies. Accordingly, this study also analyzed the mean and standard deviation to analyze the trends in experts' responses. Next, expert Delphi calculates the degree of convergence, which is the degree to which experts accept the content, and the degree of agreement, which is the degree to which opinions among experts agree. The closer the convergence is to 0, the higher the degree of acceptance by experts is interpreted, and the closer the consensus is to 1, the higher the degree of consensus among experts. If the degree of convergence is lower than 0.5, it is interpreted as good, and if the degree of agreement is higher than 0.75, it is interpreted as good. Convergence and agreement are calculated using median and percentile. Accordingly, this study also analyzed the degree of convergence and agreement using the median and percentile.

Ⅳ. Results

1. Literature analysis and draft model composition

This study analyzed literature to construct a customized learning support model based on artificial intelligence to support student learning in universities. For this purpose, we analyzed literature related to learning data analysis, learning support cases, and educational models using artificial intelligence, and through this, the area and detailed components of the model were selected. A draft customized learning support model was created by integrating the domains and detailed components. Looking at this, it is as follows.

1) Domain composition of customized learning support model

In order to construct the area of a customized learning support model, previous studies related to the learning process and design based on artificial intelligence were reviewed. As a result, the results of the research conducted by Kim and her colleagues(2023) are as follows. Kim and her colleagues' research was conducted to develop a digital learning content design model based on ar-

tificial intelligence. Through the study, the design areas were divided into learning content, learning resources, and learning data. The broadcast used digital learning model is explained as follows. First, the learning content area is the area where students engage in learning activities and where actual learning takes place using learning materials. Next, learning resources are an area that provides content for learning activities and are composed of various learning materials. Lastly, the learning data area consists of collecting various learning data generated during the learner and learning process and creating basic data to support learning through analysis. Accordingly, the area of the broadcast used digital learning content model consists of the areas of class operation, learning resources, and learning analysis data.

Next, Han and his colleagues(2023) proposed a structure that should be maintained when providing customized education based on AI in a study on the current status and challenges of AI-based customized education. It was argued that AI-based customized education has a cyclical structure of observation, diagnosis, treatment, and participation, and that artificial intelligence must have measurement, analysis, and focus. Han and his colleagues(2023) divide the areas presented in the customized curriculum based on artificial intelligence into observation, diagnosis, treatment, and participation. Specifically, participation corresponds to learning activities, treatment is a customized educational support activity, and observation and diagnosis are presented as areas where learner characteristics are analyzed and interpreted based on acquired data. Accordingly, the study by Han and his colleagues(2023) can be interpreted as suggesting three areas: learning activities, learning data analysis, and learning support.

Lastly, Lee(2021) presented a model for the system and components of an artificial intelligence-based learning system through a study on the construction of an intelligent learning platform model for religious education. The areas presented in the model are divided into learning materials, learning activities, learning data, and artificial intelligence areas. Lee(2021) proposes a learning system that can support customized learning based on artificial intelligence, taking into account learner characteristics, and consists of a learning activity area where

learning takes place, a learning material area that provides content for learning activities, and Learning data acquired through analysis of learning activities and learner characteristics was analyzed and composed of learning data and support areas supported through artificial intelligence.

By summarizing the structural areas suggested by previous studies related to artificial intelligence-based customized learning support, we can summarize the class management system in which learners' actual learning takes place, the learning data collection and analysis area for customized learning support, and customized learning based on the analyzed learning data. It can be configured as an area that supports. Accordingly, this study also seeks to construct the most basic components of an artificial intelligence-based customized learning support model as a class management system, learning analysis data, and customized learning feedback(see [Figure 2]).

[Figure 2] AI-based customized learning support model area

2) Detailed components for each area of the customized learning support model

This study structured the area of a customized learning support model, and then explored previous studies to extract detailed components. First, the elements of learning characteristics examination, learning plan establishment, learning execution, and learning outcome evaluation were extracted from the class management system area. The basis for this study extracting the following detailed elements is as follows. The study by Han and his colleagues(2023) includes diagnosis through observation, treatment based on diagnosis, and learning activities as detailed elements for learning activities. This means that a di-

agnosis of the learner must be performed before carrying out actual learning activities in order to determine that customized learning support is possible by considering the learner's characteristics. Lee(2021) study classifies the types of learners based on learner characteristic data in class operation, organizes the curriculum, plans the class, executes the learning, and evaluates the results of the learning to decide whether to support additional learning. elements are being proposed. This structure includes similar elements in the study by Kim and colleagues(2023), which identifies the learner's level through diagnostic evaluation, provides learning tailored to the level, and conducts formative evaluation during the learning execution process to provide additional learning. and ultimately proposes elements to evaluate the final learning results through unit evaluation. If you apply this to the flow of university classes, you will collect learning data by examining the learner's characteristics at the beginning of the semester, establish a learning plan considering the results of the learner's characteristics and the courses taken, and carry out learning according to the established learning plan during the semester. It can be composed of detailed elements that evaluate learning results at the end of the semester.

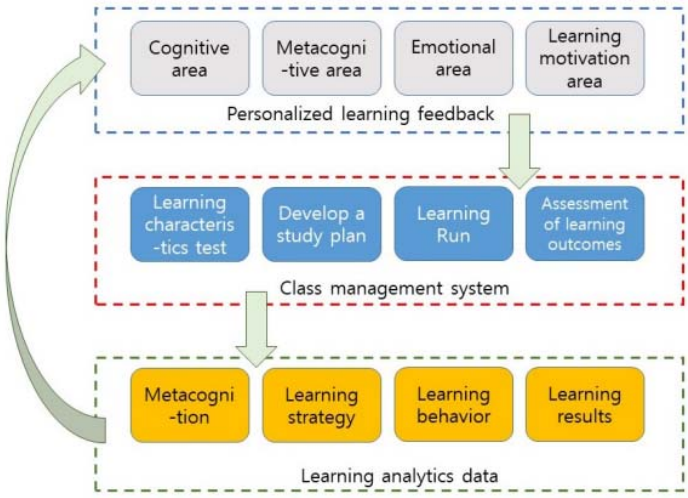
Next, in the learning analysis data area, detailed elements were extracted into metacognition, learning strategy, learning behavior, and learning results. The basis for this study extracting the following detailed elements is as follows. First, in a study by Son and colleagues(2019) on configuring learning analysis and data types for customized education support, the types of data collected for customized learning support were defined as Learning content data(curriculum content, evaluation, basic academic content, basic academic ability). Evaluation 22 items, Learning activity data (login, content usage, bookmarks, assignment results, evaluation, basic academic ability evaluation results) 22 items, Operational data (progress rate information, consultation, basic academic ability video lecture) 50 items, Career & Profile data There are 37 types of data (required information, required information (minors), optional information, completion of transfers, counseling, basic academic ability support, NEIS), and it is suggested that a total of 131 pieces of data are collected and utilized. The study by Kim and colleagues(2023) suggests that profile data, learning content data, opera-

tional data, and learning activity data should be collected, and Lee(2021) suggests that learner characteristic data and learning activity data should be collected. I'm doing it. Accordingly, the researchers took into account the learner characteristics of college students and the characteristics of college classes and derived metacognition, learning strategy, learning behavior, and learning outcome data types among the types of learning analysis data presented in previous studies.

Lastly, detailed elements of the customized learning feedback area were extracted into cognitive area, metacognitive area, emotional area, and learning motivation. The basis for this study extracting the following detailed elements is as follows. Heo and colleagues(2024) analyzed the demand for ways to build and utilize an artificial intelligence-based learning support system in universities and presented use cases from each university. As a result, it was analyzed that many universities support students' cognitive, metacognitive, and learning motivation areas as feedback elements of customized learning support. In addition, Lee and Kim(2012) argue that although customized learning support mainly supports learners' cognitive, metacognitive, and learning motivation areas, the emotional area should also be supported for comprehensive and integrated support for effective academic achievement. a model that supports the emotional domain was developed and its validity was proven through effectiveness verification. Accordingly, this study extracted the detailed elements of the customized learning feedback domain into cognitive domain, metacognitive domain, emotional domain, and learning motivation domain.

3) Draft artificial intelligence-based customized learning support model

This study developed a draft customized learning support model by synthesizing the areas and detailed elements of the model derived through literature analysis of previous studies. The draft model consisted of a learning analysis data area and a customized learning feedback area centered on the class management system, and the model was constructed by arranging detailed elements. The specific details are as shown in [Figure 3] below.



[Figure 3] Draft of AI-based customized learning support model

2. Expert Delphi primary results and model modification

This study constructed a draft through literature analysis to construct a customized learning support model based on artificial intelligence to support student learning in universities. To validate this, an expert Delphi was conducted, and a modified model was proposed based on the first and second results as follows.

1) Verification of validity of the entire model

An expert Delphi test was conducted on the draft customized learning support model. As a result, in the validity verification of the entire model, the hunting degree and agreement degree are as follows. Validity had a degree of convergence of 0.38 and a degree of agreement of 0.81, appropriateness had a degree of convergence of 0.38 and a degree of agreement of 0.75, usefulness had a degree of convergence of 0.38 and a degree of agreement of 0.81, universality had a degree of convergence of 0.38 and a degree of agreement of 0.81, and degree of understanding had a degree of convergence of 0.50 and a degree of agreement of 0.71. (Refer to 〈Table 5〉). Judging by the criteria of expert Delphi results of convergence of less than 0.50 and agreement of more than 0.75, validity, appropriateness, usefulness, and universality were evaluated

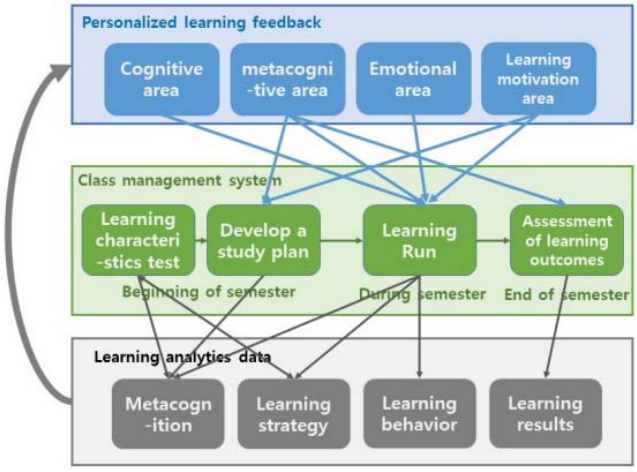
as reasonable, but the degree of understanding required revision.

〈Table 3〉 First expert Delphi results

Area	M	SD	Convergence	Agreement
Feasibility	3.67	0.47	0.38	0.81
Explanatory power	3.33	0.47	0.38	0.75
Usefulness	3.67	0.47	0.38	0.81
Catholicity	3.67	0.47	0.38	0.81
Understanding	3.50	0.50	0.50	0.71

2) Modified model

To revise the model, experts' opinions on improvement are summarized as fol- lows. "It is necessary to indicate the hierarchy of learning procedures and activities.", "It is not clear whether the learning activities are in chronological order or an arrangement of elements.", "It would be good to present the relationship between each element in detail." By reflecting the opinions of experts, the relationships between areas and elements were structured in more detail to help understand the model. The following is a model modified to reflect the opinions of experts.



[Figure 4] Modified model

3. Second expert Delphi results

An expert Delphi test was conducted on the draft customized learning support model. As a result, in the validity verification of the entire model, the hunting degree and agreement degree are as follows. Validity is convergence 0.00, agreement 1.00, appropriateness is convergence 0.00, agreement 1.00, usefulness is convergence 0.00, agreement 1.00, universality is convergence 0.00, agreement 1.00, and understanding is convergence 0.00, agreement 1.00. (Refer to 〈Table 4〉). Judging by the criteria of convergence of 0.50 or less and agreement of 0.75 or more as a result of the second expert Delphi, validity, appropriateness, usefulness, universality, and understanding were all evaluated as valid.

〈Table 4〉 Second expert Delphi results

Area	M	SD	Convergence	Agreement
Feasibility	4.00	0.00	0.00	1.00
Explanatory power	4.00	0.00	0.00	1.00
Usefulness	4.00	0.00	0.00	1.00
Catholicity	4.00	0.00	0.00	1.00
Understanding	3.83	0.37	0.00	1.00

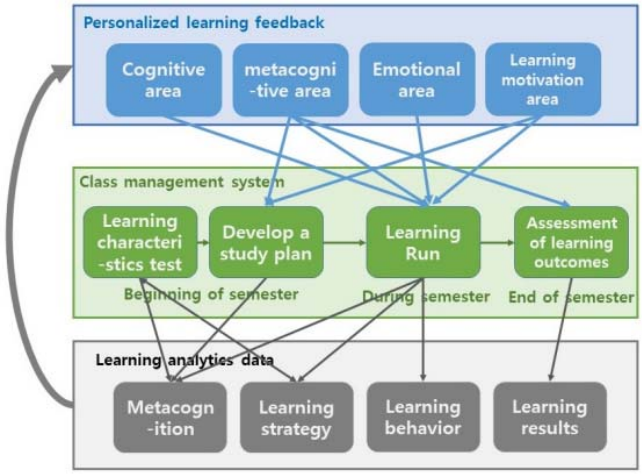
4. Final model construction

In order to construct a customized learning support model based on artificial intelligence to support student learning in universities, this study constructed a draft model by analyzing the literature, modified the model through expert Delphi, and constructed the final model. did. The final model proposed in this study is as follows.

1) Customized learning support model

The artificial intelligence-based customized learning support model proposed in this study is shown in [Figure 5]. The artificial intelligence-based customized

learning support model divides the learner customized support system into customized learning feedback, class management system, and learning analysis data. First, the class management system is basically the area where learners' basic classes are operated and learning behaviors are performed. The class management system examines students' learning characteristics at the beginning of the semester and encourages them to establish a study plan for self-directed learning. Next, study is carried out according to the individual study plan and course subjects, and the learning results are evaluated.



[Figure 5] Final model

In order to support learners' learning activities in the class management system, learning data generated in the class management system is first collected and analyzed. The types of data collected at this time are collected and analyzed, including metacognition, learning strategies, learning behavior, and learning results, and are used as basic data to support learners' smooth learning. In addition, a system was created to provide feedback for learners in the areas of cognition, metacognition, emotion, and learning motivation through scaffolding, instructor messages, and system messages.

2) Detailed components of customized learning support model

Based on the final model, the detailed components of the model are shown

in 〈Table 4〉 below. In the detailed components, learning analysis data was presented separately from related content and data that needed to be collected.

〈Table 5〉 Detailed components

Item	Related content
1. Class management system	
Learning characteristics test	• Learner characteristics (learning type, self-directed learning ability, learning motivation, personality type), academic achievement level (previous semester grade and overall grade)
Develop a study plan	• Cyber course attendance plan, assignment performance plan, test preparation plan for courses taken, additional study plan for courses taken, personal study plan (foreign language, certification study, etc.)
Learning Run	• Implement cyber learning, perform assignments, prepare for exams in courses taken, perform additional studies in courses taken, carry out personal study
Assessment of learning outcomes	• Cyber class attendance rate, assignment grades, grades for each course evaluation item, individual learning results (whether a certificate is acquired or foreign language skills are improved)
2. Personalized learning feedback	
Cognitive	• Providing knowledge and information related to tasks and learning, supporting principles and concepts related to solving tasks, providing a list of materials for tasks and learning,
Metacognitive	• Providing procedures for solving tasks, providing guidance on the roles of members during team activities, supporting strategies for establishing learning plans, providing information on the learning process or task solving process, guidance on the learning process, and guidance on reflection on the learning process and results, Guidance on the degree of implementation of the study plan
Affective	• Messages of praise and encouragement to support positive emotions in learning, messages to encourage enthusiastic participation in the learning process, and social messages to support positive emotions.
Learning motivation	• Feedback on the learning process and results to promote learning motivation, messages encouraging efforts to achieve learning

	results, guidance on the value that learning results can provide, and providing messages about what to expect from the learning process. , Message about study plan achievement rate

Item	Application area	Collected data
3. Learning analysis data		
Metacogniti-on	• Establishment of customized learning support method through learning style test results • Adjustment of learning support methods according to the type of student response to the learning style test results	• Learning style test response data • Frequency of checking learning style test results • Apply for additional activities based on learning style test results
	• Support self-directed learning by collecting data on the establishment and implementation of individual study plans outside of individual classes	• Personal self-directed study plan input data • Target grade for each subject • Goals and plans for what you want to learn in addition to the subjects
	• Notification provided in case of delays in submitting course assignments and taking online classes during the semester	• Input data for assignment submission plan during the semester • Date and time of assignment submission during the semester • Input data for cyber class attendance plan during the semester • Date and time of taking online classes during the semester
	• If the syllabus is not read before the start of the semester, a notification is provided regarding the need to view the syllabus. • Provide customized learning support according to the type of question about the lesson plan	• Date and frequency of viewing the syllabus • Type and frequency of questions about syllabus
Learning strategy	• Support customized learning by identifying cyber class attendance patterns (completion of the course at once, completion after leaving the course, frequency of leaving the course)	• Start and end times for cyber classes by session • Time and frequency of withdrawal during cyber classes by session • Frequency and section of repeated viewing of the same cyber class • Date and time of lecture material

	• Notification provided if lecture materials are not downloaded before class starts.. • If there is no request for help from instructors and fellow learners, regularly inform them of the merits and necessity of asking for help.	download for each session • Frequency and type of requests for help from fellow learners • Date and frequency of viewing cyber class attendance plans by session
	• Check the content of questions and repeated viewing sections to understand class content to provide cognitive support for sections that learners find difficult due to the high level of difficulty.	• Class video sections with frequent questions to understand class content and video sections with high frequency of repeated viewing
Learning behavior	• Customized support according to cyber campus usage patterns • Support for convenience specifications depending on the device used for cyber campus and cyber classes	• Cyber campus login time and frequency, cycle • Average time spent on cyber campus • Progress and completion rates of cyber classes • Average time to complete cyber classes • Main access devices for cyber campus and cyber classes • Frequency of use by cyber campus menu
	• Supports feedback based on offline learning behavior	• Offline attendance-absence-tardiness status
	• Customized support according to individual study and cyber class attendance patterns	• Individual learning plan implementation rate • Response to personalized messages • Time required from presentation of assignment to submission • Time required to respond after receiving personalized learning support and recommendation messages
Learning results	• Organizing future learning support plans according to the degree of completion of cyber classes	• Cyber class attendance rate • Individual Learning Plan Performance Rate

	• Constructing a self-directed learning support plan according to the individual learning plan performance rate • Organizing learning strategy support plans based on end-of-semester grades and rank	• End of semester grades • Assignment grades • Face-to-face class attendance status • Rank within major
	• Construct customized learning support messages through analysis of instructor's feedback response type	• Reaction time to instructor feedback • Whether the instructor's feedback is negative or positive

Ⅴ. Conclusion

This study conducted research to develop a model for a customized learning support system based on artificial intelligence that can be used in university classes. For this purpose, the literature was analyzed and the customized learning support area was composed of a class management system, learning analysis data, and customized learning feedback. Next, the detailed elements of the class management system were derived from learning characteristics inspection, learning plan establishment, learning execution, and learning outcome evaluation. Detailed elements of learning analysis data derived metacognition, learning strategy, learning behavior, and learning results, and detailed elements of customized learning feed-back derived cognitive domain, metacognitive domain, emotional domain, and learning motivation domain. The data and specific tasks that must be collected and utilized in each detailed element were organized and presented.

The model proposed through this study is designed to support self-directed learning by considering the characteristics and learning activities of individual learners based on artificial intelligence in a university classroom environment, and it is important to suggest elements that can support customized learning. This can be said to be an implication. In particular, the presentation of specific tasks to be performed in each detailed element can be said to be a very

important implication. In particular, the proposal of a basic model that can be used as a reference when designing a customized learning support system based on artificial intelligence at universities can be said to be a very important implication. Accordingly, this study suggests that practical research should be conducted on ways to apply the customized learning support system model in actual classes and class design methods.

References

Ahn, M. R., Choi, Y. Y., Bae, Y. H., Ko, Y. M., & Kim, M. H. (2016). Review of domestic literature on learning analytics: Focusing on empirical research using log data. *Educational Technology Research, 32*(2), 253-291.

Cho, I. H., Park, Y. J. & Kim, J, Y. (2019). Understanding learning analytics. Park Young Story.

Cho, Y. H., Kim, K. H. & Han, J. Y. (2019). Learners' perception of adaptive collaborative learning support based on learning analytics. *Educational Information Media Research. 25*(1), 25-57.

Gye, B. K., Lim, W. C., Park, Y. J., Son J. E., Kim, J. H., Park, S. G., & Jeong T. J. (2018). Research on improving data collection and analysis API for intelligent learning analysis. Korea Education and Research Information Service.

Han J. Y., Son, C. H., Hwang, E. H., Kim E. Y., Jang H. S., Jeong H. J., Park H. J., Heo S. Y. & Choi D. Y. (2023). Current status and challenges of AI-based customized education. Korea Educational Development Institute.

Heo, S. Y., Lee, G. Y., Ji H. K., Kim, M. S. & Kim, M. J. (2024). Analysis of needs for building and utilizing a university artificial intelligence-based learning support system. *Culture and Convergence, 46*(1), 971-980.

Jin, S. H. & Yu M. N. (2015). A dashboard design study on e-learning learning participation activities and interactions. *Korea Educational Technology Association. 31*(2), 191-221.

Kim, S. J., Hwang,E. H., Kim, S. H., Cho, M. J., Han, J. Y., Kim, S. A., Koo, Y. R., Yang, H. K., Eun, J. H. Lim, Y. E., & Lee, E. C. (2023). A study on design methods for broadcasting and used digital learning content according to the 2022 revised curriculum. Korea Educational Development Institute.

Lee, E. C. & Kim, M. J. (2012). Development of an integrated support model for wiki-based collaborative learning and verification of effectiveness. *Educational Technology Research, 28*(3), 587-617.

Lee, E. C. (2021). A study on the construction of an intelligent learning platform model for faith education in the post-corona era. *Journal of Christian Education, 66*, 309-341.

Lee, E. J., Kang, S. G., Do, J. W., Jeong, J. W., Yang, H. K., Jeong, Y. S., Yu, M. N., & Lee, J. Y. (2020). Development of a learning analysis model for customized education support for broadcasting middle and high schools. Korea Educational Development Institute.

Lee, E〉 J., Kim, S. J., Do, J. W., Lee, J. Y., Kim, S. C., Kang, S. G. & Jeong, Y. S. (2021). A study on designing a dashboard based on learning analysis for broadcasting middle and high schools. Korea Educational Development Institute.

Lim, S. T. & Kim, E. H. (2017). Dashboard design to provide instructor feedback based on learning analytics. *Journal of Computer Education Society, 20*(6), 1-15.

Ministry of Education (2023a). Ministry of Education work implementation plan for 2023.

Ministry of Education (2023b). Digital-based education innovation plan.

Son, C. H., Han, J. Y., Jeong, J. W., Do, J. W., Lee, E. J., Lee, Y. H., Lee, K. J., Jeong, Y. S., & Lee M. S. (2022). A study on ways to build and utilize smart data for customized education: Focusing on cases of online education using content. Korea Educational Development Institute.

Son, C. H., Jang, H. S., Kim, E. Y., Kim, S. M., Lee, E. J., Jo, I. H., & Jeong, G. S. (2019). A study on customized educational support methods based on online learning analysis. Korea Educational Development Institute.