Original Article

Learner Model of Technology Education for AI Convergence Individualized Learning

Mika Lim[1]

[1]Chungnam National University, Daejeon, Korea. E-mail: mika@cnu.ac.kr

Abstract

The purpose of this study was to derive a learner model from technological education for AI convergence individualized learning. The learning model devised in this study reflects the characteristics of technological problem-solving as it considers all areas of cognition, definition, and psychodynamics. Among the dimensions of recognition, judgment, creativity, execution, attitude, and interaction of technological problem-solving learning styles, the dimensions that acted mainly according to the content of the problem and the learning type could be selected and constructed as a model. In this study, a creativity-execution model was devised in consideration of the 'adaptation-innovation type' of the creativity level and the 'reflection-action type' of the execution level. In addition, an interactive-attitude model was devised in which the 'independent-cooperative type' in the interaction dimension and the 'avoidance-participation type' in the attitude dimension act dynamically. Furthermore, a three-factor learner model was developed considering the dimensions of cognitive judgment, creativity, and execution. Also, a five-factor learner model for technological problem-solving was devised and presented, with all five dimensions of cognition-judgment, creativity, execution, interaction, and attitude of the technological problem-solving learning style as factors. The learner characteristics defined through the model design suggested the direction of AI convergence education considering individual characteristics of learners and provided basic data for it. In the future, it is suggested that specific individualized teaching and learning development research be conducted in AI convergence education, considering the characteristics of learners according to the learning style of technological problem-solving.

Keywords: AI, AI Convergence Education, Learner Model, Technology Education, Individualized Learning.

DOI: 10.47750/pnr.2022.13.S03.103

INTRODUCTION

The revolutionary change in human life occurs due to an automated labor force or intelligence is called the industrial revolution. Right now, artificial intelligence is at the forefront of the 4th industrial revolution, an intelligent information society that is explained by technologies such as IoT, big data, and augmented reality (Lim, 2020). The Oxford English Dictionary defines AI as the ability of computers or other machines to display or imitate intelligent behavior (OED, 2018). Governments and private sectors around the world are preparing and conducting AI training courses. The AI4AL (AI for ALL), a non-profit organization in the United States, insists on the need for artificial intelligence education to solve social problems and says that AI education should be for all citizens. The fields of AI and education are still in the early stages of research, so there are many areas where concepts and terms are not clearly defined. Lim (2020) classified AI into 'education about AI' and 'education using AI'. It is expected that AI convergence education will be able to achieve quantitative and qualitative expansion of education by enabling education beyond the limitations of time and space. Among them, one of the major changes will be the promotion of individualized instruction that considers learners' characteristics. However, since AI education research is currently in the beginning stage, there is a need to be more actively researched in various subject education including technology education. Holmes, Bialik and Fadel (2019) introduced the AI in Education (AIED) system to date with the Intelligent Tutoring System (ITS) and the Dialogue-Based Tutoring System (DBTS), and exploratory learning environment (ELE). It is expected that AI convergence education will be able to achieve quantitative and qualitative expansion of education by enabling education beyond the limitations of time and space. Among them, one of the major changes will be the promotion of individualized instruction that considers learners' characteristics. However, It is still hard to find artificial intelligence convergence and individualization research in the area of technology education.

The use of artificial intelligence in education will become an indispensable trend in education in the future. Therefore, AI convergence education is being studied in each area of education. Kim, Oh & Kim (2019) analyzed the effect of unplugged education focused on analysis of algorithm execution time to enhancement of third grade elementary school students' computational thinking. Han (2020) examined the effects of voice-based AI chatbots on Korean EFL middle school students' speaking competence and their related affective domains: level of interest, belief, motivation, and perceived anxiety. However, Lim (2020) said that artificial intelligence technology in technology education has a slightly more special meaning compared to other subjects. One of the goals of technological education is to have 'technological literacy', and technological literacy is 'technological knowledge, skills, and attitudes to increase adaptability to a changing technological society'. Lim (2020) also said that the contents and methods pursued by technological literacy and artificial intelligence literacy are almost identical, and the procedure and process of problem solving are also similar. Kim (2017) said that teachers should design a teaching-learning strategy to use teaching methods effectively. There are many factors affecting students' ability to learn, such as personal interests and student diversity. Therefore, the purpose of this study was to develop an AI learner model that can be used in technology subject classes and to use it as a basis for AI convergence technology education.

THEORETICAL BACKGROUND

AI convergence education and individualized learning

The characteristics of AI convergence education compared to existing education are realization, connection, intelligence, and convergence. Realization refers to realistic education that stimulates students' senses; connection refers to education that interacts anytime, anywhere; intelligence refers to an AI teacher who knows the person better than oneself, and; convergence refers to education that reinforces the fusion of educational content. Among them, intelligence is the trend of advancement of customized education for learners, and practical individualization and harvest instruction are possible (Nam, Cho, 2020). Shin and Shin (2020) suggested the teaching and learning strategies of AI-based science education through automation, individualization, diversification, and cooperation. Automation means that AI continuously analyzes and manages individual students' information in real time; individualization means that AI enables individual learning guidance that considers students' level, and; diversification means that individual customized curriculum and textbooks are provided. In addition, cooperation means promoting a multi-faceted system of cooperation between schools and communities. Wu, Kuo & Wang (2017) provided the contents of the lesson after examining whether it had a precedent concept for the learning concept. The AI convergence education algorithm of Wongwatkit, Srisawasdi & Hwang (2017) is shown in Figure 1.

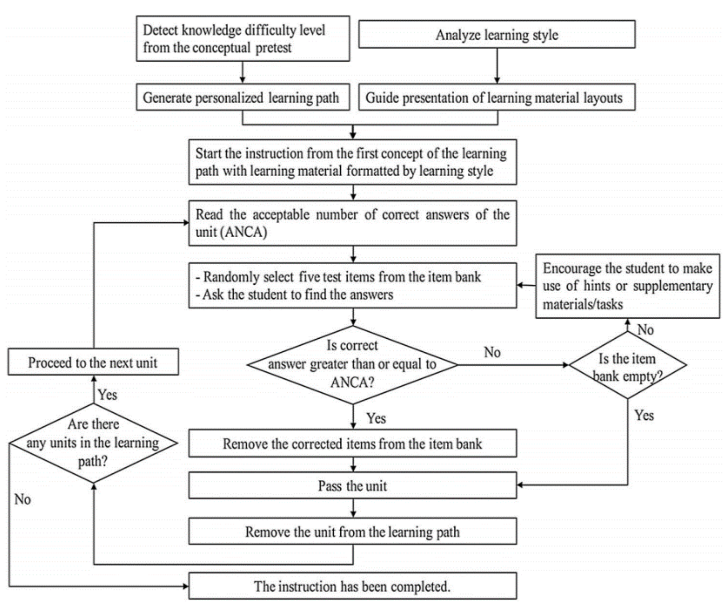

Fig. 1: Procedure of the personalized web learning system based on the personalized information and formative assessment

AI convergence education, breaking away from the traditional classroom teaching framework, freed teaching-learning from the constraints of time and space. Therefore, in the future AI convergence education, it is necessary to actively explore ways to reflect the characteristics of learners appropriate to the subject content and area.

Learning style of technological problem-solving

The characteristics of AI convergence education compared to existing education are realization, connection, intelligence, and convergence. Realization refers to realistic education that stimulates students. The learning style is a generic term for learning habits, learning methods, and learning tips that the learner continuously selects during the learning process. Learning styles help learners to understand individually and provide appropriate information related to teaching and learning. Technological problem-solving means dealing with technological problems that create tangible outputs or related systems in the process of learning, solving problem situations or learning how to solve them'. It comprehensively utilizes the learner's cognitive, affective, and psychomotor areas. In this regard, Lim, Kim (2020) identified the types of learners related to technological problem-solving and learned technological problem-solving based on this in order to construct an appropriate teaching-learning environment according to the characteristics of students in technology subject classes. The form was derived as shown in Table 1.

Table 1. Learning style of technological problem solving

Dimension	Type
cognition and judgment	thinking-intuition
creative	adaptation-innovation
execution	reflection-action
interaction	independence-cooperation
attitude	evasion-participation

The dimension of recognition and judgment is divided into thinking type and intuition type. When solving a problem, a thinking learner systematically establishes a plan and develops theories, and considers the process built through thinking as important, searches for information, makes decisions, and solves problems based on logical thinking and rationality. In the process of problem solving, there is a tendency to adhere to the set steps through analytical thinking. Intuitive learners rely on external information or feelings rather than internal logic when learning. When solving a problem, there is a tendency to perceive the meaning implied in the problem as a whole, and the process of problem-solving does not proceed sequentially. Through holistic thinking, it is often the case that jumps through steps and quickly arrives at a conclusion.

The dimension of creativity is divided into adaptation type and innovation type. In the process of solving problems, the conformant seeks efficiency and safety, and seeks to work within regulations and agreements. The innovation type generates a lot of original ideas without being bound by a given situation and is more interested in generating ideas rather than efficiency. The value of further development of the idea is valued rather than the importance of rules, structures, and agreements.

The execution dimension is divided into reflection type and action type. The reflection type carefully observes and judges, and views objects from various perspectives in the process of observation. It is also related to a kind of imitation learning, rather than acting prematurely, observes the surrounding situation or procedure, collects as much information as possible, and plans of action. The action type tends to approach problem-solving impulsively, omitting the reflective thinking process. They prefer to solve problems directly, draw concrete conclusions, and value the realization of results.

The level of interaction is divided into independence and cooperative. Independence learns in its own way when learning, learns what is thought as important, and prefers lecture-style classes. They prefer personal activities and are more interested in solving problems than interacting with members. The cooperative type draws energy from interactions with others, discussions of possibilities, and ideas of others.

Attitude dimension is divided into evasion type and participation type. Evasion learners do not participate well in class activities when learning, and do not feel much interest in the contents of the class. Participatory learners want to actively participate in class activities when learning, and in many cases, they actively participate in activities other than classes.

METHODS

Since technological problem-solving activities consider the abilities of various fields, it is difficult to always dynamically associate the propensities derived in Table 1. However, it is possible to select and categorize certain dimensions that are important. It helps to understand learner characteristics a little more comprehensively. In addition, it can be used significantly as basic data for individualized classes in AI convergence education. Since the dimensions considered to be important may differ depending on the learning situation, this study attempts to present several types of models that can be used mainly depending on the situation. The composition method followed the method of Kolb. Kolb (1993) derived four learning styles by synthesizing the correlation between two types of information perception methods and two types of information processing methods. Using this method, a model was derived by synthesizing the dimensions in [Table 1]. At this time, the type of learning style was symbolized and concisely expressed using English words expressing meaning.

RESULTS

Creativity-Execution Model

Technological problem solving has to do with 'producing tangible products or creating a system related to it'. In this regard, Nam (2010) stated that technological thinking is a process based on creative and practical activities, unlike other fields. Accordingly, in this study, among the derived learning styles, the most important dimension of the technological problem-solving learning style was the creativity and execution dimension. In addition, a creative-execution model was constructed in which the 'adaptation type-innovation type' of the creativity level and the 'reflection-action type' of the execution level act dynamically. In Figure. 2, a total of four learner types can be identified, and consideration is most appropriate for problem-oriented classes.

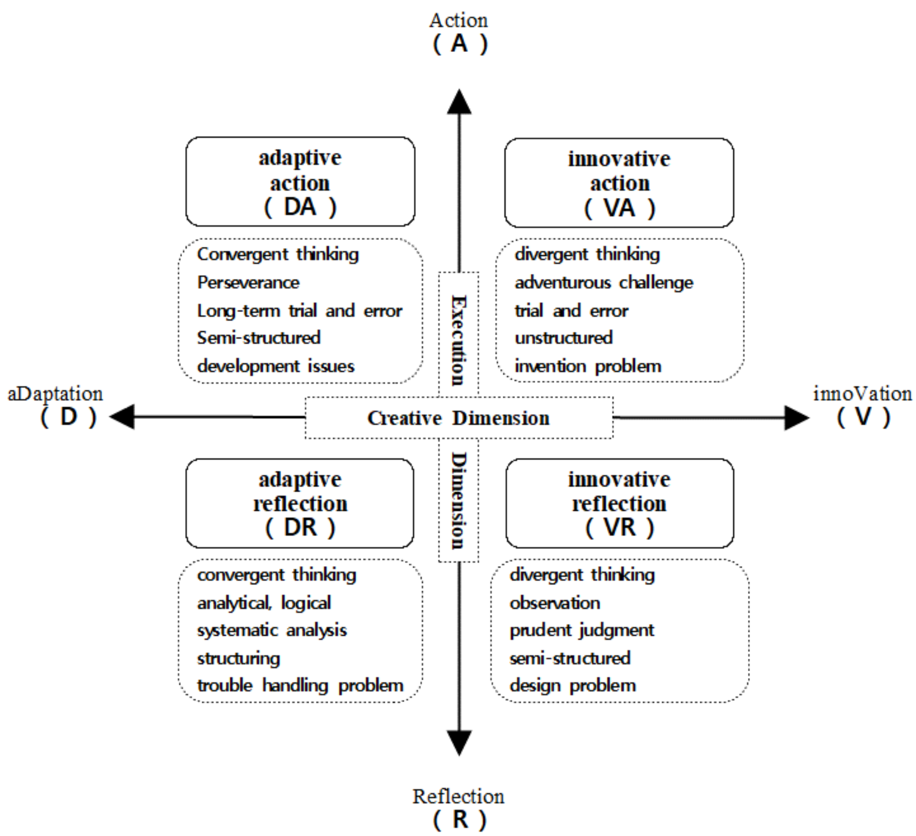

Fig. 2: Creativity-Execution Model

Learners who are innovative at the creative level and behavioral at the execution level are classified as innovative behavioral types (VA). The innovative behavior type is good at diffuse thinking and enjoys adventurous challenges. This type of learner is suitable for presenting unstructured invention problems.

Learners who are innovative in the creative level and contemplative in the execution level are classified as innovative contemplation (VR). The innovative contemplation type is based on diffuse thinking and abundant imagination but proceeds with a heuristic process with careful judgment. Therefore, it is appropriate to present an unstructured or semi-structured design problem.

Learners who are compliant at the creative level and reflective at the execution level are classified as adaptive reflection (DR). Since this type is good at identifying and solving problems in a logical and systematic procedure, it is appropriate to present a structured problem-solving problem.

Learners who are compliant in the creative dimension and behavioral in the execution dimension are classified as adaptive behavior (DA). Based on convergent thinking, this type solves the problem while experiencing endless challenges and trials and errors. Therefore, it is appropriate to present a semi-structured development problem.

Interaction-attitude model

In situations where it is necessary to consider the affective characteristics of learners in the process of solving technological problems, the dimension of interaction and attitude can be considered. Figure. 3 is an interaction-attitude-level model in which the interaction-level 'independent-cooperative' and the attitude-level 'avoidance-participation' act dynamically. Through this, a total of four learner types can be identified. It is most appropriate to consider this model for interactive-oriented cooperative classes.

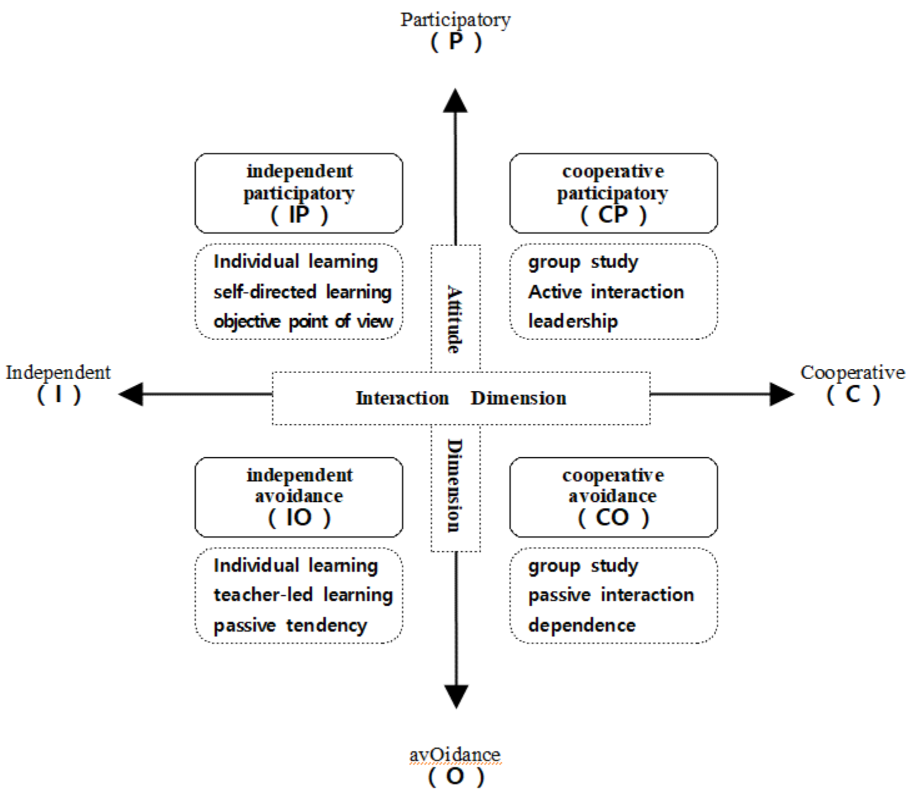

Fig. 3: Interaction - Attitude Model

Learners who are cooperative at the level of interaction and participant at the level of attitude are classified as cooperative participatory type (CP). The cooperative participatory type prefers group learning, is good at interaction, and mainly shows leadership.

Learners who are cooperative at the level of interaction and avoiding at the level of attitude are classified as cooperative avoidance type (CO). The cooperative avoidance type prefers group learning, but is somewhat passive in interaction, and is dependent on the performance of other group members.

Learners who are independent in terms of interaction and avoidable in attitude are classified as independent avoidance type (IO). Independent avoidance type prefers individual learning, prefers teacher-led instruction rather than self-directed learning, and shows a tendency to passively participate in problem solving.

Learners who are independent in terms of interaction and participatory in attitude are classified as independent participatory type (IP). The independent participatory type prefers individual learning, wants to lead learning by itself, and tends to approach it from an objective point of view rather than considering the whole or the situation of others in the process of problem solving or judgment.

Cognitive Judgment-Creativity-Execution Model

In situations where it is necessary to consider the cognitive and psychodynamic characteristics of the learner in the process of technological problem-solving, cognitive judgment, creativity and execution dimensions can be considered.

Figure. 4 shows cognitive judgment-creativity, where the 'thinking-intuitive' in the cognitive judgment dimension, the adaptive-innovation-type in the creative dimension, and the reflective-action type in the execution dimension act dynamically. It is an execution model, and a total of eight learner types can be identified. Since this model includes all the cognitive and psychodynamic tendencies that should be considered in each process of problem understanding, conception, execution, and evaluation, which are the entire process of technological problem-solving, it is most appropriate to consider it in a process-oriented class.

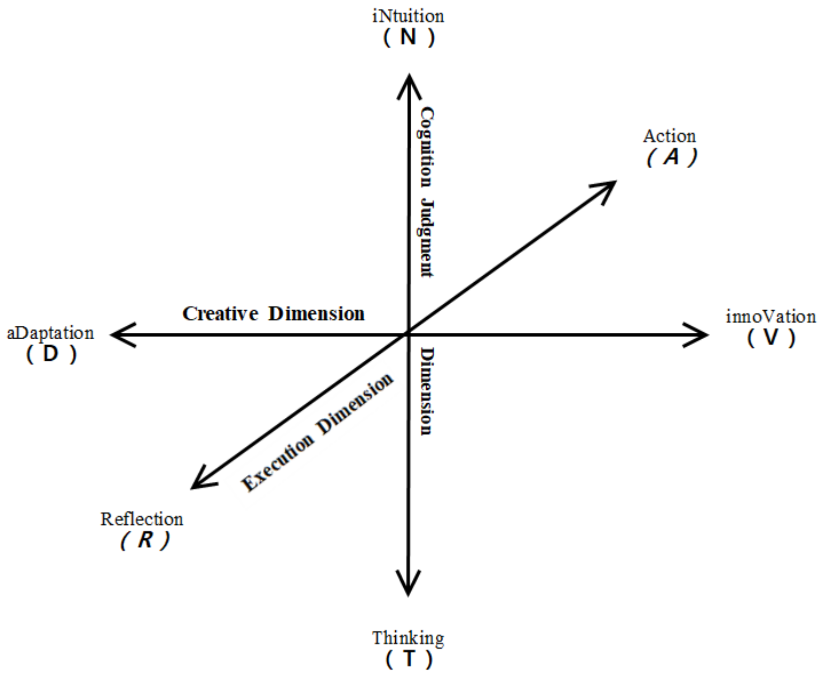

Fig. 4: Cognitive Judgment – Creative – Execution Model

Intuitive learners perceive problems in a holistic, rather than detailed, understanding of problems, and tend to seek out various possibilities through insight. Rather than the problem-solving process proceeding step-by-step, the steps can be easily adjusted by the individual's insightful thinking. Learners who are both intuitive and innovative behavior type are classified as intuition-innovation-action type (NVA). In the process of conception and implementation, the advantages of the innovative behavior type (VA), which enjoys divergent thinking and adventurous challenges, are maximized, but there is also a risk of experiencing excessive trial and error. Learners who are both intuitive and innovative contemplation type are classified as intuition-innovation-contemplation type (NVR). Intuitive learners' insightful tendencies meet the divergent thinking of the conception stage and easily generate many ideas. Learners who are both intuitive and adaptive-contemplative are classified as intuition-adaptive-contemplation type (NDR). They understand the problem through insight, explore various possibilities, but in the process of conception, we analytically select the best idea and proceed with problem-solving carefully. Learners who are both intuitive and adaptive behavior type are classified as intuition-adaptation-action type (NDA). They select the best ideas from within a variety of possibilities, boldly execute the selected ideas, and produce results with patience. Since the idealistic intuitive learner values relative values rather than absolute values, there is a tendency to look for positive factors rather than critical ones in the evaluation process. Thinking learners recognize problems from a detailed and objective perspective when understanding problems, and explore possibilities through analytical thinking. In the process of problem-solving, They tend to follow a set step and try to minimize uncertainty. A learner who is both a thinking type and an innovative behavior type is classified as a thinking-innovation-action type (TVA). In the process of conception, They think diffusely and create various ideas, but rather than simply creating ideas based on feeling or insight, They generate ideas that They think are valid based on logic and analytical thinking, and They can objectively evaluate ideas. Various methods are tried in the process of implementation, but based on analytical thinking, They try to minimize trial and error or to identify the cause. A learner who is both a thinking type and an innovative reflection type is classified as a thinking-innovation-reflection type (TVR). They generate valid and diverse ideas based on analytical thinking, but act with careful judgment based on logical validity when implementing them. A learner who is both a thinking type and an adaptive reflection type is classified as a thinking-adapting-contemplation type (TDR). They have a tendency to be cautious in the process of conception, so they cannot easily to generate ideas, and in implementation, logical validity and analytical thinking are better than bold attempts, so they cannot produce various results. Although it seems passive in solving technological problems, it should be viewed as cautious rather than passive, and good results can be obtained without trial and error. A learner who is both a thinking type and an adaptive behavior type is classified as a thinking-adapting-action type (TDA). In the process of conception, they approach carefully with analytical thinking, and make various and steady attempts in implementation. The above thinking learners have a strong tendency to judge according to the principle of fairness rather than being bound by recognition, and have a tendency to seek critical elements in the evaluation process.

Five-factor learner model for technological problem-solving

The five-factor learning style model of technological problem-solving can be constructed that takes all five dimensions of the technological problem-solving learning style as factors: perception, judgment, creativity, execution, interaction, and attitude. This model considers all dimensions and propensity of technological problem solving, and a total of 32 learner types can be identified. When constructing the model, the type with the tendency of introverted energy for each dimension was placed inside and the type with the tendency of introverted energy was placed outside. Introverted means the learner's interest and problem-solving process is mainly directed towards the inner world or has a convergent characteristic, while extrovert means the learner's interest and problem-solving process is mainly directed to the outside world or has a diffuse characteristic.

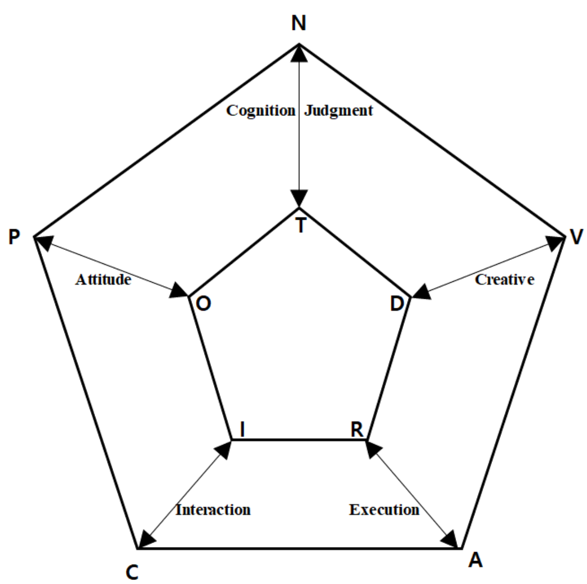

Fig. 5: Five-factor learner model of technological problem solving

When constructing the model, for each dimension, the type with relatively introverted energy was placed on the inside, and the type with relatively extroverted energy was placed on the outside. Here, introvert means that the learner's interest and problem-solving process are mainly directed toward the inner world or have convergent characteristics, and extrovert means that the learner's interest and problem-solving process are mainly directed toward the outside world or have a diffuse characteristic.

The profile of thinking-innovation-consideration-collaboration-participation (TVRCP) is shown in Figure. 6.

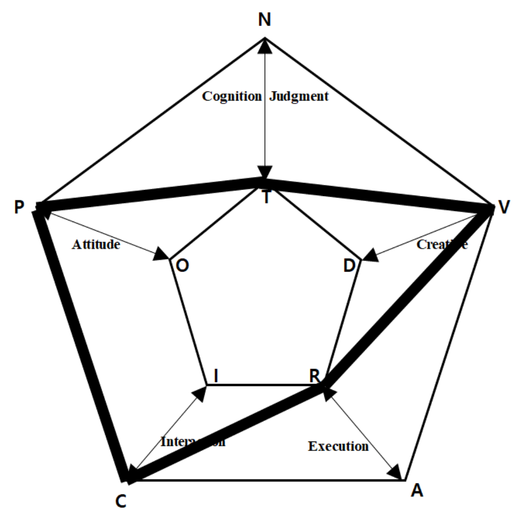

Fig. 6: TVRCP profile

This type has a relatively balanced distribution of introverted and extroverted energy, and has the following characteristics in the process of technological problem-solving.

When understanding a problem, this type recognizes it from a detailed and objective point of view, and explores possibilities through analytical thinking. In the process of problem-solving, they tend to follow a set step and try to minimize uncertainty. Based on analytical and divergent thinking, they generate valid and diverse ideas, but they act with caution when implementing them. Therefore, it is appropriate to present an unstructured or semi-structured design problem. This type prefers group learning and is good at interaction.

The profile of thinking-adaptation-consideration-cooperation-participation type (TDRCP) is as shown in Figure. 7.

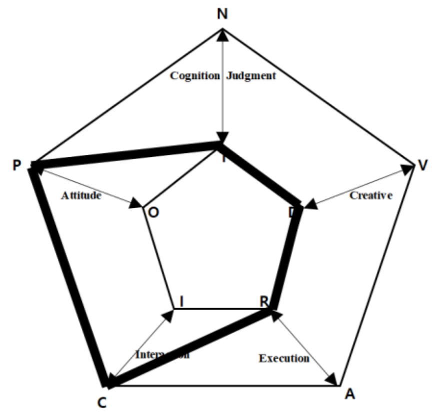

Fig. 7: TDRCP profile

This type has a relatively balanced distribution of introverted and extroverted energy, but has only introverted energy in cognitive and psychodynamic domains and only extroverted energy in affective domains. In the process of technological problem-solving, this type has the following characteristics.

When understanding a problem, this type recognizes it from a detailed and objective point of view, and explores possibilities through analytical thinking. In the process of problem-solving, they tend to follow a set step and try to minimize uncertainty. They have a tendency to be cautious in the process of conception, so they cannot easily generate ideas, and in implementation, logical validity and analytical thinking are better than bold attempts, so they cannot produce various results. Therefore, it is appropriate to present a structured problem-solving problem. Although it seems rather passive in solving technological problems, it should be viewed as cautious rather than passive, and good results can be obtained by minimizing trial and error. This type prefers group learning and is good at interaction, so they can overcome their shortcomings by interacting with colleagues who have extroverted energy.

The profile of intuition-innovation-action-collaboration-participation type (NVACP) is shown in Figure. 8.

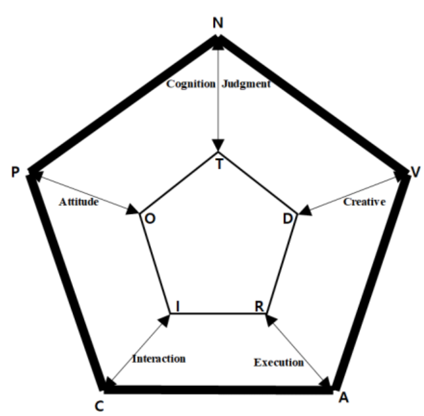

Fig. 8: NVACP profile

In this type, only extroverted energy is extremely distributed. In the process of technological problem-solving, this type has the following characteristics.

When they understand a problem, they tend to see it in terms of the whole rather than the details, and they tend to look for different possibilities through insight. Rather than the problem-solving process proceeding step-by-step, the steps can be easily adjusted by the individual's insightful thinking. Because they are good at divergent thinking and enjoy adventurous challenges, it is appropriate to present the unstructured invention problem. However, there is also the risk of excessive trial and error due to a lack of prudence. However, since this type prefers group learning and is good at interaction, they can overcome their shortcomings by interacting with colleagues who have introverted energy. Because relative values are more important than absolute values, they have a tendency to look for positive factors rather than critical ones in the evaluation process.

The profile of the Thinking-Adaptation-Contemplation-Independent-Avoidant type (TDRIO) is as shown in Figure. 9.

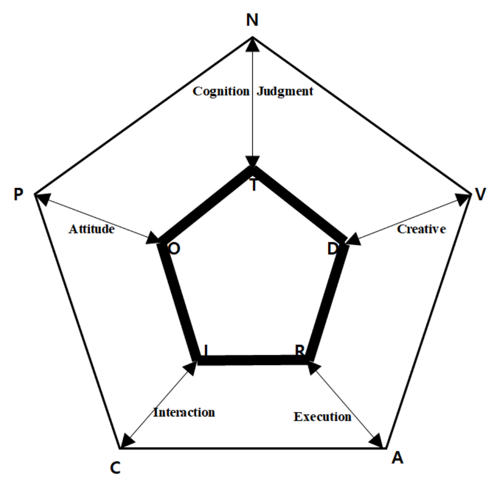

Fig. 9: TDRIO profile

In this type, only introverted energy is distributed, and in the process of solving technological problems, this type has the following characteristics.

When understanding a problem, they recognize it from an objective point of view, and explore possibilities through thinking. In the process of problem-solving, they have a tendency to try to minimize uncertainty, not trying to deviate from the set steps and methods. They have a tendency to be cautious in the process of conception, so they cannot easily generate ideas, and in implementation, they cannot make a variety of results because they have not boldly tried. Therefore, it is appropriate to present a structured problem-solving problem. Overall, it seems rather passive in solving technological problems. Because this type prefers individual learning, they may feel difficult to interact with colleagues and have a strong tendency to avoid solving the presented problem. Therefore, the active intervention and help of teachers is required.

Conclusion and Suggestions

The purpose of this study was to devise a learning style model for individualized learning of AI convergence in technological problem-solving, which is the main teaching-learning method of technology subject. The learning model devised in this study reflects the characteristics of technological problem-solving as it considers all areas of cognition, definition, and psychodynamics. Among the dimensions of recognition, judgment, creativity, execution, attitude, and interaction of technological problem-solving learning styles, the dimensions that acted mainly according to the content of the problem and the learning type could be selected and constructed as a model. The learner characteristics defined through the model design provided the direction and basic data for the type of problem and the learning process to be presented in AI convergence education considering the individual characteristics of the learner. In the future, it is suggested that specific individualized teaching and learning development research be conducted in AI convergence education, considering the characteristics of learners according to the learning style of technological problem-solving.

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