

A Design-Based Research on Application of Artificial Intelligence(AI) Teaching-Learning Model in Elementary School

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Abstract

Recently, artificial intelligence(AI) has been used throughout society, and social interest in it is increasing. Accordingly, the necessity of AI education is becoming a big topic in the education field. As a response to this trend, the Korean education authorities have also announced plans for AI education, and various studies have been performed in academic field to revitalize AI education in the future. However, the curriculum research on what differentiates AI education from existing SW education and what and how to train AI is still in its infancy. In this paper, Therefore, we focused on the experiences of elementary school students in solving problems in their own lives, and developed a teaching-learning model based on design-based research so that students can design a problem-solving process and experience the process of feedback. We applied the developed teaching-learning model to the problem-solving process and confirmed that it increased students' understanding and satisfaction with AI education.

Keywords: *Artificial Intelligence, AI Education, Design-Based Research, Teaching-Learning Model, Elementary Education*

1. Introduction

Since 2015 Revised National Curriculum in Korea, the improvement of problem-solving ability based on computational thinking has been emphasized, thus the software education was organized as a regular curriculum in elementary schools [1].

The artificial intelligence (AI) education has attracted many attentions as an axis of the new curriculum, evidenced by announcement of a national plan for AI education plan in 2020 [2]. AI education, beyond software educations, is expanding its subject areas not only to problem-solving abilities but also to development of learners' various competencies. The course of these problem solving may not be covered by current curriculum classes because it takes time for a series of processes that include discovering problems in one's daily life and finding solutions to them using AI. In addition, it is considered that the students experience the process of

problem solving in the activities of sharing and reflux in connection with various projects in the school, through which, AI education in the future should include the development of learner competency in the intelligence & information society as a goal. The purpose of this paper was, therefore, to investigate various learner competencies and teaching-learning models in this era of intelligence & information proposed for AI education and to develop an AI teaching-learning model for enhancing the capabilities of learners in the intelligence & information society.

This paper is organized as follows: In section 2, various AI teaching-learning model and design-based research are addressed. In section 3, a teaching-learning model is presented aided by the design-based research. In section 4, the proposed model is tested through application cases and in the last section, conclusion is provided and the studies in the future are discussed.

2. Related Works

2.1 AI education

First, there is a study about AI education program for elementary school teachers, a teaching-learning program consisting of the steps such as understanding AI, understanding and using AI tools, and understanding and using AI programs [3].

Second, there is a study that focused on AI education for elementary school students. As such, they developed an AI education teaching-learning model for elementary school students consisting of such steps as problem recognition, data collection, selection of AI modeling, AI programming, and reporting [4].

Third, there is a study that focused on the core competencies that learners should develop in intelligence & information society, and developed a teaching-learning model composed of such steps as problem recognition and analysis, collecting data, data processing and selection, ML-based software teaching-learning model training and evaluation, ML programming, applying and solving, and sharing and reflux [5].

Fourth, there is a study that facilitate the understanding of AI principles, developed contents and method for AI education consisting of the steps of understanding AI, understanding AI principles, and applying AI [6].

Fifth, there is a study that focused on the DL concept and computational thinking (CT) factor and proposed an AI education for the DL concept [7].

Sixth, there is a study that expanded the learners in AI education to all citizens, and for this, provided the Open Learning platform for free and the courses included 'what is AI?', 'what is data?', and 'the process of the AI project' [8].

Although these various previous studies related to AI education suggest a teaching-learning model, there have been no consensus on the stages and their contents.

2.2 Design Based Research

The design-based research (DBR) is a paradigms used in research. The paper adopting DBR conducts research, to promote teaching-learning, focusing on various situational factors and interactions in the classroom [9,10,11]. DBR mainly goes through the cycle of design - use - effect evaluation - redesign in the actual educational field through educational programs and teaching-learning models. This cyclical flow itself is a research process that improves the educational program and teaching-learning model. Since DBR values the flow and context found in a series of cycles, it focuses on deriving the optimal program within a given environment rather than generalized research results.

3. DBR-based AI teaching-learning model

To develop AI teaching-learning model, DBR was performed by reflecting the ML-based SW teaching-learning model and contents of ‘AI ethics’, ‘convergence education’, and ‘problem solving in real life’ based on analysis of AI education learning-teaching model from previous studies [5, 12].

In addition, overall programs as well as unit programs followed the organic and cyclic flow of DBR, through which, the capability of learners in intelligence & information society were developed. Figure 1 shows the overall flow of teaching-learning. As shown in figure 1, Though the learners’ capability in intelligence & information society may be developed for each unit program and step, he key capabilities that should be developed were determined for each step in the process of debugging and reflux under DBR. In effect evaluation, design, and use steps, capabilities to use AI platform and basic ones of intelligence & information society were sought and capabilities of controlling oneself and others in redesign and of AI-based advanced thinking were selected for use, and effect evaluation steps.

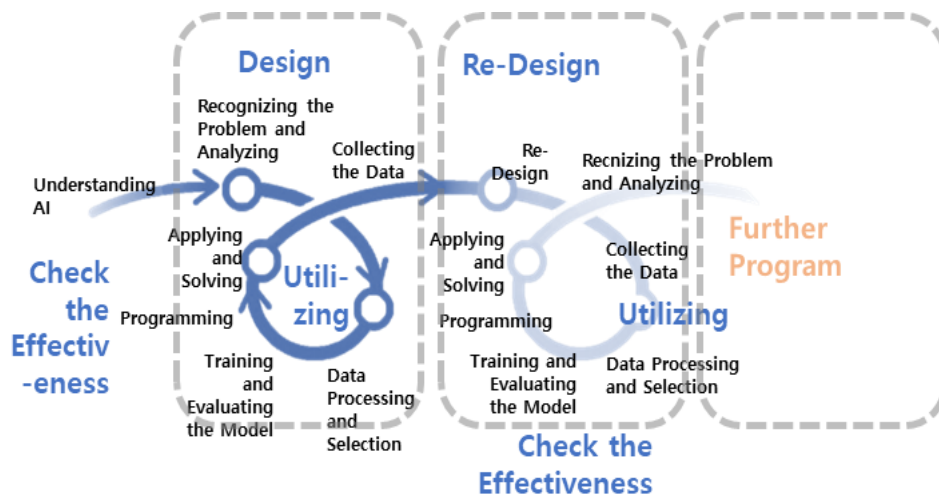


Figure 1. AI education teaching and learning model using design-based research

3.1 Understanding AI

In understanding AI step, the commons and difference between human and AI are explored. in this step, the students were encouraged to explore by themselves various fields where AI has been used, reduce distance with and fear of AI, and increase understanding and intimacy with AI. And students may explore AI ethics that should be followed in intelligence & information society by writing their own AI ethics matrix or examining algorithm bias.

3.2 Problem Recognition and Analysis

In this step, after experiencing various AI education platforms or robots, students discuss real-life problems that may be solved with AI. They also may discuss the changed appearance of future society due to AI and the necessity of AI education platforms such as Machine Learning for Kids or Teachable Machine and robot-aided programming. In this process, teachers, rather than presenting problems unilaterally, should allow learners to explore AI programs on their own and to raise awareness of AI learning that may be used in solving real life problems.

3.3 Collecting Data

The learners, in this stage, first discuss the various data formats for the real-life problems that the learners

are to solve, and then performs the activities of collecting required type of data such as text, images, and numbers according to the selected data format. In particular, among various types of data that are recognized by the AI education platform and robot, data may be collected by using the camera mounted on the robot or the webcam of the device to reflect the computer vision field. In addition, they may, in unplugged activities according to their levels, perform activities related to data collection by using data in type of various card as teaching materials.

3.4 Data Processing and Selection

In this step, the labels and learning data created in the previous steps are input to actual AI education platforms or robots such as Machine Learning for Kids and used in training. The learners, in this step, may process and select data and their process and selection of card-type data in unplugged activities may be included in it.

3.5 Training and Evaluation of Model

In this step, The AI model generated by the learners may be evaluated using the data input previously. It is checked whether the model works properly and the measures to increase the reliability of AI ML may be discussed and applied. When a series of learning activities are performed under unplugged activities, as like the AI training program for deep learning concepts in the study, this step and the programming step may be replaced by alternative activities or skipped after experiencing the principles [7].

3.6 Programming

In this step, actual AI programs are developed using programming languages used in AI education platforms such as Machine Learning for Kids. This may be used in connection with AI educational robots in terms of 'robot engineering' of AI.

3.7. Applying and Solving

In this step, the problems in real life may be solved using the developed AI program. In particular, programs reflecting the field of robotics may solve more diverse problems by using educational robots. In addition, convergence activities may be carried out in connection with other schools.

3.8. Sharing and Debugging

The AI teaching-learning model development process goes through the project learning process, rather than unit class. After completing unit project learning, the completed problem-solving program may be shared. In terms of how to solve the problem, there may be a debugging process to revise the program or remove error.

4. Case Study

4.1. Creating AI Ethics Matrix

Before implementing the project, activities to understand AI and examine AI ethics were conducted. Table 1 shows an example of class. As shown in table 1, first of all, it was necessary to learn about AI and become familiar with it before learning about the ethics of AI. In this regard, we looked at the use cases of AI related to the video recommendation algorithm in our daily life and analyzed them together. In the case of the video recommendation algorithm, after discussing for whom and for what, a related ethical matrix was prepared. We were able to evaluate the bias and fairness of the AI-based recommendation algorithm examined through the

ethics matrix and extend it to other services in our daily life.

Table 1. Creating AI ethics matrix

Steps	Contents
Understanding AI	Take a look at AI in life (Video Recommendation Algorithm)
Problem recognition and analysis	Recognizing problem situations in artificial intelligence used in life, such as personal information used when recommending videos
Data Collection	Discussion (collection) of various problem situations in the use of artificial intelligence in daily life
Data Processing and Selection	Classify problems by context (create ethics matrix)
Model training and evaluation	Ethics Matrix Assessment
Apply and Problem solving	Applying the created ethics matrix to other AI services
Sharing and Debugging	Share, feedback, and improve

4.2. Data-based Unplugged Activity

Among the sub-themes of the ‘development of infectious disease prevention program’ project, ‘data-based unplugged activity to prevent infection’ consisted of three unplugged activities to understand the principles of ML, such as supervised learning, unsupervised learning, and reinforcement learning. This is an activity that especially focuses on the basic capability required for intelligent & information society. Table 2 shows the contents of the ‘understanding reinforcement learning Using self-diagnosis of infectious disease’. As shown in table 2, the self-diagnosis system, which students participate in every day in an infectious disease situation, is becoming increasingly sophisticated. This class begins with a discussion about what would happen if an AI function was combined to automatically classify whether students were able to attend school or not. Agreeing on the need to deal with a lot of data for classification, the self-diagnosis system proceeded with an unplugged activity using a data card to determine what data should be used to classify whether or not to go to school. This was further expanded and applied to the case of AI chat-bot production in everyday life, and it was possible to conclude with a mutual evaluation.

Table 2. Data-based unplugged activity to prevent infectious diseases

Steps	Contents
Understanding AI	Take a look at AI in life (Various examples of handling and processing data in life)
Problem recognition and analysis	How does the AI of the self-diagnosis system determine whether it is possible to attend school?
Data Collection	Collection of data by symptoms such as high fever, upset stomach, and chills (Cards)

Data Processing and Selection	Create a decision tree based on data cards
Model training and evaluation	Training and evaluation of AI models
Apply and Problem solving	Apply the created model and apply the chatbot to other situations
Sharing and Debugging	Share, feedback, and improve

4.3. Data-based Unplugged Activity

Among the sub-themes of the ‘development of infectious disease prevention program’ project, ‘development of program to detect mask-wearing’ was composed of two contents using Teachable Machine and Entry. The contents of class focused on enhancement of ability to use AI platform, using Teachable Machine and Entry, are shown in Table 3. As shown in table 3, I implemented my own AI program based on my understanding of the principles of AI. In particular, he sympathized with the need for an AI classification program that detected whether a mask is worn for school entrance in an infectious disease situation, and discussed the necessary data for this. After examining the need for facial image data for wear detection, a machine learning model was created with the image project of Teachable Machine, and by expanding it, I was able to create my own program using the entry video detection command.

Table 3. Making a program for mask wearing detection

Steps	Contents
Understanding AI	Take a look at AI in life (With regard to the teachable machine)
Problem recognition and analysis	Analyze the data required to detect wearing a mask (face images)
Data Collection	Facial images data collection
Data Processing and Selection	Face image data processing and selection (class creation and classification)
Model training and evaluation	Training and evaluation of AI models (Checking for face recognition)
Apply and Problem solving	Apply the created model and apply the chatbot to other situations
Sharing and Debugging	Share, feedback, and improve

4.4. Create a school education program

Among the sub-themes of the ‘development of infectious disease prevention program’ project, ‘development of counseling program to prevent infectious disease’ is an educational activity to create a chatbot program using Machine Learning for Kids and Dialog Flow and focused on the capability of AI-based advanced thinking to solve problems in real life. The detail contents are found in Table 4. The detail contents are found in Table 4. As shown in table 4, as the importance of psychological counseling education increases in infectious disease situations, a chat-bot program based on the AI programming discussed above was produced. First, we analyzed chat-bot programs that are often used in our daily lives, and discussed the data needed for this. The AI chat-bot collected and classified various text data to make correct recommendations according to input values. It could be applied by making it as an AI model and programming it with Scratch.

Table 4. Making a program for psychological counseling in infectious disease situation

Steps	Contents
Understanding AI	Take a look at AI in life
Problem recognition and analysis	Data analysis required to create a chatbot program
Data Collection	Text data collection according to context
Data Processing and Selection	Text data processing and selection
Model training and evaluation	Training and evaluation of AI models
Apply and Problem solving	Apply the created model and apply the chatbot to other situations
Sharing and Debugging	Share, feedback, and improve

5. Conclusion

This paper sought to develop of AI teaching-learning model for elementary school students.

First, the existing AI teaching-learning models were comparatively analyzed through literature review, and a model suitable for this paper was selected. Next, following the principle of DBR, the stages and contents of the selected model were reconstructed to include the elements of each AI education, and based on them, an AI teaching-learning model for elementary school students was developed. The developed model was applied to the AI class in which 23 students of the D elementary school participated. In the course of the class, students were encouraged to understand and utilized AI to solve real-life problems. After class showed that most of the students became interested in AI through the classes applying model and, in the process of solving problems on their own, learned the usefulness of AI.

We considered that various educational contents, including detailed programs should be developed to facilitate the application of developed teaching-learning models in actual elementary school classes. In addition, the follow-up studies on the AI capability of the future generation to verify the degree of capability development of students are required.

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