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AI learning modules for elementary students

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***Abstract*---**The article is a documentary research. The results were brought for assessment and trial, with the objectives to synthesize AI learning components for elementary students and to create the prototype AI learning modules for elementary students. The results revealed as follows. 1) There were 5 AI learning components for elementary students, i.e., (1) perception (of the computer world by using sensors), (2) representation & reasoning (3) machine learning (ML), (4) natural interaction, and (5) societal impacts. These 5 dimensions covered the principles of teaching educational concepts and AI. 2) There were 5 prototype AI learning modules for elementary students, i.e., (1) Perception Module, (2) Representation & Reasoning Module, (3) Machine Learning Module, (4) Natural Interaction Module, and (5) Societal Impact Module; with practice through teaching media in accordance with the contents. There was an intelligent decision support system (IDSS) to assess AI learning competency for students. To clarify, the system predicted each dimensions of their AI ability. There was also an intelligent advice management system (IAMS) for teachers to reinforce learning management. The prototype modules were assessed by 5 experts. It was found that the suitability of most modules was highest, followed by the high ones. Besides, they were brought for a workshop in 5 computer teachers of elementary students. According to the results of the interview, the modules were suitable to be used in real. Media used were also suitable. However, the number of media used were suggested to be more in accordance with the number of students. Also, utilization may require adjustment of different activities in accordance with the contexts of students. In case computer appliances are required, activities of each module

should be adjusted into the same period for easier learning management.

***Keywords*---**artificial intelligence (AI), elementary students, module, AI learning, documentary research.

Introduction

Artificial intelligence (AI) contains key roles in our daily life, e.g., automatic electrical appliances, smartphones, Google Maps, Siri, social media, and voice control devices. These all require AI knowledge. Thus, basic AI knowledge has become a key issue like literacy in the past. Thus, basic knowledge for children to learn and get ready in the digital world is necessary. Prepare students for AI to be suitable for this change, it can be done through learning management because it is a necessary process for knowledge transfer through modern and systematic learning management modules to assist teachers. According to the significance, as stated, this article is documentary research. The prototype modules were assessed by experts and teachers for their suitability. The objectives were to synthesize AI learning components for elementary students and to create the prototype AI learning modules for elementary students, with the determination to develop their basic AI knowledge through suitable module lessons for their understanding of basic AI so that they can utilize such knowledge to in their life, and will be ready to be key personnel of technology for national development in the future.

The principles of AI learning management for elementary students

The principles of AI learning management for elementary students were defined differently as follows. Principle 1: It is about AI content selection and arrangement, consisting of 5 issues, i.e., 1) support students to see its response mechanism to create problems by dataset collection or disconnected algorithms for data processing. 2) Create experiences in developing representatives to imitate AI system instead of contents. 3) Sequence topics for content collection and conclusions of AI characteristics. 4) Teach students how to use and create AI based on simple components for further development on their own. And 5) compare AI ability of humans in various dimensions, including psychological dimension for student awareness of similarities and differences between humans and AI (Langley, 2019). Principle 2: It is about using the scope of AI knowledge to specify key principles or issues in teaching, consisting of 5 issues, i.e., 1) perception (of the computer world by using sensors) as a process that a computer uses sensor to see, hear, or touch for further data processing and responses; 2) representation & reasoning because AI system is compared to perception and expressions of the world, depending on input data and processed data; 3)machine learning (ML) that causes computers to create representatives from data training and input by humans, which still contain biases that must be considered; 4) natural interaction that is created by the challenge of developers in term of some limitations of computers to learn natural languages due to lack of reasoning and communication ability in children, so AI requires such skills to function efficiently; and 5) societal impacts , both positive and negative, so students

should be able to specify that AI affects all humans in the dimensions of social growth and ethics (Touretzky, Gardner-McCune, Martin & Seehorn, 2019). Principle 3: It views that the key concept of teaching AI is to understand AI, consisting of 7 issues, i.e., 1) automatic system displaying decision-making process in sequence; 2) intelligent mediators displaying modelling process for decision-making; 3) graph, data structures, basic computer science, arrangement, and control of concepts; 4) sequencing basic concepts of AI and algorithms until further utilization; 5) solving problems by searching, as a key AI concept in various ways of utilization; 6) classical planning as to use logics for creating problem models, decision-making models, and implementation plan assessment; and 7) ML as a different method from learning of mediators in the forms of a decision-making mind map and a natural network (Kandlhofer, Steinbauer, Hirschmugl-Gaisch & Huber, 2016). These can be concluded as in Table 1.

Table 1: The principles of teaching AI concepts

Langley (2019)	Touretzky, Gardner-McCune, Martin & Seehorn (2019)	Kandlhofer, Steinbauer, Hirschmugl-Gaisch & Huber (2016)
- Support students to see its response mechanism.	- Perception.	- Automatic system.
- Create experiences indeveloping representatives to imitate AI systems.	- Representation & reasoning.	- Intelligent mediators.
- Sequence topics for content collection and conclusions of AI characteristics.	- machine learning (ML).	- Graph, data structures, and basic computer science.
- How to use and create AI.	- Natural interaction.	- Sequencing.
- Similarities and differences between humans and AI	- Positive and negative societal impacts.	- Solving problems by searching.
-	-	- Classical planning.
-	-	- ML.

According to Table 1, it can be concluded that there are 5 components of the AI concept that students should obtain as follows.

1. Perception: It refers to the perception of computers by using sensors. Perception is a process of signal decoding from the senses. To make computers see and hear is useful for the best utilization of current AI.
2. Representation & reasoning: It refers to being a representative of the world that is used for reasoning. Representation is one of basic problems of natural and artificial intelligence. Computers create representation by using data structures. And these representatives support algorithms for reasoning that creates new data based on existing knowledge. In contrast, representative AI is capable of complex reasoning but not as reasonable as what humans think.

3. Machine learning (ML): Computers can learn from data. ML is a statistical reference that searches for various AI platforms, which have been hugely advanced in the past few years. That is because learning algorithms that create new representation platforms contain a large amount of indispensable data for success. Data training requires assistance from humans. However, this can be done by the machine itself.
4. Natural interaction: Natural interaction with humans is necessary to facilitate daily living with humans in harmony. AI must understand processes and data processing in terms of communication, behavioral observation, and suitable as well as normal responses, and emotional states. Sometimes, emotions or behavior of humans are too complex for AI to understand. Thus, this might be a limitation of natural responses of AI.
5. Societal impacts: This component refers to positive and negative societal impacts of AI. This technology changes styles of work, travel, communication, and care for other people. However, we must be careful of impacts on others. For example, biases of data using AI trend can guide someone to get something different from others. Thus, it is necessary to discuss societal impacts of AI, and to create an ethical framework for basic AI design and development. These 5 issues cover the principles of teaching educational concepts and AI.

Learning design and management the development of AI concepts

Langley (2019); and Touretzky, Gardner-McCune, Martin & Seehorn (2019) revealed 5 scopes of key concepts regarding AI teaching guidelines for elementary students. Learning management should arrange contents of basic AI, and then lead to conclusions so that students can extend advance AI creativity in accordance with the development and suitable learning, i.e., awareness, searching, trial, imitation, and creativity as advanced development. Thus, recognized AI in kindergarten as well as elementary students is at the level of perception and pleasure toward AI issues, which is the initial development. Moreover, there are 6 key issues of AI teaching contents, i.e., 1) introduction of basic concepts that consist of (a) human and machine intelligence; (b) representation, reasoning, searching, and knowledge; (c) perception and matching; and (d) decision-making and selection. 2) Inference and reasoning consist of (a) multi-stage inference; (b) deductive reasoning; (c) acceptable limitations; (d) qualitative and causal reasoning; (e) selection and description; and (f) comparative reasoning. 3) Implementation and sequence control consist of (a) interaction control; (b) control of knowledge, understanding, and sequence; and (c) implementation and monitoring. 4) Planning and problem-solving consist of (a) problem-solving by searching; (b) guidelines on self-directed searching; (c) planning; and (d) problem-solving of the opposite. 5) Integration system consists of)a) integrated representation; (b) using AI robots; (c) using system for automatic diagnosis and repair; (d) using operation-based conversation system. And 6) Advanced issues consist of personal requirements and self-description; (b) creativity and discovery; (c) emotions and personalities; (d) moral reasoning; and (e) review and conclusion (Langley, 2019; Kandlhofer, Steinbauer, Hirschmugl-Gaisch & Huber, 2016).

Most techniques that rely on AI to support learning management for students at different levels and for elementary students are to give instant feedbacks, both insights into taught contents and reasoning; including teaching students to have decision-making and problem-solving skills (Ouariachi, Li & Elving, 2020; Malik, Tayal & Vij, 2019). According to learning concepts, design, and management for the development of AI concepts, the researcher applied them to create AI learning modules for elementary students. They can be concluded as in Table 2.

Table 2: The conclusions of learning module structures

Module	Activities	Media	Measurement
Module 1 Perception	- Watching intelligent robot clip. - Unlocking phone by facial recognition. - Playing the robot and observing its responses. - Matching to study data acceptance and responses via application. - Summarizing the activities and exemplifying real AI in the daily life.	- A simple robot. - Snap photo (https://experiments.withgoogle.com/ai/giorgio-cam/view/). - The website of SHAZAM.	- Specifying and describing perception processes of computers and AI devices. - Writing the examples of perception and responses compared with AI.
Module 2 Representation & Reasoning	- Answer guessing and using Quick draw. - Word guessing. - Akinator Game. - Writing the decision tree.	- Quick draw - Akinator Game.	- Competition results against AI via Quick draw. - Writing the decision tree.
Module 3 Machine Learning	- Character guessing from pictures. - Data training on the website "Teachable Machine." - Animal classification. - Studying the principle of linear regression.	- Disney character cards. - Boards of countries' capitals with electronic circuits inside. - Boards of animals with electronic circuits inside. - http://teachablemachinewithgoogle.com/train.	- Presenting picture sorting to classify animals.
Module 4 Natural interaction	- Demonstrating talking with chatbot. - Talking with Siri. - Playing Rock Paper Scissors. - Using google translator. - Talking with online shop system.	- www.simsimi.com/ - http://machinelearningforkids.	- Concluding data training concepts for Rock Paper Scissors to make the machine function naturally.

Module	Activities	Media	Measurement
		- Application Siri. - google translator.	
Module 5 Societal impacts	- Watching AI VDO about AI. - Discussing advantages and impacts of AI. - Playing Survival of the Best Fit Game.	- Sample VDO about impacts of AI. - Survival of the Best Fit Game. - Gamification	- Answering ethical questions of AI by Plickers.

Module 1: Perception – It was the first module for students to complete their group activities by observing the robot, with teachers as question providers so that students would have the concept of perception by sensor. In addition, students played games via the application that included perception and responses, and writing human work map compared with AI.

Module 2: Representation & Reasoning – It was the second module focusing on answer guessing in order to compare the drawn answer using Quick draw. There was also the question about how the computer acknowledged which pictures were drawn. There was also word guessing activity by using questions continuously to get answers. Akinator Game was also provided to create the concept of judgement, along with writing the decision tree.

Module 3: Machine Learning – It was the module to make students understand ML. Thus, computers created representation by data training. The data was input by humans. That was why the activities included character guessing from pictures, data training on the website "Teachable Machine," animal classification, and studying the principle of linear regression to create a representation platform by maximum likelihood.

Module 4: Natural interaction – It was the module to make students understand natural interaction with humans. Thus, AI required understanding of processes and data processing in terms of communication and suitable response platforms. The activities included demonstrating talking with chatbot to study whether or not responses were same, talking with Siri to observe responses, playing Rock Paper Scissors to practice data training, using google translator to answer how the machine received data, and talking with online shop system.

Module 5: Societal impacts – This module aimed to make student realize impacts and advantages of AI. Thus, the activities in this module included watching AI VDO about AI with the examples of advantages and impacts of AI; discussing advantages and impacts of AI; and playing Survival of the Best Fit Game.

Other than these, using the modules also contained an intelligent decision support system (IDSS) to assess AI learning competency for students to predicted each dimensions of their AI ability; as in Fig. 1. There was also an intelligent advice management system (IAMS) for teachers to reinforce learning management; as in Fig. 2.

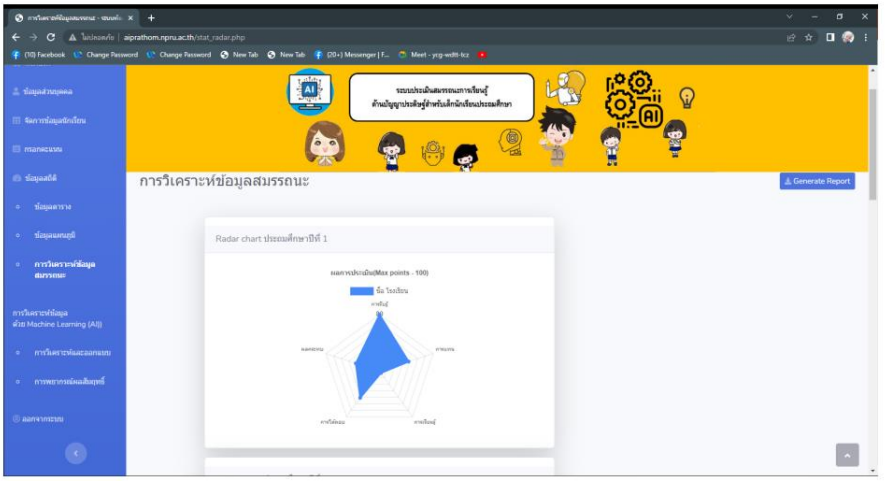

Fig. 1: The example of IDSS to assess AI learning competency for students.

Fig. 2: The example of IAMS to advice management system for teachers to reinforce learning management.

Using the learning modules for quality and suitability assessment

The researcher took the prototype modules for quality and suitability assessment by 5 experts in AI; computer studies; educational media and technologies; and learning management. It was found that the suitability of most modules was highest, followed by the high ones, as in Table 3.

Table 3: The results of quality and suitability assessment by the experts

No.	Issues for assessment	Suitability levels				
		Highest (5)	High (4)	Moderate (3)	Low (2)	Lowest (1)
1	The objectives were clear and possible.	2 (30%)	3 (60%)	-	-	-
2	The contents were suitable for the level of students.	3 (60%)	2 (30%)	-	-	-
3	The contents were congruent with	3 (60%)	2 (30%)	-	-	-

No.	Issues for assessment	Suitability levels				
		Highest (5)	High (4)	Moderate (3)	Low (2)	Lowest (1)
	learning media.					
4	The contents were suitable to be used in real.	2 (30%)	3 (60%)	-	-	-
5	Module setting was suitable.	2 (30%)	3 (60%)	-	-	-
6	Learning activities were suitable to achieve the goals.	2 (40%)	2 (40%)	1 (20%)	-	-
7	The duration of each module was suitable.	3 (60%)	2 (30%)	-	-	-
8	Learning media were suitable for the contents.	2 (30%)	3 (60%)	-	-	-
9	The assessment was suitable.	2 (30%)	3 (60%)	-	-	-
10	The learning result modules were possible to be used in real.	3 (60%)	2 (30%)	-	-	-

The prototype modules were brought for a workshop in 5 computer teachers of elementary students. There was also an interview to assess suitability and possibility to be used in real. Media used were also suitable. However, the number of media used were suggested to be more in accordance with the number of students. Also, utilization may require adjustment of different activities in accordance with the contexts of students. In case computer appliances are required, activities of each module should be adjusted into the same period for easier learning management.

Results

According to the assessment of the prototype modules by 5 AI experts, it was found that the suitability of most modules was highest, followed by the high ones. And according to the results of the interview with 5 teachers after the workshop, the modules were suitable to be used in real. Media used were also suitable for students. Utilization may require adjustment of activities and media equipment in accordance with the contexts of schools.

Conclusions

This article can be concluded as follows according to the objectives. 1) There were 5 AI learning components for elementary students, i.e., (1) perception (of the computer world by using sensors), a process of signal decoding from senses; (2) representation & reasoning, to use the representatives for reasoning, and to invent computers to create representation by using data and those representatives to support algorithms for reasoning that creates new data based on existing knowledge; (3) machine learning (ML) as computers can learn from data, and ML is a statistical reference that searches for various AI platforms; (4) natural interaction with humans as AI can understand processes and data processing; and (5) societal impacts, referring to positive and negative societal impacts of AI, and that AI changes working styles. These 5 dimensions covered the principles of teaching educational concepts and AI. 2) There were 5 prototype AI learning modules for elementary students, i.e., (1) Perception Module, (2) Representation & Reasoning Module, (3) Machine Learning Module, (4) Natural

Interaction Module, and (5) Societal Impact Module with practice through teaching media in accordance with the contents. There was an intelligent decision support system (IDSS) to assess AI learning competency for students. To clarify, the system predicted each dimensions of their AI ability. There was also an intelligent advice management system (IAMS) for teachers to reinforce learning management.

Conflict of Interest

The authors have no conflicts of interest to declare.

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