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## **Development of artificial intelligence indicator for elementary students**

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**Abstract**--This research aimed to develop the Artificial Intelligence (AI) indicator for elementary students by synthesizing the components of artificial intelligence learning for elementary students which is designed to be aware of the issue of mental health of children as well. The results were assessed for appropriateness by five experts. Findings demonstrated that the indicator consisted of five aspects ordering by the complex from Grade 1 to 5. Firstly, it was Perception which the student could explain the origin of interaction between the AI and human by designing a reception system to conduct perception and response, and draw the response diagram. Secondly, it was Representation & Reasoning which the student could explain the reasoning algorithm of the AI. Thirdly, it was Machine Learning which the student could explain the machine learning, criticize the input data defect. Fourthly, the Natural interaction, which the student could justify the purpose of data trending and improvement of AI to be more natural by creating a realistic response system. Lastly, it was the Societal Impact which the student could suggest the solution to AI system problems to be more accurate and appropriate with the fewest impact on humans and facilitate human living efficiently.

**Keywords**---indicator, artificial intelligence (AI), elementary students.

## **Introduction**

Artificial Intelligence or AI is the technological drive emerging during this century that will transform the virtual and imaginary world. It is one of the core branches of computing science, smart management, machine adjustment, and learning from science and engineering knowledge to imitate the human brain to respond to things (Ner, 2020; Holmes, Bialik & Fadel, 2019). AI has been applied to the computer and other devices to support education, business, and personal management. Therefore, apart from being a teaching aid, AI might be a robot that assists a teacher in a classroom in the future (Malik, Tayal & Vij, 2019; Timms, 2016).

As it has been pointed out, AI is crucial for education, particularly for the professional who has to prepare for the change, especially the children in elementary education. For this reason, some studies examine the development of artificial intelligence concept in elementary students that requires time to construct their foundation by focusing on the three core elements. (1) Ethics and creativity construction (Ali, Payne, Williams, Park & Breazeal, 2019), such as results of teaching AI to elementary students for three years from the fundamental concept, AI vocabularies, and AI application to human life. Teaching provided knowledge and experience in AI via games and robots. Most students perceived the AI function. However, the technical content and concept of AI must be explicit. (2) Environment was vital to support the student to be confident in learning AI (Heinze, Haase & Higgins, 2010). (3) The explicit guidelines for assessing the student's understanding so the teacher could apply the results to enhance the learner. Thus, this research developed the AI indicator for elementary students for the teacher to extend the results as a tool for AI assessment.

## **Research objective**

To develop the AI indicator for elementary students from Grade 1 to 5 in the basic education system.

## **Concepts of AI basic competency for children**

Touretzky, Gardner-McCune, Martin & Seehorn (2019) AI has identified 5 concepts

Concept 1

Kindergarten to Grade 2

- Identify and recognize the role of a sensor of a computer, robot, and smart device.
- Interact with a smart devices, such as Alexa or Siri.

Grade 3 to 5

- Explain the methods the sensor receives the data and transforms it into the analog or digital signal.
- Demonstrate the limitation to the perception of a computer.

- Create an application by using the perception to Scratch plugin or Calypso

#### Concept 2

##### Kindergarten to Grade 2

- Create a model of something and simulate it with the existing item.
- Apply the Decision tree to the decision-making

##### Grade 3 to 5

- Create or design a representation of the classification system of humans, animals, and items using the decision tree.
- Describe AI representation to support the reasoning for answering a question.

#### Concept 3 - Kindergarten to Grade 2

- Learn from the data model from the Unplugged activity.
- Use a classifier to identify an item on the picture/data, such as Google Autodraw or Cognimates Train Doodle, to study the function of a training set to identify the item in the picture/data, and exchange the opinion on the method the program recognizes the drawing picture.

##### Grade 3 to 5

- Explain and compare the three machine learning methods: Supervised, Unsupervised and Reinforcement.
- Adjust the interacted machine learning position with a training model.
- Exhibit the function of algorithms and machine learning that expresses the bias.

#### Concept 4

##### Kindergarten to Grade 2

- Categorize words with positive and negative meanings.
- Perceive and identify/facial expressions (happiness, sorrow, and anger) and explain a reason.
- Try out with a program that recognizes emotion and facial expression.

##### Grade 3 to 5

- Distinguish that the human adapts things to understand communication, vocal and facial expression, and body language.
- Explain some tasks that AI works efficiently beyond humans and some tasks that AI cannot perform.

#### Concept 5

##### Kindergarten to Grade 2

- Identify a general AI application in daily life.
- Exchange opinions on the strengths and weaknesses of AI technology.

##### Grade 3 to 5

- Survey the behavior whether it is influenced by bias and affects the decision-making or not.
- Explain the method of how AI is designed for the required task.

## **Concepts of Artificial Intelligence Learning for Elementary students**

### **Perception**

Perception is a process to pull data from the sensation. Human perceives things via five senses: hands, nose, eyes, ears, and tongue. Meanwhile, AI perceives things via a camera, microphone, infrared, pressure, rotation, temperature, infrasonic wave, and acceleration, which is a computer sensor. The senses of AI

lead to complex processing and better response than the general machinery that has a static function and follows a single command. The limitation of computer perception is the low resolution that the computer perceives for processing. Perception of spoken language or image presentation is based on the broad knowledge about the domain, such as the perception of speaking that requires knowledge about vocabularies, grammar, and voice recognition, or the face recognition that remembers the special characteristic beyond the distinguishing of the human face from the environment.

### **Representation & Reasoning**

Representation and reasoning exist naturally and artificially. A computer creates a representation using the data structure to support the reasoning algorithm with a different idea ordering from a human brain. Representation is classified into two main types (1) certain knowledge, such as representation with logic for sorting the significance or positioning things, and (2) uncertain knowledge, such as abductive reasoning, which is different from certain knowledge: right/wrong, yes/no, to resolve the complex problem, such as an automatic cloth washing system, by measuring the volume and concentration of washing liquid and adjust the appropriate washing cycle, or the ABS system by measuring the temperature of the ABS system to control the appropriate anti-lock breaking. Uncertain knowledge minimizes the limitation to the reasoning algorithms of the AI function.

### **Machine learning**

The computer can learn from data. Machine learning refers to the statistics that search for the data pattern from the convergence when the data samples increase, which is a linear regression, and data replication for creating the representation model with maximum likelihood.

### **Natural interaction**

Natural interaction with a human is crucial to facilitate daily living. For this reason, the AI must understand the process and processing of communication, behavior observation, and response to the appropriate and patterns of humans, and emotion. Sometimes, the emotion or behavior of humans is too complicated for AI to understand. It is one limitation of the natural interaction of AI.

### **Societal impact**

The AI should be conditioned that it facilitates its own and human living. Further, it should not harm society. The assessment or forecast of the impact of AI on social change is required. Ethics should be embedded in the AI system, not only in the application but also in the basic concept and goal to set an impact on the human way of life.

### **Creation and development of indicator**

1. Study the relevant documents, concepts, theories, and research about mental health of children to set a framework of AI components structure for

- elementary students by synthesizing the concept of Langley (2019) Touretzky, Gardner-McCune, Martin & Seehorn (2019), and Kandlhofer, Steinbauer, Hirschmugl-Gaisch & Huber (2016).
2. Determine a definition of indicator based on the synthesized component. The five components include Perception, Representation & Reasoning, Machine learning, Natural interaction Module, and Societal impact.
  3. Assess the concordance and appropriateness of the synthesized indicator definition framework by the experts. Scoring is 1 represents the indicator that is concordant and appropriate to the AI concept, at 0 represents the indicator that might not be concordant and appropriate. Five experts involve 1) three experts in AI/educational technology/computer study, 2) one expert in psychology which is designed to be aware of the issue of mental health of children as well, and 3) one expert in measurement and assessment.
  4. Assess the results to find the Index of Item Objective Congruence between the indicator and AI concept. Results showed that all indicators was more than 0.6, so all indicators were concordant and appropriate to the AI concept for elementary students.

## Results

Results of indicator development for elementary students revealed that the indicator comprised five aspects ordered by the complex from Grade 1 to Grade 5, as shown in Table 1.

Table 1: Results of AI indicator development for elementary students

Grade	indicator				
	1	2	3	4	5
1. Perception	The student can explain the method of interaction to allow the AI to perceive the computer vision of image and natural language processing; for example, the student can identify when the phone is standing up and the light comes up. When placing it at the owner's face position, it will unlock.	The student can explain the method of interaction to allow the AI to perceive the computer vision of image and natural language processing; for example, the student can identify when the phone is standing up and the light comes up. When placing it at the owner's face position, it will unlock.	The student can explain the origin of interaction between AI and humans and draw the response diagram.	The student can explain the origin of interaction between the AI and human by drawing the response diagram of the AI to signal to receive in a different specific form.	The student can explain the origin of interaction between the AI and humans by designing the signal receiving system to originate a perception and the limitation of the AI (draft on a paper) and draw a response diagram.
2. Representation &	The student can explain the	The student can explain the	The student can explain	The student can explain	The student can explain the reasoning

Grade	indicator				
	1	2	3	4	5
Reasoning	<p>reasoning algorithms to obtain the answer of AI. For instance, the student can explain the guess of the answers of the computer that it has the significant shape and characteristic of ice cream. Thus, it identifies that the drawing picture is ice cream. Therefore, when drawing important features of ice cream, the computer can pick the correct answer.</p>	<p>reasoning algorithms to obtain the answer of AI. The student can write a sequence of the computer's idea to acquire the answers (ice cream) and compare the similarity and differences of their idea ordering when playing with friends or the computer.</p>	<p>the basic reasoning algorithm of AI, which is certain knowledge. The student can explain the scope of the computer that if questioning the individual if (1) it is a living thing or not (No), the computer narrows down the answer to the category of a non-living thing. When asking if (2) the character is in Marvel or not (No), the computer will change the company group if (3) the character is in Disney or not (Yes). Then, the computer will narrow down the answer in terms of appearance, complexion, hair color, or other concerned characters.</p>	<p>the reasoning algorithm of AI, which is certain knowledge as IF &lt;Condition&gt; ELSE (if not) &lt;Consequence &gt;, and uncertain knowledge as IF (if) &lt;Condition&gt; THEN &lt;Consequence &gt;. The student can write the condition sequence that leads to the answer of both representation methods.</p>	<p>algorithm of AI and code a computer program to set the condition and response.</p>
3. Machine learning	<p>The student can explain that the AI still needs the human support to provide the basic data to conduct the</p>	<p>The student can explain the machine learning that the data will be convergent when the</p>	<p>The student can basically explain the machine learning that inputting a high volume</p>	<p>The student can explain machine learning by identifying that the machine applies the</p>	<p>The student can explain machine learning, criticize the defect of input data for data trending, and propose machine training guidelines to</p>

Grade	indicator				
	1	2	3	4	5
	learning of representative. Thus, the student should be able to identify that the response of AI is the neutral answer for everyone depending on the input data.	samples increase and can imitate the machine learning by being able to write the sequence to compare the activity or thinking step that leads to the learning to match the country with a capital city and to distinguish the continent.	of data for trending leads to the referential model that mostly matches with reality.	linear regression method with a high volume of input data to navigate the data to the center and be similar to reality, and can use the maximum likelihood method to model the data to trend itself apart from the data input by a human.	display the results that accurately refer to reality.
4. Natural interaction	The student can explain that the AI can respond to the individual. Thus, the student should be able to identify that when showing the paper, the machine will show a scissor, which is the normal response of the Rock-paper-scissors.	The student can explain the data trending to the AI to be able to respond to the individual by learning from the data input for trending. The student can identify that showing a paper will force the machine to show a scissor, which is the normal response of the Rock-paper-scissors, which is a response resulting from the data input for trending by a human.	The student can explain the goal and method of data trending to the AI to respond to humans. The student can identify how the response of a computer is similar to or different from the human response.	The student can explain the goal and method of data trending to the AI to respond to the individual. The student can distinguish whether they are talking to a human or a computer and give the reason to justify and give the suggestion for improvement, so the user feels more natural while interacting.	The student can explain the goal and method of data trending, and the improvement of AI to be more natural. The student can create a response system to human that is natural and cover the data input from all users.
5. Societal impact	The student can identify the characteristic of AI that facilitate their life and people's lives under the possible scope.	The student can identify how AI drives or change society and what might happen in the future.	The student has the judgment to consider the impact of AI apart from thinking about the	The student can criticize the possible impact of long-term and short-term use of AI, and consider the	The student can design the solution to resolve the AI system to be accurate and appropriate with the fewest negative impact on humans to support efficient

Grade	indicator				
	1	2	3	4	5
			outcome or benefits of the AI.	solution and prevention to the problem.	human living.

## Conclusion

Artificial Intelligence (AI) indicator for elementary students comprised of five aspects ordering by the complication from Grade 1 to Grade 5. The first aspect was Perception which the student knew how the interaction between the AI and human occurred. Next, it was Representation & Reasoning which the student understood the reasoning algorithm of the AI. The third aspect was Machine learning which the student understood how the machine learned. The fourth aspect was Natural interaction which the student recognized the goal of data trending and improved the AI to be more natural. The last aspect was Societal impact which the student could determine the solution to the AI system problem to make it more accurate and appropriate to have the fewest impacts on humans to support human living and society efficiently.

## Conflict of Interest

The authors have no conflicts of interest to declare.

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