The responses to artificial intelligence in teacher integrated science learning training program

K D H Gunawan¹,²*, Liliasari¹, I Kaniawati¹, and W Setiawan¹

¹Program Studi Pendidikan Ilmu Pengetahuan Alam, Sekolah Pascasarjana, Universitas Pendidikan Indonesia, Jl. Dr. Setiabudhi No. 229, Bandung 40154, Indonesia
²Program Studi Komputerisasi Akuntansi, Politeknik Ganesha Guru, Indonesia

*hendratmagunawankadek@upi.edu

Abstract. Artificial intelligence (AI) in education is the current development that provides solutions to problems in various contexts and levels. The use of AI in science teacher training programs is something that rarely done, especially in integrated science learning. The purpose of this study was to mapping the competencies of science teachers after receive pedagogical suggestions based on AI. This activity was attended by 20 science teachers in West Java who are members of the teacher training program. The competency patterns of science teachers were analyzed descriptively qualitatively in order to see the combination of knowledge between AI and natural knowledge of science teachers. The results show some teachers made innovative integrated science learning and teachers were able to follow, modify, or ignore pedagogical suggestions. These results also provide a field evaluation of the development of an integrated science learning program assisted by AI.

1. Introduction

Technology-based community life has become a research trend in recent years. AI based on big data and robotics is the latest part that reaches and supports all human activities [1,2]. This era is related to the Japanese government's proposal of society 5.0 [3]. AI-based deep learning provides a method for predicting models and finding patterns through artificial neural networks [4]. Education is one of the main areas of AI that has so far developed in facilitating teachers and students in various contexts and levels.

The role of AI in education can generally help facilitate student learning. Various products that have been developed and have shown results, such as facilitating the achievement of learning objectives as well as providing motivation in self-regulated learning [5], provide active learning [6], increase student engagement in learning and self-efficacy [7], interaction to collaborate with each other in learning [8], and various other effective benefits in learning. However, this rarely happens, when teachers are provided with AI assistance in training programs and improving their competencies. The urgency of AI in teacher training programs is needed to assist teachers in overcoming the various problems they face. In integrated science learning, teachers have a role not only to teach one science content, but also to require interdisciplinary studies and socio-scientific issues. The analysis is described in the form of learning activities to improve thinking skills and achieve learning objectives. This condition is difficult for teachers who have a background outside of science education [9,10,11]. Scientific literacy and teacher competencies in various fields are very much needed by teachers in integrated science learning [12].
Blended learning have been carried out in several teacher training programs. Blended learning methods can be used to help facilitate the various needs of teachers. In blended learning, the absence of tutors in teacher training programs can be facilitated with support of AI. Users can be assisted with adaptive learning technology according to their needs and pace (one-on-one support) [13]. This condition encourages an alternative intelligent system that can act as a lecturer as a scaffolding agent, so that it can provide individual guidance, solve problems, measure individual and group performance, and provide real-time feedback [5].

The various uses and advances of AI, especially in the field of education have had a significant impact [6,14,15,16]. Although various positive impacts of AI appear, higher order thinking skills are also an important part to be applied in life. This is because the focus of learning is not only on mastering concepts, but more on developing thinking skills [17]. The thinking process is expected to occur in the formation of concepts, decision making, analyzing, and creating something with the integration and support of AI. In the teacher training program, AI support is a concern to be studied regarding mapping the competence of science teachers after receiving AI's pedagogical suggestions. This part becomes the aim of this research to mapping teachers’ response AI in integrated science learning training program.

2. Methods
The AI-assisted science teacher training program is implemented using the blended learning method. Twenty training participants were representatives from several schools in West Java province. Each participant assigned to participate in all program sessions and compose integrated science learning in the form of lesson plans. Descriptive qualitatively was used to analyzed the data. The data recorded in the system and interviews were also conducted to complement the data findings. Program evaluation done by using a questionnaire to reach the teacher's response to the implementation of the program.

3. Result and Discussion
Teacher competencies mapped from lesson plans in general have shown good performance in the form of Innovative integrated science learning. Various pedagogical suggestions were received by the teacher to be followed up. Pedagogical suggestions are in the form of variations of learning theme suggestions, knowledge content suggestions, and collaborative discussion suggestions based on the teacher's knowledge and learning interests. Simple tests and online questionnaires were given at the beginning to determine the teacher’s knowledge profile, so that appropriate pedagogical suggestions were given. The AI system also requires a weighted percentage of each basic competency to be integrated. Teacher input is then processed and analyzed mathematically by the system to present pedagogical suggestions. All pedagogical suggestions can be used to improve teacher competence in designing integrated science learning.

Various responses emerged from the teacher in responding to pedagogical suggestions. The teacher's responses were then grouped into three parts, namely: 1) followed suggestions, 2) modified suggestions, and 3) ignored suggestions. The distribution of teachers responses to AI pedagogical suggestions in the suggested learning themes is presented in Figure 1.
Teacher competencies that are recorded when responding to learning theme suggestions are dominant in modified suggestions. The given suggestion then developed to combining basic competencies according to the interests and conditions of the science teacher class. Teachers who follow the suggested learning theme (35.00%) directly integrate the basic competencies provided by the AI system. Teachers who ignored the suggestions of a learning theme (20.00%) arrange a learning theme outside the interest topic at the beginning of the activity. Examples directly followed are the classification of science, being a scientist of the universe, heat and energy, science in a substance. The teacher directly uses the theme to plan the lesson. Examples of modified suggestions are: science in the process of classification in the universe which is modified from the classification of science, the benefits of heat and energy from various substances that are modified from the theme of heat and energy, objects in the universe that are modified from the classification of science.

An example of ignored suggestion is when the teacher gets pedagogical suggestions about heat and energy, a lesson plan is developed using a learning theme about sound waves. There is a discrepancy between the suggestions and the development of the lesson plan. The discrepancy in the ignored suggestions has an impact on the update knowledge suggestions and collaborative discussion. This is because the teacher is not consistent in developing lesson plans in accordance with the interests and weights of the percentage of basic competencies at the beginning. Suggestions for update knowledge in the categories of followed suggestions (30.00%) and modified (50.00%) are still dominant compared to ignored suggestions. Modified suggestions are made not only relying on content stored in the system, but various knowledge content from various relevant sources. Likewise with collaborative discussion suggestions, where the teacher discusses with each other regarding the lesson plan. Followed suggestions have dominant results (60.00%) because each topic has been adjusted to the desired learning theme. There are also suggestions for collaborative discussion that have been modified or ignored. The modification means that the teacher creates his own discussion topic which he wants to get a response from other participants.

The teacher combines the existing knowledge with pedagogical suggestions. The combination appears through an integrated science lesson plan. An example of a lesson plan pattern developed by following the advice directly is on the theme of becoming a scientist about the universe. The combined basic competencies are 3.1 on the concept of science objects and their observations, 3.2 on the classification of living things, and 3.3 on matter, elements, compounds and mixtures. Suggested courses for updating knowledge are material on measurement using international units, surrounding objects, living and non-living things, grouping living things, matter, elements, compounds, and mixtures, acids and bases, separation of mixtures, physical and chemical properties, and physical and chemical changes. The recommended collaborative discussion is about a summary of learning activities, and attitudes and
thinking skills that need to be developed as a young scientist. The lesson plan designed is directed at observing living and non-living things. Students are directed to dig up information independently and involve online expert consultation. The information explored is about the use of scientific methods such as measurement, use of units, and data presentation; observation of animal bodies and groups; elements, compounds, and mixtures necessary for animal growth. Critical thinking skills are trained and assessed both in terms of process and improvement.

Lesson plan developed by modifying pedagogical suggestions, namely on the theme of utilizing heat and energy from various substances. The integration pattern is made from the theme of heat and energy. The addition of content about substances is used to further explore the process of respiration, substances that are important as energy sources, chemical digestion, substances needed in photosynthesis, and substances used as sources of chemical energy. Besides that, the teacher also designs changes in temperature to the rate of photosynthesis, energy transformation in cells, thermoregulation in living things, and mechanical digestion. These various content integration patterns emerged by modifying the learning theme suggestions and knowledge update suggestions. The learning activities planned in the worksheets are students are invited to analyze substances that are important as sources of energy and to analyze physical and chemical changes in mechanical and chemical digestion. Students are directed to collaborate and think critically in finding the required information and answering worksheets.

The lesson plan developed by considering directly following, modifying or ignoring AI's pedagogical suggestions shows quite optimal results. Teachers' knowledge is growing with the ease of using AI pedagogical suggestions. Ease arises because suggestions are tailored to the needs and desires of users in using the AI system [18]. This characteristic is carried out by imitating the reasoning and thought processes of an expert to help explain problems and help solve them [19]. Therefore, teachers can creatively create their own unique and complex learning (creative teaching), and analyze and evaluate a learning pattern in its content and pedagogy and understand the advantages and challenges of each integrated science learning.

The evaluation of the AI-assisted training program provided several field evaluations to improve the system. It is necessary to add learning themes suggested by the system to accommodate the learning needs of science teachers. The addition of various features such as online courses, the addition of learning videos, suggestions for learning activities are a common part of teacher input. Some teachers also provide input to be applied to the Android system and make it more user friendly. The lack of variety in the suggested learning theme may be due to the selection of the chosen programming method. This system is designed using a certainty factor (CF) method based on Measure of Belief (MB) and Measure of Disbelief (MD), so it may not be able to accommodate the needs of teachers. The next stage that might be considered is changing the machine learning-based system method, in order to create a more complex pattern in reaching the teacher's wishes in determining learning themes, updating knowledge, and collaborative discussions.

4. Conclusion
Optimal integrated science learning can be obtained by properly combining various content and pedagogy from various scientific perspectives. The point of view and depth of this material play a very important role in creating integrated science learning. Choose relevant material by combining each basic competency to be relevant to the learning objectives and skills to be developed. The existence of AI pedagogical suggestions can help teachers develop their competencies and obtain positive responses to be followed or modified according to teacher needs. Although there are still those who ignore the suggestions because of certain considerations, it does not close the role of the pedagogical suggestions given. Various inputs from teachers as users can be used as further evaluations to improve the system according to the needs of teachers.

5. Acknowledgments
We thank all parties who have supported the implementation of this research.

6. References
[1] Liliasari S, Amsad L N, and Wahyudi A 2021 J. Phys. Conf. Ser. 1731 1
[2] Timms M J 2016 Int. J. Artif. Intell. Educ. 26 701
[3] Fukuyama M 2018 Japan SPOTLIGHT 27 47
[4] Perrotta C and Selwyn N 2020 Learn. Media Technol. 45 251
[5] Duffy M C and Azevedo R 2015 Comput. Human Behav. 52 338
[6] Castro-Schez J J, Glez-Morcillo C, Albusac J and Vallejo D 2021 Inf. Sci. (Ny). 544 446
[7] Mohamed H and Lamia M 2018 Comput. Educ. 124 62
[8] Olsen J K, Belenky D M, Alevén V and Rummel N 2014 Using an intelligent tutoring system to support collaborative as well as individual learning Intell. Tutoring Syst. p. 134–143.
[9] Gunawan K D H, Liliasari S and Kaniawati I 2019 J. Phys.: Conf. Ser. 1157 022051
[10] Sun D, Wang Z H, Xie W T and Boon C C 2014 Int. J. Sci. Educ. 36 808
[11] Sias C M, Nadelson L S, Juth S M and Seifert A L 2017 J. Educ. Res. 110 227
[12] Rubini B, Ardianto D and Pursitasari I D 2019 Teachers Perception Regarding Integrated Science Learning and Science Literacy 253, Aes 2018 p. 364–366
[13] Holstein K, McLaren B M and Alevén V 2017 Intelligent tutors as teachers’ aides: Exploring teacher needs for real-time analytics in blended classrooms ACM Int. Conf. Proceeding Ser. p. 257–266
[14] Jiménez S, Juárez-Ramírez R, Castillo V H and Armenta J J T 2018 Affective Feedback in Intelligent Tutoring System A Practical Approach (Cham: Springer International Publishing)
[15] Gunawan K D H, Liliasari, Kaniawati I and Setiawan W 2020 Univers. J. Educ. Res. 8 4776
[16] Gunawan K D H, Liliasari, Kaniawati I, Setiawan W, Rochintaniawati D, and Sinaga P 2021 J. Phys.: Conf. Ser. 1806 012139
[17] Gleason N W 2018 Higher Education in the Era of the Fourth Industrial Revolution (Singapore: Palgrave Macmillan)
[18] Jenny C S and Sebastian A S 2012 J. Comput. 2 1
[19] Różewski P, Kieruzel M, Lipezynski T and Prys M 2019 Procedia Comput. Sci. 159 2304