Profile of teachers’ integrated science curricula that support by intelligent tutoring systems

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Abstract. Learning innovation by involving technology has helped the quality of education according to the concept of the Internet of Things (IoT). Intelligent tutoring systems are form of that support for science learning through science teacher competency improvement programs. This study aims to describe the types of science integration supported by ITS. A total of 29 science teachers joined this program which was implemented in blended learning. The science teacher lesson plan products were analyzed descriptively. The results show that the development of integrated, immersed and networked type lesson plans is in accordance with innovative learning, because of the scope of integration, learning themes, and appropriate learning activities. These results also demonstrate the effectiveness of using ITS to assist teachers in providing educational suggestions for developing integrated science learning.

1. Introduction
Involving technology in learning is growing nowadays, to solve various educational problems [1]–[4]. The use of various smart devices (computers, tablets, smartphones, etc.) to facilitate learning activities are things that are of interest to all academic community members. Especially with the outbreak of Covid-19 causing changes in the learning system towards online learning [5]. Such conditions cause various approaches and new learning methods to develop, and lead to the application of the internet of things (IoT). IoT in education includes various smart devices connected through the internet to create online content, online forums, smart portfolios, advanced analysis of big data, and intelligent tutoring systems (ITS) [1].

The use of ITS as an IoT application has been widely implemented in education that provides a guide for students who are adaptive according to student learning progress [6], and has also shown a positive impact on students [1], [4], [7]. However, there are still few ITS designs and studies that help teachers in learning activities. Even though the teacher has an important role in student success. This appears in the implementation of Integrated Science learning.

Integrated science learning still has various weaknesses. Referring to the results of PISA for Indonesia, obtaining unsatisfactory results from science that has not improved since 2006 [8]. The qualifications of science education teachers in Indonesia have also inadequate due to differences in scientific qualifications which have caused a lack of mastery of science content [9], and also the
difficulties in integrating science content in interdisciplinary [10]. Related to the lack of integrated science competencies can lead to misconceptions from both teachers and students [11].

Researchers are increasingly developing ITS products to enhance science learning. The learning system designed using ITS on human circulatory system material can significantly improve student learning outcomes while increasing scaffolding skills and student motivation with self-regulated learning methods [4]. The development of ITS also shows high satisfaction on the seven characteristics of living things material that is designed in stages to provide direction to the user according to the development of their learning [12]. ITS which is applied in combination with the flipped classroom method can provide benefits for increasing student competency as well as self-efficacy and collaborative social ties [1]. The results also contribute continuously to the factors that increase students' interest in learning process.

The benefits of ITS are very interesting to study further, especially for science teachers. Science learning that is designed through lesson plans can be analyzed for the type of integration after being directed using ITS. Thus, it can be described and become input for creating curriculum integration in effective science learning.

2. Methods

A total of 29 lesson plans were analyzed descriptively. The product is an outcome of the teacher competency improvement program implemented by Universitas Pendidikan Indonesia. The number of participants involved was 29 science teachers who were assigned to make the integrated science lesson plans after the training was conducted with a blended learning system. The distribution of participants had a scientific background in physics education at 44.82%, chemical education at 13.79%, biological education at 31.03%, and science education at 10.35%. Participants receive face-to-face learning and are trained in using ITS. In ITS, participants conduct online learning guided by a system that provides integration recommendations using an integrated, immersed, and networked model based on Fogarty [13].

3. Result and Discussion

3.1. integrated science curricula

The whole lesson plan of the science teacher competency improvement program generally presents an interesting theme, the theme is also associated with student experience. Themes are prepared by considering the scope of basic competencies in an integrative manner. At the beginning, the teacher studies and maps the main competencies and basic competencies of the field of study to be integrated. The teacher analyze the relevance of each basic competencies, and pays attention to actual, contextual, and interesting issues. Based on these issues, the concept of connectedness matrix is made, which includes branches of physics, chemistry, biology, and various other branches of science using integrated, immersed and networked types. The indicators are then formulated based on integration patterns to be further elaborated in preparing syllabi and developing lesson plans. The distribution of lesson plans according to the types of integration is described in Figure 1.

Learning activities developed in lesson plans vary greatly by science teachers. In general, the pattern of integration of integrated, immersed, and networked types can be described in student learning activities. Development of learning activities varies between 1 to 4 meetings depending on the scope of basic competencies integrated. Themes that have a large range of basic competencies are implemented in several meetings, with each meeting referring to the theme, as well as the worksheets developed. In the closing activity the teacher with students concludes the learning theme and teacher gives feedback, also provides applications related to the learning theme.
Figure 1. Distribution of lesson plans based on integration types

Figure 1. shows the distribution of the lesson plan development in integrated, immersed, and networked types. All of them are generally classified as large integration patterns because it already has a valid relationship between basic competencies. Only a few lesson plans have complete integration, where the basic competencies related to the skills developed. For instance, integrated type in a theme of "changes in matter and energy" (Figure 2). Its integrating basic competency of 3.3 (Explain the concepts of mixtures and single substances (elements and compounds), physical and chemical properties, physical and chemical changes in everyday life) and 3.5 (Analyze the concept of energy, various sources of energy, and changes in the form of energy in daily life including photosynthesis).

Figure 2. Summary of integration using integrated types

In immersed and networked types, their characteristics are different from integrated because they are arranged based on students' interests (inside the mind of student). The teacher gives several topics related to the theme of "the motion system that you do" with basic competencies of 3.1 (Analyze motion in
living things, the motion system in human body, and efforts to maintain the health of the motion system) dan 3.3 (Explain the concept of work, simple machines, and its application in daily life including the work of muscles in the human skeletal structure). One option for students to integrate is to analyze the mechanism of the biceps and triceps, and also conduct experiments and identify the mechanism of a simple machines and its relation to the work of muscles (Figure 3).

Figure 3. Summary of integration using immersed types

In the networked type, it similar to the immersed type, which happens inside the students' mind based on the learning theme. The difference lies in the involvement of experts. The characteristics are a collaboration between students and several experts in finding data, information, or other related to subjects they like or are interested in so that students can indirectly find out from various sources to improve their knowledge. For instance, when integrating basic competency of 3.5 (analyze the digestive system in human body and understand disorders related to the digestive system, as well as efforts to maintain the health of the digestive system) and 3.6 (describes various additives in food and drinks, addictive substances, and their impact on health). One of the student's choice is to analyze disturbances in the human digestive system. Students identify the organs and the workings of the human digestives system, identify additives and addictive contained in food and its effects, analyze the abnormalities that occur in the human digestive system caused by substances additive and addictive, and make scientific papers on the effects of using additive and addictive substances (Figure 4).
Figure 4. Summary of integration using networked types.

The development of the lesson plans carried out by all science teachers can be categorized as good. This is inseparable from the treatment carried out through blended learning. In face-to-face learning is carried out by providing a variety of relevant material such as: development of higher-order thinking skills, multiple representations, theme selection and integrated science learning, and designing innovative integrated science learning. In online learning, science teachers are given guides in the form of expert systems (in ITS) who directly provide suggestions based on user progress such as developing learning themes, integrating basic competencies, taking courses and conducting discussions between users, and also helping direct uploading lesson plans to be validated by a team of experts. This is in accordance with ITS flexibility during online learning [14]–[17].

Science teachers who have different disciplinary challenges can be helped by the presence of ITS in blended learning. Realtime system support is very useful for science teachers, especially in integrating basic competencies according to the type of integrated, immersed, and networked. Similar technology in the form of online learning has also been proven to help teachers in helping learning, especially in the development of lesson plans, learning, and improving student learning achievement [15], especially to create integrated science learning that is strongly influenced by differences in science backgrounds of science teachers [9], [18].

The implementation of learning with ITS support is not solely without obstacles. Various challenges that must be faced when implementing the program, especially in the digital literacy of science teachers on the use of computers and the internet. The face-to-face meeting process is also adjusted to the teaching schedule of each science teacher and the different learning schemes between full day schools, so some
teachers do not participate in class activities fully. But these obstacles are facilitated by the presence of online learning with ITS schemes.

The implications of ITS support must continue to be developed, especially in the pandemic Covid-19. The availability of intelligent online tutors and unlimited space and time can help both teachers and students while maintaining the quality of science learning. This support is also expected to bring up new ideas in the development of ITS in-learning science.

4. Conclusion
Integrated science curricula that supported by ITS has been described with the use of integrated, immersed and networked types for combining several basic competencies into one theme. These types of integration have been able to cover basic competencies that are distributed through interesting and contextual learning themes. Several integrated types also develop students’ skills based on the learning activity. In the immersed and networked types, student skills are not explicitly contained in the pattern of integration. These skills have automatically arisen because this approach enables students to integrate all concepts from each field of science and produce their thoughts by their area of interest to be applied in daily life. Students filter out all the concepts they learn according to their point of view and immerse themselves. In the networked type, it also allows collaboration with experts to find data, information, or other related to student interests, that directs students to use all their abilities to think, which leads to higher-order thinking skills.

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