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Development the innovation science learning based on technology embedded scientific inquiry (TESI) to improve problem solving skills and curiosity of junior high school students

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Abstract. This research was conducted to develop innovation in science learning based on TESI (Technology Embedded Scientific Inquiry) in substance themes that has been validated. This research used development design. Data was collected using innovation science learning assessment to validated lesson plan, worksheet and instruments. The data were analysed descriptively to determine the validity of science learning plan. This research can produce innovation science learning through technology embedded scientific inquiry that have good criteria.

Keyword: *innovation, science learning TESI*

1. Introduction

The challenges of the education world are even greater in efforts to increase the quality of superior human resources. This is in line with the challenges of the industrial revolution 4.0 in the 21st century, namely the need for changes in learning, thinking and acting for students in developing innovations in various fields. The development of the flow of science and technology in the 4.0 revolution era demanded the urgency of mastering skills in digital literacy, technological literacy and skills in the 21st century. Digital literacy includes capabilities in the fields of information literacy, media literacy and ICT literacy.

In addition, the formation of a supportive attitude in that era is also absolutely necessary. This is the urgency to develop skills and attitudes in this 21st century era. The demands of global development require that science learning be oriented towards the achievement of thinking skills and character formation. Education in the 21st century needs to be oriented towards mastering 21st century skills that develop skills that support competition in today's globalized and digital world. These skills need to be developed in students in addition to competence in the knowledge dimension. This is confirmed by Larson & Miler, 21st-century skills required by students to form their activities in the future or 21st-century skills are beneficial to their lives after graduation [9]. Greenstein explains that aspects of thinking skills in the 21st century include creativity, critical thinking, problem-solving and metacognition, communication, collaboration, information, and technology literacies are the tools for working [9]. Science learning is oriented towards the achievement of knowledge and skills competencies. This is in line with the nature of science that science as a way of thinking, a way of investigating, a body of knowledge, and its interactions with technology and society [5]. The word



science as "both a body of knowledge and a process". In science develop dimensions of ways of thinking, ways of investigation, building knowledge and its relation to technology and society [19]. This becomes the fundamental substance of the importance of science learning which develops the competence of scientific skills for the formation of students' mind-set. The demands of the 2013 curriculum require scientific learning. This learning develops process skills, thinking skills, and problem solving skills. The 2013 curriculum has achievements not only in the cognitive dimension but also in the process and attitude dimensions. This is the need to strengthen character education to develop the affective dimensions of students.

Curiosity is one of attitude dimension that urgent to be developed. Science learning which according to its nature requires technology that can facilitate students to conceptualize the science phenomena. Without intermediaries or learning media, science symptoms are less to be conceptualized by students. This is the urgency of using integrated technology in natural science investigations. This model is known as TESI (Technology Embedded Scientific Inquiry). Substantially that innovation is needed in learning science. This innovation is adapted to the skills demands of the 21st century and the literacy needed in the 4.0 revolution era. The form of innovation uses technology and learning models that develop skills and attitudes, including the Problem Based Learning. The Technology-Embedded Scientific Inquiry (TESI) learning model is a learning model using innovative technology accompanied by scientific inquiry to improve digital literacy skills and 21st century skills. This is in line with other theory that learning models Technology-Embedded Scientific Inquiry (TESI) is useful in science experimentation activities using innovative technology [4]. The use of TESI can foster 21st century skills. The use of TESI can develop digital problem solving and literacy skills [15]. Problem solving and digital literacy are necessary skills in the 21st century. Based on the identification of the problems above, this study aims to develop innovative science learning through the development of a science learning device based on TESI (Technology Embedded Scientific Inquiry) that is suitable for use in learning science. The target to be achieved in this research is the creation of TESI-based science learning tools (lesson plans, worksheet, media, teaching materials and assessment instruments) that have been validated by science experts and teacher. This research aims to develop science learning based on TESI (*Technology Embedded Scientific Inquiry*) that validated.

2. Research method

This research used development design from Borg and Gall [3]. The stages has been limited in research and information collection, planning, develop preliminary form of product and preliminary field testing.

3. Results and Disussion

3.1. Developing the innovatine science learning with Technology Embedded Scientific Inquiry

Innovative learning was developed consisting of lesson plans and worksheets. The preparation of learning tools begins with the task analysis stage. This stage consists of determining basic competencies, formulating indicators and learning objectives, determining the scope of material, and learning scenarios. Needs analysis is done to integrate learning with technology. With the role of this technology, limitations in observing science symptoms can be overcome. This is in accordance with the nature of science that science is a way of inquiry, a way of thinking and is closely related to technology and society. Science is also a body of knowledge which contains a collection of knowledge including facts, concepts, principles, laws and theories. This collection of knowledge was obtained through a scientific process [5]. In science also contained aspects of attitude. This is supported by the theory that science encompasses processes, products and attitudes [19].

The interesting thing from this research is that learning science is presented with integrated science. It means that science is studied holistically. This is supported by the theory which states that in science there are complete phenomena and phenomena. The object of science is examined from aspects of physics, biology, chemistry, astronomy, environment and other related fields [13].

An approach that uses technology in scientific inquiry is called TESI (*Technology Embedded Scientific Inquiry*). In accordance with the nature of science, science as a process of inquiry (inquiry) and science as a way of thinking are very important aspects, in addition to science as a collection of knowledge or a body of knowledge. In the practice of learning, technology is needed to be an intermediary in scientific activities in the investigation, conceptualization to communicate.

The learning tools are then validated by experts and science teachers. The following data is the result of product eligibility from the results of expert validation.

3.1.1 Validation of Lesson Plan

Table 1. Data of lesson plan validation

Validator	Score
Expert (Lecturer)	84
Science Teacher	77
Mean	80.5
Category	Good

The data in table 1 shows that the developed lesson plan product has a good category from the assessment of experts and science teachers.

Table 2. Criteria of lesson plan.

Range	Criteria
$X > 83.99$	Very good
$67.99 < X \leq 83.99$	Good
$52.01 < X \leq 67.99$	Enough
$36.01 < X \leq 52.01$	Less
$X \leq 36.01$	Very less

3.2. According to the validation results and teacher suggest to improve lesson plan that integrated component of TESI (*Technology Embedded Scientific Inquiry*).

3.2.1 Assesment of Worksheet

Table 3. Data of worksheet validation.

Validator	Score
Expert (Lecturer)	25
Science Teacher	24
Mean	24.5
Criteria	Good

The data in table 3 shows that the developed worksheet product has a good category from the assessment of experts and science teachers.

Table 4. Criteria of worksheet.

Range	Criteria
$X > 25.2$	Very good
$20.4 < X \leq 25.2$	Good
$15.6 < X \leq 20.4$	Enough
$10.8 < X \leq 15.6$	Less
$X \leq 10.8$	Very less

3.3. According to the validation results, there is an interesting thing that the need for a TESI (*Technology Embedded Scientific Inquiry*) component clearly appears in science learning.

3.3.1 Technology Embedded Scientific Inquiry TESI is a learning model that uses technology in conducting scientific or investigative processes. TESI has three characteristics, as the schematic Ebenezer illustrates in the picture as follows:



Figure 1. Schematic of TESI.

Based on Figure 1, three characteristics of TESI include:

Scientific Conceptualization, technology in scientific conceptual involves material knowledge gained through inquiry and assessing and clarifying concepts that lead to deepening mastery of the material [4].

Scientific Investigation, technology in scientific activities includes formulating problems, hypotheses, designing experiments and conducting experiments. Teachers need to develop scientific skills with a variety of technologies including measuring, conducting experiments, collecting data.

Scientific Communication, technology in scientific communication involves the process of communicating the process of inquiry, results and knowledge through discussion and presentation with critical responses [4]. Forms of technology that can be used include websites, avatars, padlets, scoop It, concept maps mind-maps [18].

Technology can assist the inquiry process. Inquiry can improve students' understanding of concepts, science process skills, ability to construct knowledge, and create more meaningful science learning. This is because the concepts obtained can be stored in long-term memory [23].

Innovation in science learning was seen in the emergence of the TESI component at the learning stage. The learning stage has the characteristics of the problem based learning model including direction on the problem, interdisciplinary problem solving, independent inquiry and collaboration [1]. The syntax of problem based learning that is used includes problem orientation, student organizations to research, assist independent investigations, present artifacts, and evaluate problem solving processes [2]. The scientific conceptualization component can be seen when the problem orientation stage, discussion activities to solve the problem and conclude the results of the investigation. The component of scientific investigation can appear in designing investigations through the process of formulating problems, hypotheses, designing experiments and conducting experiments. The component of scientific communication is demonstrated through the preparation of power point slides and presentations. In addition, power point slides are uploaded via edmodo which can be accessed by all students.

3.4. Innovative learning to improve problem solving and curiosity

The developed device contains TESI (Technology Embedded Scientific Inquiry) component using a problem based learning model. This technology can be integrated in scientific conceptualization, scientific investigation and scientific communication. The use of TESI can foster 21st century skills. Using of TESI can develop digital problem solving and literacy skills [15]. Problem solving and digital

literacy are necessary skills in the 21st century. One of the teaching model that can develop problem solving skills is a problem based learning model.

Curiosity is the desire to obtain content knowledge about natural phenomena and their processes. [21]. This curiosity can be stimulated by the presentation of problems and the use of media or technology in learning. Problems are given to bring up the desire of students to ask questions in formulating problems, making hypotheses, designing investigations, conducting investigations and communicating the results of investigations. Hand on activity can develop positive attitudes of students in learning science [10]. Problem-based learning activities can lead to students' curious attitude. Students' curiosity which includes enthusiasm, attention to objects, asking about activities and sources related to activities carried out by students [16].

4. Conclusion

Innovative learning based on Technology Embedded Scientific Inquiry (TESI) that developed has the potential to engage problem-solving and curiosity skills in good category.

References

- [1] Arends Richard I 1997 *Classroom Instruction and Management* (USA : McGraw Hill Company) pp 157-8
- [2] Arends, Richard I 2007 *Learning to Teach*. (USA: McGraw Hill Company) pp 57
- [3] Borg, W. R. and Gall, M D 1983 *Educational Research An Introduction* 4th Ed (New York) pp 124-455
- [4] Calik M 2013 *Eurasia Journal of Mathematic Science & Technology Education* **9** 223-32
<http://dx.doi.org/10.12973/eurasia.2013.931a>
- [5] Chiapetta, Eugene L, Koballa and Thomas R 2010 *Science Instruction in the Middle and Secondary Schools* (NewYork: Pearson) pp 105
- [6] Cindy L. Lynch and Susan K W 2013 *Helping Your Students Develop Critical Thinking Skills*
<http://insight.improvement.impact>.
- [7] Widoyoko E P 2011 *Evaluasi Program Pembelajaran: Panduan Praktis Bagi Pendidik dan Calon Pendidik* (Yogyakarta: Pustaka Pelajar) pp 238-49
- [8] Fadel C 2008 *21 st Century Skills* (Paris: Global Lead Education) pp 14-39
- [9] Haviz M, Karomah H, Delfita R, 2018 *Jurnal Pendidikan IPA Indonesia (JPPI)*. **3** 360-8
<https://doi.org/10.15294/jpii.v7i3>
- [10] Lin Jang Lon, Meng-Fei Cheng, Ying-Chi Chang, Hsiao-Wen Li, Jih-Yuan Chang & Deng-Min Lin 2014 *Eurasia Journal of Mathematics, Science & Technology Education* **10** 415-26
<https://doi.org/10.12973/eurasia.2014.1103a>
- [11] Skills On Biology Learning 2018 *Jurnal Pendidikan IPA Indonesia*. JPPI **3** 355-63.
<https://doi.org/10.15294/jpii.v7i3>
- [12] Lamb, Maire & Doecke 2017 *Key Skills for the 21st Century: an evidence based review*. (Australia: NSW Government Victoria University) pp19
- [13] Hewitt P G 2007 *Conceptual Integrated Science* (US: Pearson Education) pp 17-24
- [14] Liliyasi 2012 *Jurnal Pendidikan IPA Indonesia* **1** 22-29
<https://doi.org/10.15294/jpii.v1i1.2008>
- [15] Nurcahyo M A 2016 *Peningkatan Literasi Digital dan Keterampilan Pemecahan Masalah Siswa SMP Menggunakan Model Pembelajaran Technology Embedded Scientific Inquiry pada Materi Struktur Bumi dan Bencana* (Bandung: UPI) pp 87
- [16] Nasution Derlina, Syahreni Putri Harahap, Marabangun Harahap 2017 *Derlina IOP Conf. Series: Journal of Physics: Conf. Series* **970** p 4
<https://doi.org/10.1088/1742-6596/970/1/012009>
- [17] NSTA 2003 *Standards for Science Teacher Preparation* (Paris: Global Lead Education) pp 26
- [18] Sheffiel & McIlvenny 2014 *International Journal of Innovation in Science and Mathematic* **22**

46-60

- [19] Sund and Trowbridge 1967 *Teaching Science by Inquiry in the Secondary School*. (Ohio: Charles E. Merrill Publishing Company) pp 2
- [20] Trefil, James and Hazen R 2007 *The Sciences, An Integrated Approach* (USA: John Wiley and Sons, Inc) pp 12
- [21] Weible, Jennifer L. & Toomey Zimmerman, Heather 2016 *International Journal of Science Education* **38** 1235–55 <https://doi.org/10.1080/09500693.2016.1186853>
- [22] Zender, Seitz, Klautt 2018 *Eurasia Journal of Mathematics, Science, and Technology Education* **14** 1305-8223 <http://doi.org/10.2933/ejmste>
- [23] Langitasari, Effendy, Fajaroh 2018 *Jurnal Penelitian dan Pembelajaran IPA* **4** 1-13 <http://dx.doi.org/10.30870/jppi.v4i1>