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Improvement of Students' Science Literacy Skills Using STEM-Based E-Modules

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Article Info	Abstract
	Scientific literacy is one aspect of ability in facing the challenges of the 21st century. Efforts to train students 'scientific literacy skills include the use of teaching materials that can support students' scientific literacy skills in the form of STEM-based E-modules. The purpose of this research is to analyze the effectiveness of the use of STEM-based E-modules on learning outcomes and the ability of student science literacy. This research is an experimental research design with one group pre-test and post-test design. The research sample was taken using purposive sampling method with a total of 32 students. based on research results, the average student learning outcomes obtained a value of 70.9. The results of the N-Gain analysis with the medium category show that the STEM-based E-module is effective for improving students' scientific literacy skills.. The results of the analysis with the Paired Sample T-test showed that the probability value (sig) 0.000 <0.05 means that there is a difference in the value of scientific literacy between before and after using the STEM-based E-Module. Furthermore, for each aspect of scientific literacy it also shows an increase, namely science as the body of knowledge, science as a way to investigate, science as a way to think and the interaction between science, technology and society.. Thus, it can be concluded that the development of STEM-based E-Module for environmental pollution material is effective in improving student learning outcomes and scientific literacy skills of grade VII students at the SMP / MTs level.

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INTRODUCTION

The Teaching and learning activities are an important component of achieving educational goals. Good education will be created if the supporting components can be optimized properly. Based on the results of observations in schools that in general the teaching materials used are still limited, so that student learning outcomes are still in the low category, namely under the KKM on environmental pollution material.

Regarding teaching materials, currently teaching materials are still limited to student worksheets, and there are no additional teaching materials that support students' abilities. As for the abilities that students need to have in facing the 21st century, namely the ability of scientific literacy and in the era of the 4.0 industrial revolution related to the use of technology in learning (Wardani, 2018). Because of this, it is necessary to use appropriate teaching materials so that they can train students' scientific literacy skills.

Based on the results of PISA 2018, Indonesian students' scientific literacy skills are still in the low category, namely getting rank 6 from below/ 75 out of 80 participating countries (OECD, 2019). Of course, the results of the 2018 evaluation have decreased compared to the results in 2015, namely the rank of 64 out of 72 participating countries (OECD, 2015). The decline in value in evaluation occurs in three aspects, namely reading skills, mathematics and science abilities (Tohir, 2019). Seeing this phenomenon, it is necessary to improve the quality of education for Indonesian students.

Efforts that can be taken are using an integrated approach. One of the integrated approaches as an innovation in science learning is the STEM approach (*Science, Technology, Engineering and Mathematic*) (Permanasari, 2016). Learning with the STEM approach is a combination of integrated knowledge such as science, technology, mathematics and the selection of tools to use that are easily affordable (Morrison, 2006).

According to the National Science Teacher Association/ NSTA (2012) individuals with scientific literacy are people who use science concepts, process skills, and values in making everyday decisions related to other people or their environment. Based on this, it is necessary to use STEM terraced teaching materials as an effective step in training students' scientific literacy skills. through STEM learning is able to have a positive impact on the development of students' scientific literacy skills (Yuiati & Saputra, 2019; Rusyati et al., 2019).

Furthermore, developments in the era of the industrial revolution 4.0 in education refer to the use of technology in learning activities. There are many choices of various forms of technology that can be used in learning activities, one of which is mobile phones/ gadgets based on Android. Cabanban & Marcos (2013) stated that android is an operating system on mobile devices that is open source. through teaching materials that are packaged in the form of an android application is expected to help students in learning. of course the use of teaching materials in android / E-module can make it easier for students to learn because it is more flexible and effective (One, 2019).

The teaching materials developed in the form of STEM-based E-modules are expected to accommodate the need for achieving learning objectives, namely in the context of scientific literacy skills. In addition, it is hoped that it can assist in facilitating teachers as an alternative teaching material that can be used in learning. Furthermore, in this study, the use of STEM-based E-modules to improve students' scientific literacy skills.

METHODS

This research is an experimental research (Sugiyono, 2009). The design in this study used one group pre-test and post-test design which is presented in Figure 1

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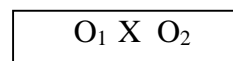
Figure 1. Research Design

The subjects in this study were 32 students of class VII F MTs Al-Ishlah Pulokulon. Sampling was done by purposive sampling. STEM-based E-module effectiveness test research design to improve students' scientific literacy skills. STEM-based e-module is an innovative teaching material that uses a mobile phone with the Android operating system. Learning using STEM-based E-modules on

Environmental Pollution material is composed of the fields of Science, Technology, Engineering and Mathematics. The implementation of learning by displaying visualizations in the form of pictures, videos, graphics etc. as well as factual examples encourages students to understand and practice students' scientific literacy skills.

The instrument used in this study used the instrument description questions. Then the data analysis technique used in the descriptive quantitative analysis technique using the N-gain test to determine the effectiveness of learning outcomes when using STEM-based E-module in improving students' scientific literacy skills as well as the T test, Paired Sample T-Test to determine the difference between values. before and after using the STEM-based E-module.

RESULTS AND DISCUSSION

The research data is the result of students' scientific literacy scores. Students' scientific literacy scores were obtained based on the results of the pretest and posttest scores. Analysis of the students' pretest and posttest scientific literacy data showed a difference, namely there was an increase in the value between before and after using STEM-based E-Module on Environmental Pollution.

The results showed that the pretest and posttest mean scores showed a difference, namely that there was an increase in the average value from an average value of 43 to 70.9. Then the gain test results obtained a value of 0.49 in the medium category.

The N-Gain value is 0.49 in the medium category. The N-Gain value with a moderate category means that the use of STEM-based E-Modules trains students in relating fields of science, besides that with interesting visualizations related to daily life, it makes it easier for students to understand and be active in learning activities. The use of teaching materials that can encourage students to be more active in learning has a positive effect on learning outcomes (Seputra and Wening, 2017). Learning by integrating STEM helps students understand the material and trains students in improving students' scientific literacy skills (Rusyati et al, 2019).

The normality and homogeneity tests are prerequisite tests in conducting the paired sample t test. the results of the normality test pretest (0.530) and posttest (0.413)> 0.05, which means the data is normal. Homogeneity test results pretest-posttest value (0.284)> 0.05, which means the data is homogeneous. Then the results of the paired sample t test, the pretest-posttest value (0.000) <0.05 means that there is a difference between before and after treatment using STEM-based E-module.

The prerequisites for the paired sample t test have been met, namely by performing the normality and homogeneity test. Furthermore, after the prerequisites are met, then the parametric analysis with the t test, paired sample t-test is obtained by comparing the probability value (sig) 0.000 <0.05., then H_0 is rejected. This means that the mean scores of students 'scientific literacy before and after using STEM-based E-Modules are not significantly different, which means that the use of STEM-based E-Modules has significantly increased students' scientific literacy skills. STEM-based learning trains students in linking fields of knowledge to each other which are interconnected, so that students can understand the material as a whole as well as interesting examples of visualization in the form of pictures/ photos, videos in everyday life make it easier for students to remember and understand the material being studied .

The real difference between scientific literacy scores between before and after using STEM-based E-modules in improving scientific literacy skills. Integrated teaching materials provide students with new experiences in studying environmental pollution material in terms of theory, application and impact on society. In addition, innovative and flexible learning encourages students to learn. Learning that is integrated and combined with technology, namely in the form of electronics / via gadget (mobile) provides convenience, flexibility and effectiveness for students (Laaili et al., 2019). Learning using a technology-integrated STEM approach is able to provide students with opportunities to train and improve students' scientific literacy skills (Ismail et al, 2016). Based on the research data, the use of teaching materials that are good and in accordance with learning needs encourages the creation of an effective, efficient and flexible learning process which is an alternative that can be taken to achieve learning objectives. next for each aspect of scientific literacy can be seen in Figure 1.

Aspects of Science as the Body of Knowledge

Based on Figure 1. In the aspect of science as a body of knowledge, the average value pretest 55 and posttest 74. This means that between the two averages there is an increase in value. In this aspect, students are intended to be able to remember information on facts, theories and concepts. Learning activities using STEM-based E-Modules display visualization of real phenomena/ problems in everyday environments, for example; water pollution/ waste disposal. Learning with STEM-based E-modules that show real phenomena makes it easier for students to receive and understand learning material. in line with Afriani's (2018) research that contextually packaged learning in observing phenomena helps students remember and understand material concepts

Aspects of Science as a Way to Investigate

Based on Figure 1. In the science aspect as a way to investigate, the average pretest score is 57 and posttest 75. In this second literacy aspect students are trained in explaining answers by involving students in experiments/ observations/ through graphics/ others. . Learning activities through video observations about the effect of polluted water on fish can encourage students to think, generate curiosity. In addition, observation/ investigation activities help students understand and solve problems (Muhandas, 2015). And contextual learning can train scientific literacy skills (Amri et al, 2017). In this aspect, students are able to understand and get the highest average scientific literacy compared to the other three aspects of scientific literacy.

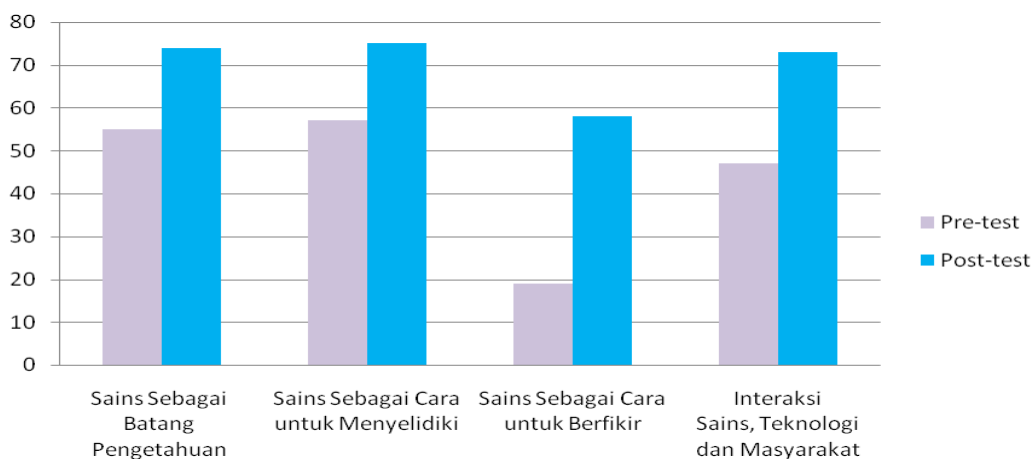**Aspects of Science as a Way of Thinking**

Figure 1. Increasing aspects of scientific literacy

Based on Figure 1. In the aspect of science as a way of thinking, the average value of the pretest 19 and posttest is 58. Although in this aspect there is an increase in students' scientific literacy abilities, in this aspect it has the lowest average compared to the third average other aspects. This aspect emphasizes the students' empirical abilities, namely being able to illustrate assumptions and provide a good inductive/ deductive causal relationship. The implementation of STEM integrated learning can train students in understanding related fields of science, so as to provide students with new experiences in assuming problems related to environmental pollution.

Based on the results of the study, through giving questions by showing the relationship between pesticide use and environmental pollution,

students had not given the maximum answer, there was a lack of explanation in answering this effect. The ability of students to assume causal relationships needs to be improved, including through integrated learning. Therefore the importance of habituation in training students' thinking by providing examples of internal assumptions/ causes everyday life (Cristiana et al., 2016; Pratiwi & Utami, 2019) .

The science aspect as a way of thinking is one aspect of scientific literacy that is measured in students' scientific literacy abilities. The level of thinking of students in understanding and making assumptions about causal relationships is still low. In line with research conducted by Diana et al (2015); shows that the results of research on aspects of scientific literacy skills obtained by students are

still in the low category, namely in the aspects of thinking and explaining phenomena while other aspects are higher than these aspects.

Interaction Aspects of Science, Technology and Society

Based on figure 1, the last aspect, namely the interaction aspect of science, technology and society, the average score of the pretest is 47 and the posttest is 73. In the fourth aspect, like other aspects, there is an increase in the average score from pretest to posttest. In this aspect, students are trained to be able to discuss social and environmental problems related to science or technology. STEM integrated learning helps students in studying environmental pollution material, namely the relationship between environmental problems and society as well applied technology used in overcoming and providing solutions to the impact of environmental pollution. Integrated learning encourages students to understand and determine alternative solutions through applied technology in the community environment.

Learning with the integration of science can provide interrelated patterns of interaction. The design of E-module teaching materials based on STEM environmental pollution material presents materials that are interconnected with other sciences such as technology etc. Furthermore, the use of technology / android-based in learning is one of the innovations in the world of education, of course, to facilitate teachers and students in learning.

Ercan et al. (2016); that learning through a combination of science, technology, engineering and society can develop knowledge and skills. The use of technology in visual and virtual learning makes learning more effective and can train students' scientific literacy (Ismail et al., 2016).

CONCLUSION

Based on the results of the research, the conclusions that can be drawn are (1) The use of STEM-based E-modules in environmental pollution material can improve students' scientific literacy skills, (2) There are significant differences between before and after using STEM-based E-modules and (3) The average increase in the aspect of scientific literacy is the highest in the aspect of science as a way of investigating and the lowest is in the aspect of science as a way of thinking.

REFERENCES

Afriani, A. 2018. Pembelajaran kontekstual (Contextual teching and learning) dan pemahaman konsep siswa. jurnal Al-Muta'aliyah. Vol 1(3),80-88.

Amri, M.Y.B., Rusilowati, A., dan Wiyanto, W. 2017. Penerapan model pembelajaran conceptual understanding procedure untuk meningkatkan kemampuan literasi sains siswa SMP di Kabupaten Tegal. Unnes Physics Education Journal. Vol 6(3), 80-92.

Cabanban, C. L. D., & Marcos, D. M. (2013). "Develoment of mobile learning using android platform". International Journal of Information Technology & Computer Science, 9(1), 98-106.

Cristina, A., Rusilowati, A., &Sunarno. (2016). Pengembanganbahan Ajar IPA Terpadu berbasis literasi sains bertema aplikasi konsep energi dalam kehidupan. Unnes Physics Education Journal. 5(1), 36-41.

Diana, S., Rachmatullah, A., & Rahmawati, E.S. (2015). Profil Kemampuan Literasi Sains Siswa SMA Berdasarkan Instrumen Scientific Literacy Assesments (SLA). "Seminar Nasional XII Pendidikan Biologi Fkip UNS", 285-291.

Ismail, I., Permanasari, A., & Setiawan, W. (2016). STEM Virtual Lab : An Alternative Practical Media To Enhance Student's Scientific Literacy" *Jurnal Pendidikan IPA Indonesia.* 5(2), 239-246.

Laili, I., Ganefri., dan Usmeldi. 2019. Efektifitas pengembangan modul project based learning pada mata pelajaran instalasi motor listrik. Jurnal ilmiah pendidikan dan pembelajaran (JIPP).Vol 3(3),306-315.

Morrison, J. (2006). Attributes of STEM education: The student, the school, the classroom. Baltimore, MD: Teaching Institute for Excellence in STEM. Retrieved from http://www.tiesteach.org/.

Muhandas, R. (2015). Pengaruh Model Pembelajaran Kooperatif Tipe Investigasi Kelompok Terhadap Pemecahan Masalah Matematis Siswa Kelas VIII MTsN Kota Padang. *Suska Journal Of Mathematics Education.* 1*(1)*, 35-44.

National Science Teacher Accosiation. (2012). Defenition Literacy Science. Website: http://www.nsta.org/about/positions/beyond2000.aspx

OECD. (2019). Assessment and Analytical Framework: Science, Reading, Mathematic and Financial Literacy, PISA, OECD Publishing, Paris.

One, W. P. S. 2019. Pengembangan media modul elektronik pada materi pokok bilangan bulat dan pecahan mata pelajaran matematika kelas VII di SMP Negeri 1 Pamekasan. Jurnal mahasiswa teknologi pendidikan. 9(2).

Permanasari, A. (2016). "STEM Education: Inovasi Dalam Pembelajaran Sains". Peningkatan Kualitas Pembelajaran Sains Dan Kompetensi Guru Melalui Penelitian & Pengembangan dalam Menghadapi Tantangan Abad-21. Seminar Nasional Pendidikan Sains (SNPS).

Rusyati., Permanasari, A., dan Ardianto, D. 2019. Rekonstruksii bahan ajar berbasis STEM untuk meningkatkan literasi sains dan teknologi siswa pada konsep kemagnetan. Journal of science education and practice. Vol 2(2), 10-22.

Seputra, D.C.,dan Wening, S. 2017. Hubungan pemanfaatan modul pembelajaran dengan hasil belajar pembuatan pola kemeja pria kelas XI di SMK Negeri 3 Purworwjo. Jurnal pendidikan teknik busana, Edisi April, 1-11.

Sugiyono. 2009. Metode Penelitian Kuantitatif Kualitatif dan R&D. Bandung: Alfabeta.

Tohir, Muhammad. 2019. Hasil PISA Indonesia Tahun 2018 Turun dibandingkan Tahun 2015. Artikel . 2. 1-2.

Wardani, R.(2018). "21st Century Educator: Menyongsong Transformasi Pendidikan 4.0". Seminar Nasional Dinamika Informatika (SENADI), 9 Mei (2018) di Universitas PGRI Yogyakarta.

Yuliati, Y., dan Saputra, D. S. 2019. Urgensi pendidikan STEM terhadap literasi sains mahasiswa calon guru sekolah dasar. Proceding of ICECRS. Vol 2(1), 321-326.