Science Web-Module Integrated with Tannery Waste as Local Potential to Improve Students' Problem Solving

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Abstract. Problem solving skills are very important skill students must owned. The low score of students' problem solving skills becomes a serious problem in the 21st century teaching and learning. The development of science web-based module integrated with tannery waste as local potential became a research that must be done. This research examined the appropriateness and the effectiveness of a science web-based module integrated with tannery waste as local potential in improving students' problem solving skills. The Four-D research and development model was employed, consisting of define, design, develop, and disseminate. This research was conducted in the form of pretest posttest control group design. The appropriateness analysis conducted by content expert, teaching media expert, and science teacher indicating that the product was categorized very good. The effectiveness of the learning was tested using the independent sample t test with sig. value set at 0.000. The test showed that the science teaching done using the science web-based module was effective in improving students' problem solving skills in SMP Negeri 1 Wungu. The product resulted from this study is expected to overcome the teaching and learning problems associated with the low score of students' problem-solving skills. Moreover, it can provide a real experience and independence to students in using the science web-based module to study.

Key words: Web-Based Science Module; Local Potential; Problem Solving; Waste; Tannery

INTRODUCTION

The concept of 21st century education adapted by the Ministry of Education and Culture of Indonesia promotes the 21st century skills, scientific approach, and authentic assessment. 21st century skills are skills needed by students to stay competitive in the 21st century. They are seen as the basis of the 2013 Curriculum which aim to educate generations with strong competitiveness in this global era.

The implementation of science learning-based on the 2013 curriculum was not yet optimal due to too much focus on students' cognitive competence (Dwiyanto et al., 2017). The 2013 curriculum is expected to promote multiple aspects, one of which is problem solvings skills. Problem solving skills is an important aspect to develop in the 21st century learning. Science learning activities that are interesting, challenging, and fun can foster students' problem solving skills (Mukhopadhyay, 2013).

A preliminary observation done in SMP Negeri 1 Wungu showed that students were rather passive during the learning activities as evidenced by the absence of questions and responses given by students toward teacher's explanation. This passive attitude might occur due to less attractive learning activities since the teacher was rather text-book oriented in giving explanation and assignments for students. The teacher did not employ the available (Information and Communication Technology) ICT items including wi-fi hotspot and LCDs optimally. The teacher rarely used electronic media such as powerpoints and videos in science learning. Assignments were given individually based on the exercises available in Students' Book with teacher's assistance. As the consequence, peer interaction was not promoted. Whereas, interaction between students has been proven effective in improving students' problem solving skills.

Problem solving skill refers to the ability to organize various information to obtain a solution of a certain problem using certain methods (Seyhan, 2015; Syafii & Yasin, 2013; and Taufik, 2014). Appendix IV Permendikbud No. 81A states that students' problem solving skills must be developed and enhanced through learning activities based on the findings and manifestations of students' ideas. Argaw et al. (2017) stated that problem-solving skill covers some sub skills including the skills to identify, search, select, evaluate, organize, consider various alternatives, and interpret relevant information. Students' problem solving skill can be enhanced using various information and communication technology which are used as learning media aiming to develop students' problem solvings skills.

Beside using various information and communication technology, the integration of local potentials in learning has been confirmed effective in improving students' problem solving skills in science subject.

According to Hasanah et al. (2016), learning activities that integrate local potentials of the surrounding environment developes students' awareness of various environmental problems around them. Integrating local potential into learning will also provide students with strong insights related to the values of the local wisdom around them, which values will be internalized in such ways to form virtue characters (Cahyaningtyas et al., 2017). One of the local potentials in Magetan is the leather tanning industry.

Tannery is a process of processing animal skin for leather craft materials (Suparno, 2010; and Murti et al., 2013). The tanning process uses toxic chemicals such as sodium sulfide, chromium, lime, and ammonia, leaving solid, liquid, and gas wastes that makes the environment polluted (Pawiroharsono, 2008; and Wahyulis et al., 2014). Environmental pollution is one of the science curricula presented for junior level students, in the 3.8 Basic Competence (*Kompetensi Dasar/*KD), covering the ability to analyze the environmental pollution and its impact on the ecosystem, and KD 4.8 regarding students' writing ability about solutions to pollution problems in the environment based on observations. The learning materials that integrate local potentials can be presented through website as the learning media.

Maharani and Dewi (2015) and Stanojević et al. (2018) pointed out that the use of websites makes it easier for students to access various sources of information regardless of time and place, and foster students' interest in learning science. Learning using a website can also improve students' problem solving skills (Doyan & Sukmantara, 2014; and Ambarwati, 2019). Utilization of the website in learning can be done by the teacher by creating materials that suit the website such as a module.

Learning modules are defined as a learning unit that presents various activities and components, such as learning objectives, materials, methods, media and resources, and assessment to achieve the learning objectives (Herawati, 2016 and Arpan et al., 2018). Regarding those issues, it was considered necessary to develop a web-based module integrated with local potential of tannery for science learning. The purposes of this study was to (1) determine the appropriateness of the web-based module integrated with local tannery potential (2) to analyze the effectiveness of web-based module integrated with local tannery potential in improving students' problem solving skill.

This research is expected to provide useful insights for relevant parties to increase the waste shelter capacity for better waste management. This research also highlights the necessity to apply strict regulation regarding illegal littering to the rivers. Those improvements will be greatly beneficial for both the environment and the society living around the factory.

METHODS

This research and development (R&D) study was conducted based on the the Four-D model proposed by Thiagarajan, et al. (1974). The Four-D model includes define, design, develop, and disseminate. The product being developed in this study was a web-based module that integrates the local potential.

Product trial was carried out in January 2020 in SMP Negeri 1 Wungu involving seventh-grade students in the even semester of the 2019/2020 academic year. Field trial using the quasi-experimental method with the pretest-posttest control group design was then administered. Field product test involved 56 students, including 28 students of class VII D and 28 students of class VII E. Samples for this field test were randomly selected, in which VII D was assigned as the experimental class (learning using science web-module) and class VII E as the control class (learning using conventional method and students books assisted by the teacher).

Data collection instruments included test and non-test instruments. Non-test instruments were in the forms of (1) interview sheets for preliminary study; (2) product eligibility assessment sheet for material and media expert validation; (3) practicality sheet that was assessed by the science teacher; and (4) readability questionnaire to determine students' responses to products. Test instruments were in the form of essay tests. The indicators of problem solving skill measured in this study consisted of identification of problem, determination of alternatives and solutions, application of proper solution, and evaluation on the application of the solution. Each of those problem solving skills indicators then were arranged as an essay question. Problem solving skill was measured using an essay tests distributed twice as a pretest and posttest. Prior to the implementation, all intruments had been validated.

Field trial was done in the form of pretest-posttest control group design (Sugiyono, 2011). Samples of this study were randomly selected and their responses were recorded before and after the treatment using a set of questionnaire.

The appropriateness of this product were qualitatively evaluated by practitioners based on four criteria: very good, good, fair, and poor. Wheraeas, students' responses from questionnaire were analyzed based on the percentage of students who gave positive responses. The data obtained from the expert assessment were classified according to the predetermined category based on the criteria of score classification for each item as follows.

Table 1. Scoring criteria

Score Range	Predicate	Category
$X \geq \bar{X} + 1.sbx$	A	Very Good
$\bar{X} + 1.sbx > X \geq \bar{X}$	B	Good
$X > X \geq \bar{X} - 1.sbx$	C	Fair
$X < \bar{X} - 1.sbx$	D	Poor

(Mardapi, 2008)

The effectiveness of the product was analyzed using normalized gain scores and independent sample t-tests. The test could be carried out if the prerequisite tests have been fulfilled, including univariate normality and homogeneity tests. The prerequisite test scores were analyzed using SPSS 22 program.

RESULTS AND DISCUSSION

The product developed in this study is presented as follows. The format of the science web-based module includes the web title and navigation system with several features to help users using the product in well-organized and directed manner. The navigation system consists of the next, back, home, and close buttons; the pages present a menu consisting of a homepage, instructions, competency map, learning, competency test, and author; blog content in the form of web pages consists of material, sub-material titles, student activities, question exercises, and evaluations; widgets include calendars and text widgets which provide additional information; and the search system functions to help users search for content in the science web-based module. The science web-based module integrated with tannery waste as local potentials developed in this study can be accessed on yukbelajaripa.com. The interface of the science web-based module is shown in Figure 1.

Figure 1. The interface of the science web-based module

The science web-based module consists of three learning activities arranged in accordance with curriculum and material analysis. Activity 1 contains activities for water pollution topic in the form of practicum about the impact of tannery waste on river water quality, activity 2 contains discussions for air pollution topic, and activity 3 contains activities for soil pollution topic in the form of discussion about solid and liquid waste that pollute the soil around the river. Each learning activity is adjusted to the content in the local potential used. Each activity on the module contains supporting information to help students work on the discussion material.

The advantages of web-based science module that includes the local potentials of tannery waste compared to other modules is the use of website as its media. The modules that are often used by teachers and students are mostly printed modules. Compared to printed modules, web-based modules require lower costs and can be accessed whenever and wherever using all gadgets that are connected to the internet. This module is also based on Problem-Based Learning model. Sumiantari et al. (2019) stated that Problem-Based Learning (PBL) can improve students' ability to solve problems. Local potential is also integrated in this science web-module. According to Hasanah et al. (2016), learning activities that integrate local potentials of the surrounding environment developes students' awareness of various environmental problems around them. Integrating local potential into learning will also provide students with strong insights related to the values of the local wisdom around them, which values will be internalized in such ways to form virtue characters (Cahyaningtyas et al., 2017). Specifically, SMP Negeri 1 Wungu in East Java has never used PBL based modules integrated with the local potential, so that the use of this kind of module is a new experience for students and teachers.

LCD, laptops, and chellphones were used in the teaching and learning process in class. During learning process, students accessed the material and worksheets on the web-based module using their own cellphones or laptops. The teaching and learning process which is usually monotonous by using books, was replaced by web-based modules containing not only text but also explanatory videos that made students understand the topic more easily. By being able to follow the lesson and understand the topic well, students will be interested in solving the problems presented in the web-based module. The problem solving process was carried out in groups with teacher guidance. Students found many informations in the web-based modules helped them to solve problems easier. The discussion process within and among groups also went very well. Beside problem solving skills, the discussion was also improved students' attitudes so that learning became more meaningful. The integration of local potential that was used during the discussion process aroused students' curiosity because the problems presented were familiar to them and can be found near them.

The Appropriateness of the Web-Based Module

The appropriateness of the developed product was validated through validation sheets given to the expert of content and expert of media. The validation was administered to assess the appropriateness of this product seen from some aspects. The validation was done by two expert lecturers of content and media. The results of the validation were categorized as shown in Table 1.

Based on the classification criteria, the results of validation in terms of appropriateness done by experts and the practicality assessed by science teacher are presented in Table 2.

Table 2. Results of appropiateness and practicality tests

Expert	Number of Items	Score	Average	Category
Content	16	64	4	Very Good
Media	9	31	3.1	Very Good
Science Teacher	15	55	3.73	Very Good

The appropriateness test results in Table 2 indicating that the product is considered very appropriate and ready for trial. Based on the appropriateness criteria by Mardapi (2008), the assessment of content experts which scored 64 with average 4 is categorized very good. The assessment of media experts which scored 31 with average 3.1 is categorized very good. The assessment of science teacher which scored 55 with average 3.73 is categorized very good.

A small-scale trial was conducted after the product has been declared appropriate based on the validation results. The small-scale trial involved 9 students consisting of 3 students from low, middle, and high learning skills each. Small-scale trials were carried out by giving students the web-based module link to be accessed and to be tried out for its menus. They were also asked to read the material and try all the features presented such as the videos. Small-scale trial was conducted to obtain data related to product readability based on students' responses.

Based on students' responses, 82.4% of students responded positively to product. Science learning using a science web-based module which integrates tannery waste as local potential is considered something novel for students. In addition, it can also motivate students to improve their problem solving skills. The use of websites in learning is perceived interesting among students because students had never used it before.

The website is also a global network containing massive amount of information. Situmorang (2016) stated that learning by using websites is more effective because the massive information is presented in interactive learning which improves students' problem solving skills. Asyhari & Diani (2017) stated that the use of websites in the learning process can build interactive online communication between teachers and students. In line with research conducted by Diani et al. (2018), a website makes it easier for students in learning as they do not necessarily have to do the face-to-face learning with the teacher. Schunk (2015), Yulianti (2016), and Shabrina & Diani (2019) had also confirmed that the use of websites as a teaching media can develop interesting, innovative, effective, and creative learning atmosphere, making it easier for students to understand the materials. Innovative media such as videos diplayed in the science web-based module helps students to understand the concepts and material being taught. In addition, according to a study by Sudarwati, et al. (2017), learning using a website does not reduce the quality of communication that occurs between teachers and students because its online forum facilitates the communication.

The Effectiveness Web-Based Module

Field trial was conducted involving 28 students of class VII D (experimental class) and 28 students of class VII E (control class). The effectiveness of the product in improving students' problem solving skills was measured by comparing the average normalized gain score. The results of the pretest and posttest score are shown in Figure 2.
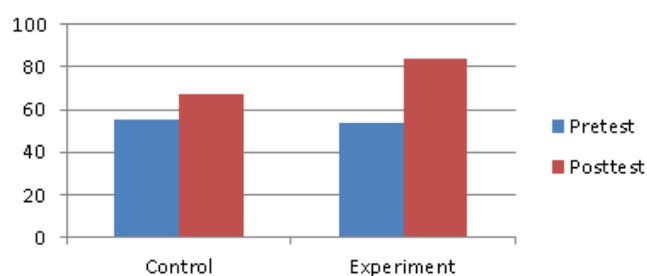

Figure 2. The Average Scores of the Experiment and Control Group

Figure 2 shows an increase in the pretest and posttest scores in each class. The increase of score in the experimental class is greater than the one of control class. The average score obtained by experimental class increased by 30, while the control class increased by 12. In addition, the normalized gain score of the experimental class is also greater than the control class by 0.65 (moderate), while the control class obtained a gain score of 0.25 (low). The normalized gain score category based on Hake (1999) can be seen on Table 3.

Table 3. The normalize gain score category

Score <g>	Category
<g> ≥ 0.7	High
0.7 > <g> ≥ 0.3	Moderate
<g> < 0.3	Low

(Hake, 1999)

Based on the analysis above, the normalized gain score of the experimental class is significantly higher than the control class due to the use of web-based module that students find innovative, interesting, and meaningful. Menawhile, the use of conventional teaching method using worksheets provided in the text book (control group) could not promote students' problem solving skills. The results of analysis on students' problem solving skills scores based on each indicator and the gain scores are presented in Table 4.

Table 4 shows the scores value of pretest (pre), posttest (pos), and gain score (<g>) for each aspect of the problem solving skills studied from the experimental (experiment) and the control class (control). There is also an average of each of these values. It shows that each aspect of students' problem solving skills was increased. The increase is indicated by the positive gain score in every aspect of problem solving skill in the experimental class. In the control class, three aspects of problem solving skill categorized low, which are identification of problem, application

of proper solution, and evaluation on the application of the solution. Meanwhile there is only one aspect of problem solving skills in the control class categorized moderate, which is determination of alternatives and solutions. In the experimental class, one aspects of problem solving skill categorized high which is application of proper solution, two aspects of problem solving skill categorized moderate, which are identification of problem and evaluation on the application of the solution. Meanwhile there is only one aspect of problem solving skills in the experimental class categorized low, which is determination of alternatives and solutions. The average of the two classes' gain score showed that students' problem solving skills in experimental class is higher than in the control class. This gap occurred due to the use of authentic problems discussed in a PBL-based science learning using the science web-based module integrated with tannery waste as local potential which successfully promoted students' problem solving skills. Questions presented in the discussion engage the students to perform higher order thinking skills that challenged students to propose different ideas to obtain solutions to the problem. Discussions held in class also trigger questions and answers that occur among students so that the ability to evaluate the solutions implemented by them can be increased.

Table 4. The gain scores of students' problem solving skills

Aspect	Control			Experiment		
	pre	pos	<g>	pre	pos	<g>
Identification of problem	62	68	0.13	68	84	0.34
Determination of alternatives and solutions	63	78	0.32	68	85	0.06
Application of proper solution	69	78	0.13	58	95	0.89
Evaluation on the application of the solution	57	63	0.14	55	86	0.69
Average	62.75	71.75	0.25	62.25	87.5	0.65

Prerequisite tests measuring the data normality and homogeneity had been conducted prior to performing the effectiveness test. Univariate normality test using the Shapiro Wilks test showed significance values for the control class and the experimental class of 0.334 and 0.132 respectively. The significance values that are greater than 0.05 show that the sample data are normally distributed. Homogeneity test in the form of Levene's Test of Homogeneity obtained a significance value of 0.423. The value that is greater than 0.05 indicates that both samples (pretest and posttest) were obtained from homogeneous populations. Threfore, the independent sample t-test was then conducted.

The effectiveness of the product is shown by the results of the independent sample t-test on the normalized gain score. The independent sample t-test resulted in a sig. value of 0.000 (2-tailed), that is

smaller than 0.05 (<0.05). This shows a significant difference between the experimental and the control class. Therefore, the product developed in this study is considered effective in improving students' problem solving skills.

The implementation of science web-based module integrated with tannery waste as local potential has been proven able to improve students' problem solving skills. In line with research conducted by Innatesari et al. (2015), the development of teaching materials can be done by integrating the local potential to make learning more meaningful at school. Local potential considered important in the web-based module developed in this study as a source of learning materials and as problems that can be used to train students' problem solving ability. Science learning materials presented in PBL can stimulate students to develop higher-order thinking, lifelong learning, and

problem-solving skills, while students are also trained to communicate verbally and work in groups (Wahyuni et al., 2017). PBL has been empirically proven improving problem solving skills in research conducted by Handayani & Sopandi (2015); Aji et al. (2017); Wachrodin (2017); and Oktaviani & Tari (2018).

Therefore the development of the science web-based module is a new innovation in the development of technology for learning purposes. The integration of technology and appropriate teaching approach, learning content, and learning method can promote the quality of education (Susilo, 2012; Irmawati et al., 2016; & Octaria, et al., 2013).

This research has never been carried out before in SMP Wungu 1. The use of tannery waste as local potential in this research also has never been found in science module. The use of websites in learning is also an innovative solution in the world of education, where the role of ICT in 21st century education is needed so that teaching materials can be accessed by students anywhere and anytime.

This research can be useful for students and teachers. For students, a learning using PBL-based science web-based module integrated with local potential of tannery waste can provide real experiences, a new atmosphere in learning that brings students enthusiasm, and build a learning culture that is independent, fundamental, comprehensive, and integrated. For teachers, this research can be used as an alternative to overcome learning problems, provide an information regarding the benefits of web-based modules to improve students' abilities, and encourage teachers to make learning more active, innovative, creative, and fun for students.

CONCLUSION

Based on the results of the analysis, it can be concluded that the science web-based module developed in this study has been regarded appropriate and also categorized very good. The effectiveness of using the science web-based module integrated with the local tannery potential has been confirmed effective in improving students' problem solving skills as evidenced in the independent sample t-test.

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