The effectiveness of scientific approach through the website in physics learning process at vocational high school

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Abstract. The purpose of this research is to describe the effectiveness of scientific approach through the website in Physics learning process at Vocational School. The defined scientific processes are: observing, making inquiries, reasoning, trying, and communicating. The type of research is pre-experiment by using a one-shot case study design. The effectiveness is viewed from the scientific processes, conceptual understanding, and students’ responses. The subject of this research is 50 students of Multimedia skill program of SMK Negeri 12 Surabaya. The students’ concept comprehension scores are obtained from the test, while the measurement of students’ scientific process and response use a Likert scale. Data analysis used is a descriptive statistic. The learning process is effective if the student’s scientific process and response percentage is ≥ 61% (good or very good), and the student’s conceptual understanding average score is x ≥ (70 ± 10). The results obtained are 1) the score of the scientific process is categorized good, 2) students’ response is categorized very good, and 3) the average score of students’ conceptual understanding x = (76 ± 9). The results showed that the application of the scientific approach through the website is effective to use in physics learning process at vocational high school.

I. Introduction

To equip students with the skills needed for the 21st century, schools must be able to train students to be flexible, adaptive, initiative, self-controlled, social, productive, spirit-minded, and responsible [1]. This ability can be trained through scientific literacy and science process skills in the school environment [2]. Vocational School is a form of formal education unit that organizes vocational education at the secondary education level as a continuation of junior high school or other equivalent form consisting of several majors. Physics subject is one of the supporting subjects in the field of expertise in vocational schools, namely knowledge related to facts, processes, theories, concepts and generalizations, which trains students not only to memorize but also processes to connect one concept with another. In physics learning, students must be given the opportunity to investigate the phenomena of everyday life, so that they need investigative activities as part of scientific work involving process skills. The effective method that can be used in physics learning is practicum because it can develop simultaneously three intelligence domains (cognitive, psychomotor, and affective). Science process
skills involve intellectual and psychomotor skills that empower students' basic skills by thinking and acting to find, develop, and apply natural science [3]. Components of science process skills include: observing, classifying, measuring, communicating, concluding, predicting, collecting, recording, interpreting data, identifying and controlling variables, making operational definitions, making hypotheses, experimenting, creating and using models [4]. The application of science process skills in learning in secondary schools is simplified based on the current curriculum in Indonesia, because it only contains components that include: observing, making inquiries, reasoning, trying, and communicating, known as the scientific approach. The nature of the scientific approach to learning refers to the view that learning is basically a scientific process. The rapid advancement of information and communication technology (ICT) has now expanded in various fields of life including education and teaching. Empowerment and utilization of ICT in the field of education and teaching can be one indicator of how much progress in the field of education and teaching. The purpose of using ICT in the field of teaching is that learning can run more effectively and efficiently, by using it as a learning medium, packing learning materials into digital teaching materials and sharing them with students online. Physics learning requires media that can present and explore material with both facts, concepts, processes, and metacognitive to students. Physics is the idea of the results of testing through a scientific inquiry about the physical properties of the universe. Mastery of the concept of physics must go through a learning process that can provide opportunities for students to process their intellectuals to the full. Physics subjects are less interested in vocational students because they only become adaptive lessons and they are more concerned with productive subjects. To encourage students' interest in Physics lessons, teachers can use various methods and approaches to learning, and efforts to synergize learning Physics with the productive fields of Multimedia majors are utilizing information and communication technology (ICT). One alternative ICT-based media is to use a website, therefore this study aims to describe the effectiveness of a scientific approach through a website in the process of learning Physics in Vocational Schools.

Natural phenomena that provide life lessons in harmony with the laws of nature are studied by physics, so they can be used as a vehicle to develop the ability to think and solve problems in everyday life. Middle school teaches Physics which leads to Basic Physics, namely the basic idea of applying scientific methods to test the most basic ideas about physical traits which include the concepts and principles of Physics needed to study further physics or other sciences [5]. Learning Physics trains scientific skills, namely skills related to products, processes and scientific attitudes, which are used to express the most important procedures used by scientists when building knowledge and solving experimental problems [6]. Vocational Schools have several departments, but not all of them require physics, and only certain majors include Multimedia majors. The role of Physics is to support improving the quality of learning for students from departments that need physics with the learning process that uses a scientific approach. Teachers should develop learning activities that develop scientific methods, critical thinking, scientific attitudes, problem-solving approaches, discovery methods, and inquiry methods. The use of inquiry-based learning can improve student literacy and research skills [7], in addition to improving student achievement [8]. Learning used in schools must use the scientific process, help students learn to learn, and help students get their own knowledge. The scientific approach emphasizes scientific processes and high-level thinking. The scientific approach needs to be applied in physics learning because students not only need knowledge, but also need to be trained to find, develop, and apply that knowledge through scientific processes. The scientific approach consists of: observing, making inquiries, reasoning, trying and communicating, each of which is explained briefly below. Observing is the act of observing a fact or symptom that prioritizes the meaningfulness of the learning process. Making inquiries is the activity of making various questions about what has been observed or asking about what has been observed. The reasoning is a learning activity to associate or look for relationships between various information sources to find alternative answers to questions that have been made. Trying is a learning activity to explore or try to prove the truth of the results of reasoning. Communicating is the activity of conveying the results of
experiments and associations to other students and their teachers. The process applied to this scientific approach is part of science process skills.

Web-based learning is a learning activity that utilizes media websites that can be accessed through the internet, and this learning is one of the applications of electronic learning (e-learning), namely learning that is carried out electronically. The characteristics of e-learning that distinguish it from conventional learning are: 1) interactivity, which has more communication channels both directly (chat, messenger) and indirect (forums, mailing lists, etc.); 2) independence, namely flexibility in time, place, teaching, and teaching material so that it is more centered on students; 3) Accessibility, namely learning resources are easily accessible through distribution on the internet network, so that distribution access is wider than conventional learning; 4) Enrichment, namely learning activities, presentation of teaching materials as enrichment, so as to enable the use of multimedia such as video, animation, and simulation. Learning using the website has the advantages of these characteristics so that it is chosen in this study because it allows the learning process that uses a scientific approach by empowering its strengths which can be integrated with multimedia. Previous research that supports the selection of website-based learning in this study are: 1) Website-based learning is effective for teaching mathematics [9] and [10], in addition it is also effective for teaching biology [11]; 2) Learning with an online environment effectively supports science process skills [12], and interactive learning gets a positive response from teachers [13].

2. Research Method
This study included a pre-experimental design of one-shot case study, which treated one group and observed the results. The treatment is a manipulation variable and the result is the dependent variable [14]. The manipulation variable in this study is learning to use a website based on a scientific approach, while the dependent variable is a scientific process, mastering the concept of physics, and students’ responses to learning using the website.

The research procedures are: 1) creating a learning website based on a scientific approach, 2) filling the website with digital learning tools (text, handouts, videos, and other learning resource links), 3) using a website based on a scientific approach to learning in vocational schools, 4) Measuring the scientific process and mastering the students' physics concepts with tasks and questions that are integrated with the website, 4) giving a questionnaire to students to find out the students’ response to the use of the learning website which is also integrated with the website. Based on existing limitations, the topic of Physics used in this study was Mirror, and the research subjects amounted to 50 XI (tenth) grade students majoring in multimedia at SMK Negeri 12 Surabaya.

Data collection techniques use written tests for scientific processes and mastery of physics concepts, and questionnaires to capture student responses. Physics concept mastery scores are netted with 20 multiple choice objective test items that have been validated both content and content by three Physics Masters. Students answered online through the website, scores of students’ scientific processes netted from the teacher's assessment of online student activity report through the website, and students' responses are netted from the scores of students' assessments of learning websites that are also filled online by students. Giving scientific process scores and student responses using a Likert scale (very less = 1, less = 2, good = 3, and very good = 4). Data analysis uses descriptions of scores obtained by students towards the scientific process, mastery of physics concepts, and student responses. Learning using a web-based on scientific approach is declared effective if the scores of each component of the scientific process of students are good or very good and the average score of mastery of students' physics concepts is ≥ (70 ± 10). The criteria for the effectiveness of scientific processes and student responses are obtained by adding up all the average scores given by students divided by the maximum score multiplied by 100%, learning using a web-based on scientific approach is declared effective if the percentage of effectiveness obtained is ≥ 61%. Scientific approach-based learning websites can be used in learning physics in vocational schools if effective can produce scientific processes, mastery of physics concepts, and student responses with good results.
3. Results of The Research

3.1. Description of a learning website based on a scientific approach

Physics learning websites based on scientific approaches made using the Google site can be accessed via the URL address: https://sites.google.com/site/fisikasmkmultimedia. The website has a main menu (home) in which there are many sub-menu buttons and some of them are related to the process in a scientific approach that can be presented as Figure 1 as follows:

![Figure 1. The main menu of learning websites based on a scientific approach](image_url)

The sub-menu buttons used for menus related to the process in the scientific approach are the deepening button of the material, the scientific approach button, the instructional button, the learning source button, the test button, and the questionnaire button. The functions of each key are: 1) The button for deepening the material is used to activate the menu which contains a description of the material related to the Physics topic being discussed; 2) The scientific approach button is used to activate scientific tasks which are processes in the scientific approach (observing, making inquiries, reasoning, trying, and communicating) and students do it directly on the menu on the activity report form; 3) Teaching material buttons are used to activate menus containing teaching materials that can be viewed or downloaded by students; 4) Learning source buttons are used to activate menus that contain related library sources; 5) The question button is used to activate the menu containing the mastery of students' physics concepts; 6) The questionnaire button is used to activate the menu containing the questionnaire. The website, integrating the use of text and multimedia (audio, video, and animation).

3.2. The scientific process of students in learning

The scientific process of students generated from learning using websites based on scientific approaches can be presented as shown in Figure 2:
Based on Figure 2, this shows that for observing, making inquiries, reasoning, students have a very good score (≥ 80%). For trying and communicating, students' abilities are still not maximal, but overall the percentage of effectiveness in terms of the student's scientific process is 84% which means it is still in a very good category. So an effective learning-based learning website can be used in Physics learning.

3.3. Mastery of Physics concepts of students
The mastery score of the Physics concept produced from learning using a website based on a scientific approach can be presented as shown in Figure 3:

Based on Figure 3, this shows that the lowest score of students is 60 and the highest score is 90 with a normal distribution. The average mastery score of the Physics Concept is (76 ± 9), which means it has exceeded the required average score. Based on these results, learning using a website based on an effective scientific approach is used in Physics learning.

3.4. Student's responses to learning websites based on a scientific approach
Students' responses to learning using websites based on scientific approaches can be presented as shown in Figure 4:
Figure 4. Student response to learning website

Based on Figure 4, this shows that in general, the student response mode is good and overall effectiveness percentages in terms of student responses are 82%. This means that a learning approach based on a scientific approach is effective for learning physics.

4. Discussion

The website that has been built as presented in Figure 1 has a complete menu for use in learning with a scientific approach. The tools needed to provide opportunities for students to have scientific processes (observing, making inquiries, reasoning, trying, and communicating) are available on the website. Conceptually the learning website created can be used to train the scientific process and mastery of students' physics concepts. There is a video that shows a symptom of Physics that allows students to make observations. The opportunity for students to have a scientific process is carried out through a scientific approach menu. The ability of students to conduct scientific processes can be known through the activity report form. The features available on this website allow learning scenarios, learning materials, learning media, and learning environments to be well developed. This scientific approach-based learning website can provide scientific processing opportunities with good results such as presented in figure 2. Scientific components observing, making inquiries, reasoning, students have a very good score (≥ 80%), but components of trying and communicating are still not optimal (trying around 70% and communicating around 65%). This is likely caused by students have not yet accustomed to designing their own experiments and writing reports on activities online. However, overall the percentage of effectiveness in terms of the scientific process of students is still very good (84%). These results are consistent with previous research that obtaining online learning can train students' science process skills [15] and [16]. The application of a website based on a scientific approach to learning can also produce mastery of a good Physics concept with an average score of students (76 ± 9) and spread normally in the range 60-90 as presented in figure 3. The opportunities are given to students to make scientific processes Physics teaching materials are more meaningful. These results are consistent with previous studies which found that learning with e-learning can improve learning outcomes in physics [17].

Students' responses to the use of scientific learning-based learning websites are very good as presented in Figure 4. All components which are asked to the students include: suitability with the multimedia field, easy access, easy understanding of Physics, providing opportunities to think, making better physics learning etc., all get a good response from students. Overall the percentage of effectiveness based on student responses is 82%. These results become an indicator that students who
come from vocational high school multimedia majors can receive Physics lessons well because they are integrated with their fields of expertise. The website is one of the important discussion topics in the multimedia department, even students are trained to design and develop it. Good responses from students are also caused because the online learning process can be more flexible which can be done anytime, anywhere, and under any conditions [18]. Vocational students give more attention to physics learning which is integrated with their expertise.

5. Conclusions
The results obtained are: Physics learning website based on scientific approach in terms of the scientific process of students produces process capabilities with good mode with an effectiveness percentage of 84%, in terms of mastery of the physics concept students produce an average score (76 ± 9), and in terms of response students produce an effectiveness percentage of 84%. Based on these results it can be concluded that the scientific approach-based learning website is effectively used in learning physics in vocational schools.

The suggestion that can be conveyed is that learning to use a scientific approach-based website needs to be considered monitoring students when doing scientific assignments and the mastery of the Physics concept. This is based on the fact that when students do scientific assignments and questions about mastering the Physics concept online, it is very difficult to condition students not to cooperate with their friends. This condition is not beneficial if the results of student work are considered individual performance. To overcome this, it is better if the scientific task and the mastery of the Physics concept are designed to be done collaboratively.

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References
[1] Trilling B and Fadel C 2009 21st Century Skills: Learning for Life in Our Times (San Francisco: John Wiley & Sons)
[2] Turiman P, Omar J, Daud A M and Osman K 2012 Procedia - Soc. Behav. Sci. 59 110-6.
[3] Sheeba M N 2013 An Anatomy of Science Process Skills In The Light Of The Challenges to Realize Science Instruction Leading To Global Excellence in Education Educ. Confab 2 108.
[4] Valentino C 2000 Developing Science Skills Hought. Mifflin Co.
[5] Feynman R 2010 Basic Physics (The Feynman Lectures on Physics)
[6] Etkina E, Heuvelen A V, White-Brahmia S, Brookes D T, Gentile M, Murthy S, Rosengrant D and Warren A 2006 Phys. Rev. Spec. Top. Educ. Res. 2 20103.
[7] Brickman P, Gormally C, Armstrong N and Hallar B 2009 Int. J. Scholarsh. Teach. Learn. 3 1.
[8] Alberta Learning 2004 Focus on Inquiry:A Teacher’s Guide to Implementing Inquiry-based Learning
[9] Prayito M 2012 Kefektifan Pembelajaran E-Learning Berbasis Website Pada Mata Kuliah Teori Bilangan Di IKIP PGRI Semarang 4 91.
[10] Rhomdani R W Pengembangan Media Pembelajaran Matematika Berbasis Web Menggunakan Quandary Di Universitas Muhammadiyah p.18.
[11] Krisno M A and Hijri M layli 2015 Prosiding Seminar Nasional Pendidikan Biologi 2015 4 34.
[12] Kustijono R 2012 J. Penelit. Fis. Apl. 2 10.
[13] Kustijono R, Sunarti T and Budiningarti H 2018 J. Abdi 3 75.
[14] Fraenkel J R, Wallen N E and Hyun H H 2006 How to Design and Evaluate Research in Education.
[15] Irma Z U and Kustijono R 2017 J. Inov. Pendidik. Fis. (JIPF ) 06 22.
[16] Apsari A N and Kustijono R 2017 J. Inov. Pendidik. Fis. (JIPF ) 06 285.
[17] Marwah S and Kustijono R 2015 *J. Inov. Pendidik. Fis. (JIPF)* **04** 16.
[18] Martono K T and Nurhayati O D 2014 *Int. J. Comput. Sci.* **11** 168.