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Physics Problem Solving Skills with IBL-STEMWeb: Students on Small Islands in Maluku

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Abstract: Learning on small islands in Maluku still has many obstacles. It is limited by inadequate supporting facilities and infrastructure in the form of internet availability in accessing learning materials. Maluku's natural resources, both biological and non-biological, are very abundant. However, they have not been managed properly in improving the community's welfare. Therefore, education is one of the spearheads in improving the quality of students so that they can manage the existing nature well in the future. One of the recommended lessons is IBL-STEWeb to improve the academic quality of students. The use of IBL-STEWeb can take into account the involvement of students' preconceptions, provide in-depth basic knowledge, help students make connections within the context of a conceptual framework, and can map students' knowledge in a way that facilitates the search and application of information.

Keywords: Problem solving skills; IBL; STEM; Web; Small Islands

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Introduction

Physics is a branch of science that studies natural phenomena scientifically and is presented systematically (Guisasola et al., 2005; Fernandez, 2017). Physics is expected to be a vehicle for students to study themselves and their natural surroundings and apply them in everyday life (Zohar & Trumper, 2020). For this reason, physics learning should use the right method to bring students into real situations, where students can see and prove their knowledge based on existing facts and gain concrete experience (Bao & Koenig, 2019).

Learning physics requires principles and understanding to apply these principles in the context of different features in-depth (Lin & Singh, 2013). Learning today must be student-centred, is the main icon in the learning process, learning must be collaborative and interactive, learning is seeking and finding, learning to develop each student's potential, and critical learning (Martinez-Maldonado et al., 2013; Harney et al., 2013; Harney et al. al., 2017). Physics learning helps students build their concepts by knowing the initial ideas that students know about certain concepts (Etkina, 2010; Park, 2020).

One of the important goals of physics subjects is to understand the basic concepts of physics deeply to be able to apply them in solving problems in the real world (Hegde & Meera, 2012; Salta & Koulougliotis, 2020). In learning physics, good problem-solving skills are needed so that students can use their knowledge to solve more complex problems (Becerra-Labra et al., 2012; Akben, 2020). Solving problems is an important part of the learning process. Problem-solving is a student's effort to find answers to their problems based on their previous knowledge, understanding, and skills (Klegeris et al., 2018). Problem-solving ability is an individual's ability to use his thinking process to solve problems by collecting facts, analyzing information, compiling alternative solutions, and choosing the most effective solution (Gök & Sýlay, 2010; Tian et al., 2014). The ability to solve problems can be strengthened through exercises often done in class by giving problems by the teacher to students, which can invite

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students to analyze and think. (Sezgin Selçuk & Çalýskan, 2008; Turşucu et al., 2020)

Science education encourages students to think about understanding natural phenomena or events with the scientific method as done by scientists (Orion & Kali, 2005). An important focus in science education is scientific literacy, an important part of 21st-century education (Holbrook & Rannikmae, 2007; Osborne, 2007; Glaze, 2018). Scientific literacy is the ability of students to use scientific concepts to apply in everyday life, explain scientific phenomena and describe these phenomena based on scientific evidence (Mun et al., 2015). Scientific literacy is important to be mastered by students. Students can understand the environment, health, economy and other problems faced by a modern society that is highly dependent on technology and the progress and development of science (Turiman et al., 2012; Kähler et al., 2020). It is what underlies the importance of scientific literacy for students. By having scientific literacy skills, students are expected to be able to face challenges in the era of globalization, namely in the form of increasingly rapid technological advances and the development of science.

Hobson (2008) says that global scientific literacy is very low. This low scientific literacy ability is caused by many factors, namely social, non-social, psychological, and physiological factors (Udompong & Wongwanich, 2014). These factors determine student learning outcomes.

Based on research conducted by Tuwoso (2016) & Goldstein (2016), physics learning in schools has not been maximized. Physics learning in schools is still a teacher centre. Learning activities carried out are lectures, discussions, and practice questions. In addition, a practicum is rarely held in schools. There are no more than three practicum activities in one semester. Students stated that learning physics would be more interesting if students did practical activities. Students find it difficult when faced with more complex exam questions. Harmonious learning can focus students' attention, which will impact students' scientific literacy and problem-solving abilities.

The selection of learning models is one solution that can create fun, challenging, and motivating learning for students (Bell et al., 2010). In inquiry learning, the knowledge and skills obtained by students are not expected to be the result of remembering a set of facts but the result of finding out for themselves (Wartono et al., 2018). Inquiry model learning is a learning model that prepares students to conduct experiments and collect and analyze experimental data to conclude (Kolovou & Kim, 2020).

Students can express opinions and relate their initial concepts to new information (Spronken-Smith & Walker, 2010). Learning with the inquiry model requires students to find concepts by doing a practicum in class in groups to improve students' scientific work (Love et al., 2015). Inquiry learning activities emphasize direct learning so that students optimize scientific literacy and students problem-solving abilities. According to the statement, inquiry learning can help students construct physics concepts learned through the thinking process (Lee et al., 2021). Students will find their concepts more easily understood and master the concept from the investigation activities. Learning activities can be more meaningful. Students interact directly with their environment and associate what they learn with their old knowledge. In addition, the concept of the results of his invention can help students solve physics problems (Lämsä et al., 2018).

The development of the times that impact the world of education, such as learning media, will experience changes. However, this is rarely communicated in classroom learning that links the concepts studied with technological products that have been developed. When students know that the physics concepts they learn are very useful and have a big role in developing various technological products, their motivation to study physics will grow. As a good science learning goal, physics learning can improve the components of problem solving and physics literacy itself.

One way to catch up with Indonesian education is to apply STEM (Science, Technology, Engineering and Math). A learning model that applies integrative thematic learning because it combines four main areas of education, namely science, technology, mathematics, and engineering. Science in the matter of work and energy is the science that studies the universe, facts, phenomena and events in everyday life. Technology and Engineering in work and energy materials are generators and power plants. Mathematics in work and energy is in the application of the questions.

The era of globalization and modernization has affected the development of technology and information, which has developed quite rapidly. The utilization of online (website) as one of the learning media is expected to overcome the limitations of space and time so that the teaching and learning process can run effectively and efficiently. Website-based learning (online) can foster students' independence to construct their knowledge, indicated by increased mastery of concepts, increased science generics, and students giving good responses. (Alonso et al., 2005; Tarhini et al., 2013).

Using Web-assisted learning, students can view learning objectives, learning resources, learning videos, and practice questions. Hopefully, students can access them easily so that learning can take place more optimally. In addition, with the use of the web, students can access the material needed to repeat material that has not been understood.

IBL-STEMWeb is a learning model that applies inquiry learning and integrative thematic learning. It combines four main areas of education, namely science, technology, mathematics, and engineering, by utilizing online learning media through the website. The incorporation of web-assisted STEM-based inquiry learning models greatly assists students in understanding difficult physics concepts and technology literacy, resulting in students' scientific literacy and problem-solving abilities. Inquiry learning often involves problem-based learning that can improve students' scientific literacy and problem-solving abilities. IBL-STEMWeb is still limited, although it is done with a separate variable (Nadelson et al., 2013; Conradty & Bogner, 2019).

Method

This research was conducted with a literature study based on the development of IBL-STEMWeb which is currently developing in the world and its application can be used in physics learning for students on small islands in Maluku. The research process was conducted with three important stages of planning, paraphrasing, and reporting (Suprapto, 2016). Research data is taken through valid references such as data on the development of IBL-STEMWeb in the USA. These results are then analyzed to determine the development of STEM in the USA so that it is successful in producing skilled STEM graduates in supporting physics learning. The existing data is then used as a guide so that IBL-STEMWeb can be used in learning for students on small islands.

Result and Discussion

Theoretical Framework

A. Inquiry Learning Model

Inquiry is a way of realizing what has been experienced. This learning system requires students to be able to think. This model places students in situations involving intellectual activities and processes the learning experience into something meaningful (Rogers, 2001). Inquiry learning is learning that emphasizes assisting students to investigate and develop their knowledge, such as the skills to ask questions and make conclusions based on data (von Renesse & Ecke, 2015).

According to Ekici & Gard (2017), inquiry learning is a series of learning activities that emphasize critical and analytical thinking processes to seek and find the answer to a problem in question. Inquiry learning is built on the assumption that humans are born with the urge to find their knowledge. Curiosity about the state of nature around him is natural since he was born into the world through the senses of sight, hearing, and other senses. Human curiosity continues to develop into adulthood by using the brain and mind. His knowledge will be meaningful when it is based on that curiosity.

The inquiry model is a learning model that emphasizes students to be more active in learning, where students can find or research problems based on facts to obtain data. At the same time, the teacher is only a facilitator and guide for students in learning.

Students can express their opinions and relate their initial concepts to new information (Voet & De Wever, 2017). Learning with the inquiry model requires students to find concepts by doing a practicum in class in groups to improve students' scientific work. Inquiry learning activities emphasize direct learning so that students optimize their understanding of students' concepts. Inquiry is a science learning centre where students can ask questions, describe a phenomenon, test ideas with previously known theories, and communicate student findings. Learning that applies inquiry can improve students' conceptual understanding (Hmelo-Silver et al., 2007). Following the statement, inquiry learning can help students construct physics concepts learned through the thinking process (Gordon & Brayshaw, 2008).

The steps of students in inquiry learning refer to the reflective thinking model from John Dewey written by Kaufmann (1959), including (a) identifying problems; (b) formulating hypotheses: (c) collecting data; (d) analyzing and interpreting data to test hypotheses, and (e) concluding. Meanwhile, the steps taken by the teacher include: (a) explaining the learning objectives; (b) sharing inquiry instructions or practical instructions; (c) assigning students to carry out a practical inquiry; (d) monitoring the conduct of the inquiry; and (e) concluding the results of the inquiry with the students. Capaldi (2015) suggests five steps of inquiry learning as follows: 1) identifying problems, 2) making hypotheses, 3) collecting data, 4) proving hypotheses, and 5) drawing conclusions.

B. STEM-Based Learning

STEM (Science, Technology, Engineering, and Mathematics) was first launched by the United States National Science Foundation in the 1990s as the theme of the education reform movement in the four disciplines to grow the workforce in STEM fields and develop citizens who are STEM literacy, as well as increasing the global competitiveness of the United States (US) in innovation. STEM lessons have the potential to develop deep thinking and develop creativity, and visual-spatial skills (Wilson, 2018).

The meaning of each word from STEM is as follows. a) Science: is part of science that studies the universe, facts, phenomena, and the regularities that exist in it. b) Technology: is an innovation, change, and modification of the natural environment to satisfy human wants and needs. The goal of technology is to make modifications to the world to meet human needs. c) Engineering: is a profession in which knowledge of science and mathematics is acquired through study, experimentation, and applied practice taking into account the development of ways to assemble materials and forces of nature to meet human needs. d) Mathematics: is a branch of the discipline that studies various patterns or relationships (DeCoito, 2016; Vakil & Ayers, 2019).

STEM integration education is integrated learning between science, technology, engineering, and mathematics to develop students' creativity through problem-solving processes in everyday life (Dare et al., 2019). The application of science is very much found in technology products. On the contrary, science is found in the emergence of technological products (Hackman et al., 2021). Several research results show that learning science in the context of technology and design can increase scientific literacy. STEM (Science, technology, engineering, and mathematics) education is currently an alternative to science learning that can build a generation capable of facing the challenging 21st century. In STEM-based learning, students use science, technology, engineering, and mathematics in real contexts that connect schools, the world of work, and the global world to develop STEM literacy that allows students to compete in a new knowledge-based economy era. (Ring et al., 2017).

C. Web-Aided Learning

The web is a collection of pages used to display text information, diagrams or motion pictures, animations, sounds, or a combination of all of them, each of which is connected to page networks (Ni, 2013). Web-assisted learning uses web facilities to facilitate something very important in learning (Chen et al., 2010).

Web-assisted learning uses the internet in learning (Jethro et al., 2012). In this model, students can access the required information through information sources that are intentionally opened online for anyone and anytime. The advantages of using web-based learning, as described by Kattoua et al. (2016), including 1) the availability of e-moderating facilities where educators and students can communicate easily through internet facilities regularly or whenever communication activities are carried out without being limited. by distance, place, and time, 2) educators and students can use structured and scheduled teaching materials or learning instructions via the internet so that both can assess each other to what extent teaching materials are studied, 3) students can study or review teaching materials every time and everywhere since teaching materials are stored on a computer, 4) if students need additional information related to the material they are studying, they can access the internet more easily, 5) both educators and students can conduct discussions via the internet, which many participants can follow to add broader knowledge and insight, 6) changing the role of students from being usually passive to being active and more independent, and 7) being relatively more efficient, for example for those who live far from conventional colleges or schools.

D. Web-Aided STEM-Based Inquiry

The web-assisted STEM-based inquiry learning model is learning that uses STEM-based inquiry in the teaching and learning process with the assistance of the Web. The syntax of the Inquiry learning model consists of 6 stages observing phenomena in the form of videos containing technology at the Orientation stage, identifying problems related to Science at the Problem Formulation stage, making temporary hypotheses related to Science at the Problem Formulation stage, collecting data obtained from experiments related to Engineering at the data collection stage, testing the truth of hypotheses related to Mathematics at the Hypothesis Testing stage and formulating conclusions based on hypothesis testing obtained at the Making Conclusions stage.

The Web-assisted STEM-based inquiry learning model has the potential to provide meaningful learning and has been considered important for future scientific innovation and knowledge (Kuenzi, 2008; Ally, 2009; Tienken, 2013). During practicum activities, students find facts, concepts, and phenomena and map the results obtained with STEM, namely Science, technology, engineering, and mathematics, from work and energy materials. The STEM-based inquiry learning model trains in conducting investigations so that students can process experimental data.

The knowledge that has been obtained in this activity will be very useful for students to study or examine the material or physics concepts related to the concept. Furthermore, assistance is provided in WEB, which will deepen students' understanding of learning. This WEB contains objectives, materials, worksheets, videos, and a collection of learning questions that can be accessed for an unlimited time in order to improve students' scientific literacy and problem-solving abilities.

Conclusion

Based on existing studies, the conclusions drawn are to recommend one of the modern learning methods, namely IBL-STEWeb, to improve the academic quality of students. With IBL-STEWeb, students can increase creativity and innovation in designing and packaging materials to become quality goods. The use of IBL-STEWeb can consider the involvement of students' preconceptions, provide in-depth basic knowledge, and help students make connections within the context of a conceptual framework. They can map students' knowledge to facilitate the search and application of information.

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