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Guided Inquiry Blended Learning Tools (GI-BL) for School Magnetic Matter in Junior High School to Improve Students' Scientific Literacy

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Abstract. This article discusses the use of learning tools in blended learning with a guided inquiry model in magnetic materials for junior high schools. Based on technological and educational developments, this learning tool was integrated with blended learning. The GI-BL (Guided Inquiry-Blended Learning) learning tools consist of magnetic textbooks, student worksheets, lesson plans and instruments for scientific literacy. The quasy experimental method in this study used a pre-test post-test control group design. The GI-BL learning tools were developed and validated in terms of content as well as the instruments. Testing the effectiveness of this learning tool was carried out on 163 samples of junior high school students. GI-BL learning tools were developed to improve students' scientific literacy, especially in solving problems related to magnetism-related phenomena. The data on the effectiveness of the GIBL learning tools were analyzed using N-gain. Based on the results of the N-gain analysis, it appears that students who learn with GIBL learning tools can improve scientific literacy. The highest increase occurred in indicators describing scientific phenomena and in understanding the concept of Lorentz Force.

1. Introduction

Science learning develops through broad and applied science education. Thus, the concept of science learning must be integrated with scientific literacy which refers to science-based knowledge and technology. This is in line with the development of education in the 4.0 era. This era expresses the need for a generation capable of innovating with technology and science [1]. One of the skills needed for such innovation is scientific literacy. Science literacy was chosen as the basic need for knowledge of students because it supports them to innovate with science. Each indicators in scientific literacy reflects the main and basic skills that students must have towards science [2,3]. Science education today requires students who are able to identify phenomena well. With the emergence of the skills of these students, science is no longer a rote for those who learn science.

PISA [1] makes scientific literacy one of the main components of the skills that students in the world must have. PISA focuses these skills in OECD countries [1]. One of these countries is Indonesia. Indonesia was ranked 55th out of 57 OECD countries for the science literacy score of junior high school students. This shows that changes and improvements are still needed in teaching science to students. As we know, junior high school students are a generation who need scientific literacy education appropriately. According to Yuliati [2], some students feel that they only memorize science material and cannot communicate it again. Science becomes a passing part of learning and

cannot be recalled when there are the same problems. In addition, Astuti et al. [3] revealed that scientific literacy has become less of a concern in today's lessons.

The problems that arise due to inappropriate science learning present various kinds of solutions. The solution is in the form of innovation from learning science itself. One form of innovation that is appropriate for developing and improving scientific literacy is the development of technology-based learning tools. According to Gunawan et al. [4], technological developments today are one of the factors that must be present in learning. The current situation also supports technology-based learning to address the limitations of offline learning (face to face). According to Wulandari & Sholihin [5], technology has a major influence on the world of education. Also, the changes that occur are reforms in the education system to balance advances in science and technology globally.

Learning tools developed by researchers are based on blended learning. This learning tool is also developed and adapted to the needs of scientific literacy. Blended learning is a new innovation that combines offline and online learning [6]. Blended learning is one of the most effective learning models for improving student achievement. Based on the research results of Hernández et al. [7], blended learning is the best learning model in improving student learning achievement. This mixed learning model is used as a complement in face to face learning that helps students to complete their information and expand it [8].

The learning tools developed based on offline learning concepts and are accessed online for applications and some examples of science phenomena. So, this learning tool can be used offline, online, or both. This learning tool consists of magnetic textbooks, Students' worksheets and scientific literacy tests. Learning tools are based on learning that utilizes technology in line with the 4.0 era. According to Nisrina et al. [9], technology-based learning can improve students' ability to understand basic concepts, especially abstract science concepts. In addition, Herayanti et al. [10] stated that learning tools based on blended learning can improve students' skills in solving physics problems related to abstract concept.

Blended learning allows students to explore more about science. This is in accordance with one indicator of scientific literacy skills, namely explaining phenomena scientifically and precisely. Thus, blended learning is one of the best alternatives in supporting the improvement of scientific literacy skills. According to Jufri [11], scientific literacy can be improved appropriately when the given learning uses the appropriate device for each indicator. Blended learning is a form of learning that is able to make students feel at home in learning and scientific literacy. Irmia & Atun [12] stated that scientific literacy is very appropriate to be developed with technology-based learning.

One of the indicators of scientific literacy that makes students successful in creating innovations is designing inquiry procedures and conducting evaluations [1]. Therefore, the learning tools developed by researchers are not only based on mixed learning but are based on inquiry. Inquiry used is Guided Inquiry (Guided Inquiry). Guided inquiry learning is very suitable for students in Indonesia. This is because inquiry learning creates an innovative atmosphere and supports the curiosity of students, especially towards science, its experiments and the phenomenon. According to Shea & Bidjerano [13], learning tools with inquiry blended learning support the activity of students and their collaboration. Guided inquiry allows educators to continue guiding without directly interfering with the activities of their students [14]. Aspects in guided inquiry learning also support scientific literacy skills, especially when students are trying to design their inquiry procedures.

This article will discuss the development of GI-BL (Guided Inquiry-Blended Learning) tools and their effectiveness in increasing students' scientific literacy in magnetic materials. This learning tool is developed based on technological developments with the concept of blended learning and guided inquiry, and is based on indicators of scientific literacy. This article showed that GIBL tools has a positive contribution to the scientific literacy of junior high school students in magnetic matter.

2. Research Methods

This research is a quasi-experimental research with a pre-test post-test control group design. The sample was selected using the cluster random sampling method from 10 schools in Mataram in order to obtain 163 junior high school students from two schools. Identification and preliminary studies regarding the use of learning tools were carried out in the two selected schools. Then, the GI-BL learning tools developed were validated by three experts, namely learning tools experts, technology experts and experts in scientific literacy. Then, the results of the development were tested for their effectiveness in increasing the science literacy skills of students after learning to use these learning tools. This learning tool was based on blended learning and guided inqury. So that learning is divided into six phases of blended learning inquiry consisting of: Orientation (Face to Face), Interpretation (Online), Planning (Online), Exploration (Face to Face), Explanation (Face to Face and Online), and Reflection (Online).

The instrument used to measure students' scientific literacy is in the form of multiple choices. Scientific literacy test refers to three indicators of scientific literacy, namely: explaining phenomena scientifically, designing scientific inquiry procedures and evaluating them, and making data-based conclusions. The effectiveness of the learning tools used was measured using the N-gain test [15]:

$$N_{gain} = \frac{S_{post} - S_{pre}}{S_{max} - S_{pre}} \times 100\% \qquad [1]$$

This analysis is used to avoid misinterpretation of the improvement of each student's scientific literacy skills.

3. Result and Discussion

Scientific literacy is one of the main components in the student innovation development. PISA has revealed this by elevating scientific literacy to be the main determinant of the success of a country's young generation in their education. Therefore, the learning carried out must be in accordance with the needs of scientific literacy. Learning using GI-BL (guided inquiry blended learning) is one of the right alternatives. Learning tool that use blended learning are of concern in the field of education and have been thoroughly researched [16]. The use of blended learning as a model in learning tools also serves as a link between the face to face learning and online learning [17].

This learning tool is developed based on the results of preliminary studies that have been conducted previously. The results of the observation show that some schools rarely use learning models based on 21st century skills. Inquiry learning models have been used but have never been coupled with computer-based learning. The form of learning is still tied to face-to-face learning only. The Guided Inquiry-Blended Learning tool was designed to meet these needs. This teaching material is developed into two main parts, namely magnetic textbooks and student worksheets. Textbooks designed based on the guided inquiry - blended learning (GI-BL) model have special features for mixed-based learning. The textbook is also based on a component of scientific literacy indicators and a component of inquiry learning. Students' worksheet was designed based on four magnetic experiments that are used during offline learning and can be accessed at any time, as well as online learning.

Table 1. Data of Science Literacy Test Results

Group	N	Scientific Literacy			Deviation
		Pre-test	Pos-test	N-gain	
Experiment	68	30	76.5	65.98%	10.1
Control	68	43	56	21.86%	13

The results in Table 1 indicate that the students' scientific literacy is the same for both groups. After learning with different learning tool, the experimental group gave better final results than the control group. The average score obtained by the experimental group was 76.5 which were higher than

the control group. These results indicate that the GI-BL science learning tool are successful in motivating students to continue literacy in science. This learning tool provides components that can build students' motivation and communication. According to Arohman et al. [18], scientific literacy is directly correlated with building a new generation who have strong scientific thoughts and attitudes that can effectively communicate knowledge and research results to society. In addition, it appears that students are more interested in using this learning tool because the results show a significant increase. Puspitasari [19] also revealed that scientific literacy is very appropriate to be developed in students by teaching them with guided inquiry. This GI-BL tool supports students to continue to create ideas and be able to see and read science from an appropriate and appropriate point of view.

These results are also in line with the research of Al-Azawei et al. [20] which states that blended learning tools are proven to be suitable and suitable for the education of this century. This learning tool is very suitable for learning that relates technology in it. There is a feature of using online learning tools with MOODLE (e-learning) as the learning website. Lee et al. [21] stated that learning with online access (e-learning) can support the rapid development of education and technology. In addition, according to Andone et al. [22], learning using an LMS such as MOODLE is able to provide a wide range of users in accessing its features and providing many benefits for educators and students. The GI-BL tool are also relevant to scientific literacy and inquiry. This result is in line with the opinion of Choy & Quek [23] which states that blended learning is very suitable for inquiry learning specifically for science material. Crawford & Jenkins [24] also added that the current context of science learning must develop at a consistent pace so that learning tools based on blended learning become an appropriate need.

Magnetic matter which is used in this learning tool is consists of abstract concept, especially on field lines and magnetic forces. Therefore, blended learning (offline and online) is very suitable to teach this matter. This is in line with argumentation by Herayanti et al. [25] which states that blended learning is successful in providing flexibility for students to learn abstract physics concepts. The use of mixed learning in this learning tool is intended to be able to complement each of the concepts provided so that they become more comprehensive. Booney et al. [26] also revealed that scientific literacy that is trying to be developed in students requires the accuracy of learning related to current technological developments.

Scientific literacy is an ability that must be taught with appropriate learning and learning tool. This is in line with the opinion of Irmita & Atun [12], namely that scientific literacy is important to be taught with learning tools that allow children to learn about the principles of science and motivate them to learn everything and apply it in everyday life. The GI-BL tool has been proved to be effective in increasing this ability. This is addressed by the results of the N-gain analysis in Table 1. Based on Table 1, the group learning to use GI-BL tool obtained an N-gain score of 65.98% for the experimental group. This shows that there is an increase in the science literacy skills of students. Garrison & Vaughan [27] revealed that the inquiry and blended learning models were able to increase students' learning satisfaction and were directly involved in scientific experiments. In addition, the N-gain score comparison between the experimental group and the control group is quite large with a difference of 40%. This shows that students' scientific literacy on magnetic matter is proved to be increased when they learn with learning tools which based on blended learning and guided inquiry. This learning tool helps students in analyzing any phenomena that exist in the concept of magnets. Hermansyah et al. [28] also revealed that learning with inquiry based on technology with virtual simulations stimulates students to be able to solve physics problems well.

Based on the research conducted, this science teaching material makes it easy for students to access the basic concepts of magnets. According to Yusuf et al. [29], abstract physics material can only be conveyed if the concept is assisted by online and offline based learning. In addition, there are various features in GIBL tools that allow students to more broadly seek for informations. The learning tool also provides opportunities for students to design their own inquiry processes. Thus, with the features of inquiry and scientific literacy in these learning tool, students are more structured in designing their ideas. Gunawan et al. [30] stated that inquiry-based learning tools were able to

improve students' science process skills so that it supported their literacy. The blended learning features in this learning tool also allow students to find as much information as possible, anytime and anywhere. This is in line with the opinion of Medina [31] that blended learning ensures flexibility in access to and use of knowledge and offers a combination of various patterns of social interaction that meet different needs and learning styles.

This GIBL tool allows students to find out as much as possible about the effectiveness and efficiency of the ideas they describe. With offline and online features in learning tool, it gives them the opportunity to ask questions and have good discussions with their teachers and friends at any time. Pektas & Gurel [32] also revealed that mixed learning allows students to access as much information as possible with guidance from their teachers. Blended learning also increases students' confidence in their ideas or solutions. This can happen because in terms of online and offline, they are given the opportunity to expand their ideas and prove them. This is in line with the results of research by Spring & Graham [33] which revealed that blended learning was able to improve the collaboration and communication of students, thereby increasing the quality of their ideas.

In addition, in magnetic matter there are many abstract concepts that can be well described in learning tool based on this blended learning. The concepts provided are not only in the form of explanations, but also some interesting questions and dialog boxes. This teaching material helps students to understand well about the magnetic material. In addition, students are not only asked to understand concepts, but to be able to creatively design their own ideas and be able to evaluate them. Hernani et al. [34] revealed that learning based on science and technology literacy requires students to be able to solve problems and be able to make the right decisions based on evidence and other important supporting considerations. It can be proven that students are able to make decisions in choosing a container based on considerations of the physical and chemical properties of the vinegar storage container and the vinegar solution itself. Kurnia & Fathurohman [35] also stated that scientific literacy is a very important thing for every individual to master because it is closely related to how a person can understand the environment and other problems faced by modern society which is very dependent on the development of science. and technology, including social problems.

Learning using GI-BL tool has succeeded in increasing students' scientific literacy in magnetic material. This learning tool can be used as a substitute for the learning tool which used in conventional learning to increase effectiveness and efficiency. Improvements also appear in each sub-material being taught. Based on the results presented in Figure 1, it can be seen that the experimental group outperformed the control group in each sub-material. While the highest gain was achieved by the experimental group in the Lorentz Force sub-material with a percentage of 80.This result is shown in Figure 1 below.
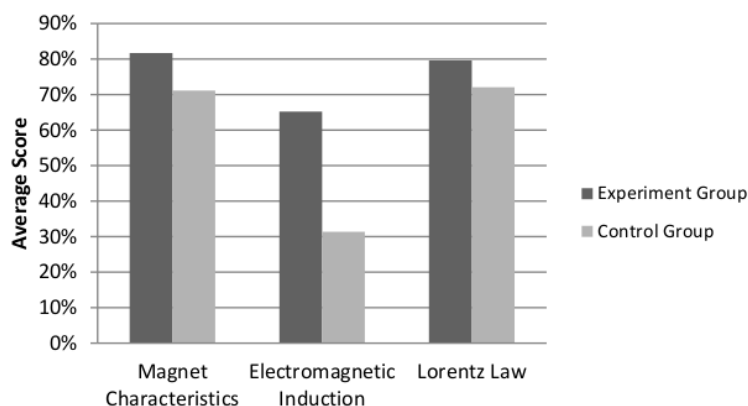

Figure 1. Comparison of Science Literacy Mean Scores

The results of the calculation of the percentage increase in scientific literacy for each indicator are presented in Figure 2. Figure 2 shows that the highest score of the average percentage score of scientific literacy was obtained by experimental group B with a total of 93%. The highest score obtained by students tends to be in the first indicator of scientific literacy which defines the phenomena scientifically. This learning tool helps students to understand well about the magnetic material. In addition, students are not only asked to understand concepts, but to be able to creatively design their own ideas and be able to evaluate them.
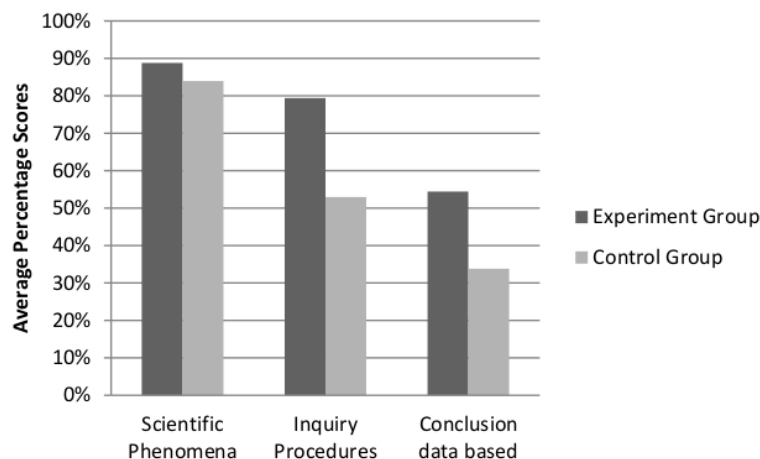
Figure 2 Percentage of Average Science Literacy Scores per-indicator

The results are in line with the results of Garrison & Vaughan [27] 's research on blended learning tools with an inquiry model which states that the combination of blended learning and guided inquiry has enormous potential to overcome a number of learning and teaching challenges facing schools. This is also in line with the results of research conducted by Herayanti et al. [36] which stated that blended learning with inquiry succeeded in improving students' problem solving abilities in physics material. Apart from blended and inquiry, according to Arohman et al. [18], scientific literacy that is integrated learning tool is directly correlated with building strong scientific ideas and attitudes so that students can effectively communicate knowledge and research results to the general public. Learning using GIBL tool has succeeded in increasing students' scientific literacy in magnetic material. This teaching material can be used as a substitute for the learning tool used in conventional learning to increase effectiveness and efficiency.

4. Conclusion

Based on the results of research and discussion of GI-BL tool, it can be concluded that this teaching material is very effective in learning science. In addition, this teaching material has succeeded in increasing students' scientific literacy in magnetic materials. This is indicated by the N-Gain score of 63% which is categorized as quite effective. This teaching material is very appropriate to be used for 21st century learning based on the results of expert validation regarding its relevance, readability, updating and presentation. This GI-BL tool can be used as an appropriate alternative in 21st century learning and the current state of education. This teaching material can be used by teachers and students anywhere and anytime because it is based on blended learning which can be accessed freely.

5. Acknowledgments

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