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Students' literacy profile on STEM-blended learning implementation in ecosystem material

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Abstract. This study aims to analyze the student literacy of students of Biology Education Department FMIPA Universitas Negeri Semarang in because of the implementation of blended learning base on STEM in Ecosystem material. This research method was quantitative research with an experimental approach using "One Shoot Case Study" design. The implementation of blended learning would consider to be successful if accomplished three aspects: (1) the implementation scenario runs well in accordance with the specified time allocation, (2) students reaches the moderate to a high level of technological literacy, (3) the implementation is successful with no severe obstacles while student response it positively. The results exposed that the middle of the second semester could accomplish the implementation of blended learning base on STEM in the Ecosystem material. This research shows that student science literacy has reached mastery learning, with AB (14%), B (72%), and BC (14%). Student technology literacy achieved very high scores. That was the highest one compared to other STEM components: science literacy and mathematics literacy. Student technology literacy ranges from 74.4 -93.5, with mastery learning. Students' mathematical literacy ranged from 42-76, with an average of 58.32, including the low category. Furthermore, most of the students expressed positively on the use of the Edmodo application, which contains an introduction and videos. The founded drawback was the technology used was still simple, and the steps in using technology tools in blended learning were incomplete.

1. Introduction

The industrial era 4.0 demands development in all sectors of life, including in the education sector. This is important to adapt to this era, and innovation is needed, especially for those who have direct contact with technology. The development of technology has various benefits and the main provision towards a modern society that has not been optimally utilized for the development of education.

Information and communication technology (ICT) tools such as cellphones, tablets, smartphones, and similar technologies are common in the community, but still not utilized to improve the quality of learning in schools. This was revealed by Husamah [1] that the development of ICT has not been utilized optimally in the learning process. Efforts to integrate ICT still lack so that the impact of ICT is less real.

The development research of the ecology mobile learning package based on Science Technology Engineering and Mathematics (STEM) has been carried out [2]. The results of the development are a learning package that is uploaded to Edmodo. These have been validated and have excellent validity and legibility. The problems are (1) In limited scale trials, its effectiveness has not been well tested; (2) One of the reasons based on students feedback that besides learning with an ecology mobile

learning package, face-to-face learning is still needed to understand better the concepts, principles, and facts of ecological material; and (3) Large-scale trials have not been conducted because the lecture period has ended in preparation for the final semester exams. Therefore, we need a learning model that combines "mobile learning" and direct learning (face to face), known as blended learning on a broader scope.

The term blended learning was originally used to describe subjects trying to combine face-to-face learning with online learning. Besides blended learning, other terms are often used, including blended learning and hybrid learning. The terms mentioned earlier contain the same meaning of integration, mixing, mixing, or learning combinations.

Blended learning is a learning model that combines or mixes face-to-face learning and computer-based learning (online and offline). Thorne [3] revealed that blended learning is a combination of multimedia technology, CD-ROM, video streaming, virtual classes, voicemail, e-mail and teleconferencing, and online text animation. All of this is combined with traditional forms of classroom training and individual training [1]. Blended learning is the right solution for the learning process that is suitable not only with the learning needs but also the learning styles of students. Blended learning as a learning model that combines or mixes face-to-face learning with computer-based learning (online and offline).

Blended learning has several objectives, including the following: (1) Helping students to develop better in the learning process in accordance with learning styles and preferences in learning. (2) Providing practical-realistic opportunities for teachers and students to learn independently, be useful, and continue to develop. (3) Increased scheduling flexibility for students by combining the best aspects of face-to-face and online learning. Components in blended learning are (1) Face-to-face Learning, (2) Offline E-learning, (3) Online E-learning, (4) Mobile Learning (M-learning).

The application of blended learning has been proven to be able to increase students' motivation in learning mathematics. This can be seen from the emergence of indicators of student motivation in class after doing blended learning. Students look enthusiastic, attentive, earnest in learning, and actively discuss and search for additional material via the internet [4]. This is in accordance with what was revealed by Sardiman [5] that in the learning process, motivation could be said to be the overall driving force in students that causes learning activities so that the desired goals of the learning subject can be achieved.

The advantages of blended learning when compared to face-to-face learning (conventional) and e-learning, both online, offline, and m-learning. Some of the advantages of blended learning are as follows: (1) Students are free to study the subject matter independently by utilizing the materials available online; (2) Students can hold discussions with the teacher or other students outside class hours; (3) Learning activities carried out by students outside face-to-face hours can be managed and controlled well by the teacher; (4) Teachers can add enrichment material through internet facilities; (5) The teacher can ask students to read the material or take a test done before learning; (6) Teachers can organize quizzes, provide feedback, and use test results effectively; (7) Students can share files with other students.

Besides having several advantages. Husamah [1] suggests that there are some disadvantages of blended learning including the following: (1) The media needed is very diverse, so it is difficult to apply if the facilities and infrastructure do not support; (2) Unequal facilities owned by students, such as computers and internet access; (3) Lack of knowledge of learning resources (students, teachers, and parents) on the use of technology. Blended learning caused various problems especially for teachers or instructors, including: (1) Teachers need to have skills in organizing e-learning; (2) The teacher needs to prepare a digital reference that can be a reference for students; (3) The teacher needs to design references that are appropriate or integrated face to face; (4) Teachers need to prepare time to manage internet-based learning, for example, to develop the material, develop assessment instruments, and answer questions raised by students [1].

Education curriculum in Indonesia is currently considered not able to shape the character to be ready to face global competition. For this reason, a science, STEM-based education method is needed.

STEM is a learning model that uses the approach of science and its application, coupled with active problem-based learning.

Each STEM aspect has special features that distinguish between the four aspects. Each of the aspects helps students solve problems far more comprehensively if integrated. The four characteristics are based on the definition described by Torlakson, namely: (1) science represents knowledge of laws and concepts that apply in life; (2) technology is a skill or a system used in managing society, organization, knowledge or designing and using an artificial tool that can facilitate work; (3) engineering is the knowledge to operate or design a procedure to solve a problem; and (4) mathematics is the science that connects quantities, numbers and spaces that only require logical arguments without or accompanied by empirical evidence. All these aspects can make knowledge more meaningful if integrated into the learning process. With the application of the STEM approach, literacy will increase, namely, scientific, technological, engineering, and mathematical literacy.

Literacy is the ability of students to apply knowledge and skills in a field, analyze, reason, and communicate effectively because students propose, solve, and interpret problems in various situations [6]. Education Development Center (EDC) states that literacy is more than the ability to read and write. But more than that, literacy is the ability of individuals to use all the potential and skills possessed in their lives. With the understanding that literacy includes the ability to read words and read the world.

The new definition of literacy shows a new paradigm in the effort to interpret literacy and learning. Now the expression of literacy has many variations, such as media literacy, computer literacy, scientific literacy, technological literacy, school literacy, and so forth. The nature of critical literacy in democratic societies is summarized in five verbs: understanding, engaging, using, analyzing, and transforming texts. All of them refer to competencies or abilities, which are more than just the ability to read and write [7-9]

Technology literacy in the world of education means students are actively involved in the technological process or learn to make the best use of technological results, not just limited to knowing. Utilization of this technology made students being able to train themselves, discover, and solve problems in everyday life. Technology literacy helps students stay active in the rapidly developing science and technology. With technology, the existence of information from all over the world can be universally known. Technology literacy is also useful for being more creative in completing tasks.

2. Methods

The study was conducted in the even semester of the 2018/2019 academic year. This research conducted in the Biology Study Program, Department of Biology FMIPA UNNES. This study uses an experimental design, one-shot case study method, by applying blended learning in STEM-based ecosystem material. Learning-related to the use of technology, delivered directly (offline) with the introduction of technology for measuring ecosystem abiotic factors, names, ways of use, and followed with the direct practice of their use in the Biology Laboratory environment. Online this activity was recorded in the form of videos uploaded on the Edmodo application

Learning outcomes in the form of technology literacy, are measured through skills tests in utilizing ecological tools with technology to measure ecosystem abiotic factors. Technical implementation of skills tests with a response system: students are faced with ecological measuring instruments, then within a certain time, can mention the name of the tool, function, and steps for its use. The results of the implementation of blended learning on technology literacy analyzed descriptively quantitatively. Blended learning is said to be effective if the scientific, technological, and mathematical literacy of students reaches mastery learning criteria.

3. Results and Discussion

Literacy of Biology Education Study Program students consisting of scientific literacy, technological literacy, and mathematical technology after STEM-based blended learning based on research results

can be explained as follows. Student's scientific literacy after implementing STEM-based blended learning can be seen in Figure 1.
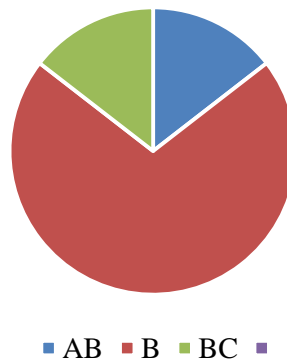

Figure 1. Student's scientific literacy on STEM-blended learning implementation

Student science literacy in 2019, both and skill science was better than in 2018. The increase in student scientific literacy in the ecosystem material is thought to be caused by the implementation of STEM-based blended learning in ecosystem material that combines online knowledge with face-to-face. STEM with elements contained in each learning process has been attempted to be included in the developed device.

Student science literacy is getting better because students are getting used to using e-learning applications. This is in accordance with the statement of Lee *et al.* [10] that there is currently an effort to develop mobile device-based learning content that is widely accessible, with better scientific content. Most of the content circulating on the market is still dominated by entertainment content that has a lack of educational aspects. Science literacy is a skill needed by students in the current era of globalization. Haug [11] stated that developing students' scientific literacy skills aims to increase scientific knowledge and inquiry, oral and written vocabulary needed to understand and communicate in science, as well as the relationship between science, technology and mathematics.

Student technology and engineering literacy on the implementation of STEM-based blended learning, was obtained from the practice of introducing tools and their response score. Among other literacies, this literacy score is the best (Table 1).

Table 1. Student technology and engineering Literacy

No	Description of ecology technology literacy	Practice report	Response Tools	Final score
1.	Highest score	92.5	97	93.5
2.	Lowest score	64.5	59	74.4
3	Mastery learning			100%

Based on the Table 1, it can be stated that the implementation of STEM-based blended learning is effective against student literacy, as indicated by 100% of students have achieved mastery learning (85% of students achieving score> 71). This is expected with blended learning, students are more free to study the subject matter independently by utilizing the materials available online by viewing videos uploaded on the Edmodo. In face-to-face learning, students face real objects, so students do activities using all five senses (seeing, touching) to understand and applying technological tools, so learning is more meaningful. According to Edgar Dale's triangle theory, if all the senses are involved in learning, by the more tangible objects, the more meaningful understanding of students is. This is in accordance with the opinion of Torlakson [12] that technology training skills (technology literacy) use an artificial tool that can facilitate work.

The results of the studies above are better when compared with the research of Ngabekti *et al*. [2]. Technology and engineering literacy can be seen from the results of the response to the introduction of ecological tools technology and the steps in their use. The responsiveness test results obtained the lowest score of 38 and the highest of 88, with an average of 70.32. This result is quite good, although not optimal. This is alleged because students carry out the use of technological tools in groups because of the lack of tools available.

Blended learning with the STEM approach facilitates the emergence of scientific, technology, engineering, and mathematics literacy. Gonzalez & Kuenzi [13] found that STEM has the meaning of teaching and learning related to the fields of Science, Technology, Engineering, and Mathematics. The STEM approach is suitable to be applied not only in primary and secondary education levels but can also be implemented up to college level and even postdoctoral levels. Bybee [14] states that character in STEM learning is the ability of students to recognize a concept or knowledge in a case. As in learning physics, STEM helps students to use technology and compile an experiment that can prove a law or scientific concept.

Technology to use tools that are still simple is even more complicated than modern technology. For example, to measure dissolved oxygen, a simple technology uses the Winkler titration method. In this method, students must know the types of chemical reagents used, the volume of use, the steps of their use, and count the number of titrants used to be calibrated to the specified dissolved oxygen levels. Students also know the chemical reaction to every step. If using digital technology like a DO meter, students just need to enter the device in the water, push the button, wait a minute, then the result will appear. Student mathematical literacy after the application of STEM-based blended learning can be seen in Table 2.

Table 2. Student mathematical literacy on STEM-based blended learning

No	Description	Literation mathematic score	Practicum report score
1.	Student number	63	63
2.	Mean	58.92	84.27
3.	Highest score	76	86.28
4.	Lowest score	42	75.1
5.	Standard Deviation	7.9	1.99

The results showed that students' mathematical literacy ranged from 42-76, with an average of 58.32, including the low category. This student's mathematical literacy is among the lowest among science and technology/engineering literacy, which is a component of STEM. If correlated with the value of the practicum report with mathematical literacy, a correlation coefficient (r) of 0.75 is obtained. Calculation of the coefficient of determination obtained a value of 56%, meaning that the contribution of the practicum report to mathematics literacy was 56%, while other factors influenced 46 %. The low mathematical literacy of students is thought to be caused by several things. First, most students (80%) enter biology majors to avoid mathematics. Among other natural sciences, biology does use the least mathematics. The second factor, students work on group practicum reports and how to make reports divided. Some write literature, tools and materials, work methods, results, and data analysis separately. Students are also reluctant to read the whole practicum report. So when tested, the data and analysis become difficult. These three things are included in students' personal or internal factors.

According to Masjaya and Wardono [15], three determinant factors cause low mathematical literacy, namely personal, instructional, and environmental factors. While the Ministry of Education and Culture's Ministry of Education and Research Assessment Center states that there are a number of variables that can be determinants of student literacy. In general, these factors can be grouped into two categories, namely, factors within students (internal) and factors outside of students (external factors). Internal factors can be sorted into cognitive aspects such as intellectual abilities, numerical abilities,

and verbal abilities, and non-cognitive aspects such as interests and motivation. The external factors include the family environment, the school environment, as well as the mass media environment, and the social environment [16].

Walberg (1992) and Wilkin, Zembilas, & Travers (2002), as quoted by Umar and Miftahuddin [17], identify three groups of personal variables that influence not only learning achievement, but also aspects of students' affective development and behavior, namely: (a) personal variables such as previous achievement, age, motivation, self-concept, (b) instructional variables such as intensity, quality, and teaching methods, and (c) environmental variables such as the situation at home, the condition of the teacher, class, school, study partners, and the media study.

The influence of instructional factors, the results of Simanjuntak's research [18] revealed that the teacher's ability to carry out learning made a positive contribution to student mathematics learning outcomes. Therefore, in this study, grouped variables which are theoretically a determinant of student achievement literacy. As a learning outcome variable, mathematical literacy is analyzed in relation to related variables (personal variables, instructional variables, and environmental variables), which are the responses of students, teachers, and schools. There are three main causes why the mathematics literacy index of students in Indonesia is shallow: the weakness of the curriculum in Indonesia, the lack of trained Indonesian teachers, and the lack of support from the environment and schools. The mathematics education curriculum in the country has not emphasized problem-solving, but rather procedural matters. Students are trained to memorize formulas but lack mastering their application in solving a problem. In addition, the subject matter provided by the teacher is also incomplete when compared to the international curriculum [19].

One other thing is the lack of use of calculators by Indonesian students. Abroad, students do not need to memorize the formula because it is already provided in front of the class. In contrast, in Indonesia, students are emphasized to memorize formulas and are often prohibited from using calculators in working on problems. Overseas students are also accustomed to using a calculator because that is just a tool in solving problems. Of course, for easy problems, they count manually. But if the questions given are difficult, then the use of a calculator is allowed because the teacher wants to encourage students' ability to solve problems, "

Meanwhile, in terms of teachers, the lack of educational qualifications is considered to have contributed to the drop in the Indonesian Mathematics literacy rank. Another factor is the lack of training and guidance on writing scientific papers for teachers. Even if there is training, control about dissemination or application of the results of the training in the classroom is still lacking.

Based on the description above, it can be stated that multifactor strongly influence the low mathematics literacy of Biology Education students above. However, based on student responses related to the application of STEM-based blended learning in ecosystem materials such as face-to-face learning is more communicative than blended learning. Blended learning can be done sometimes, especially if the material is related to quantitative data calculation and analysis.

4. Conclusion

Based on the results of research and discussion, it can be concluded that the implementation of STEM-based blended learning in ecosystem materials can improve student technology literacy, but low mathematics literacy. Although the response of students for this kind of learning is very good, if they can choose, students prefer to learn directly. application of STEM-based blended learning in ecosystem materials such as face-to-face learning is more communicative than blended learning. Blended learning can be done sometimes, especially if the material is related to quantitative data calculation and analysis.

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