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Mathematics Literacy Based on The Self-Regulated Learning on Problem-Based Learning Assisted with Electronic Module

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Abstract

Mathematics literacy and self-regulated learning have important roles for individuals to make decisions and solve problems in life. This research describes the learners' mathematics literacy of the learners based on self-regulated learning by implementing problem-based learning assisted with an electronic module. The research subjects consisted of the 20 tenth graders of TOKR 1, in the academic year of 2022/2023. The researchers collected the data with a test method, questionnaire, observation, documentation, and interview. The results showed the mathematics literacy test achievement, TL M of the learners, based on the learning self-directedness with problem-based learning and the assistance of various electronic modules. The mathematics literacy based on the learning self-directedness showed that the learners had high TLM and learning self-directedness to understand and master six indicators; the learners with moderate TLM and learning self-directedness could master four indicators; and the learners with low TLM and self-directedness could only master two indicators.

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INTRODUCTION

Sundayana (2015) explains that science and technology development occurs rapidly and influences all life aspects. Technology is important to obtain, manage, and use science and technology proportionally. This matter requires systematic, logical, and critical thought to develop by improving the educational quality. Mathematics is important to improve critical, systematic, logical, creative, and collaborative thinking effectively. Mathematics significantly influences the science and mathematics development. The implication is - new inventions in the future (Hamzah, 2014).

Mathematics becomes the content of the Program for International Assessment, PISA. PISA is a literacy study to regularly asses learners aged 15 years old in terms of reading literacy, mathematics literacy, and science literacy. PISA's questions are associated with literacy and demand the learners to reason and solve problems by applying various problems from various daily life situations. The PISA results in 2018 found that Indonesia was ranked 74 out of 79 countries (OECD, 2019). The result shows that mathematics literacy is still low.

Mathematics literacy, based on PISA, must focus on analyzing, reasoning, sharing ideas effectively, formulating, solving, and interpreting mathematics problems with various contents, such as (1) space and shape, (2) quantity, (3) change of relationship, and (4) uncertainly. Mathematics literacy refers to individual skills in formulating, applying, and interpreting mathematics in various contexts. This matter covers mathematics reasoning and implementations of concepts, procedures, facts, and mathematics tools to describe, explain, and predict certain phenomena (OECD, 2019). Besides that, mathematics literacy could realize individuals' decisions based on constructive mathematics thinking patterns (Masjaya et al., 2018).

One of the national education objectives is to realize learning self-directedness. Lestari (2016) explains that mathematics learning is important to developing the learners' attitudes and habits, the self-directed learning (Lestari, 2016). Self-directed learning refers to personal independence or reliance to accomplish tasks (Daryanto, 2014). Bandura, cited in Sumarmo et al. (2017), defines self-directed learning or self-regulated learning as a personal behavior monitoring the realization of individual hard work.

One of the solutions is - to improve mathematics literacy and self-directed learning by applying a learning model. In this case, the applicable learning model is problem-based learning to improve critical thinking, trigger initiation in working, motivation of learning, and establishment of inter-group cooperation (Amalia, 2021). Problem-based learning is applicable with the assistance of supportive learning media, a tool to convey messages for better learning activities (Sundayana, 2015). In this case, an applicable learning medium is a module. A module provides relevant teaching materials based on the curriculum demands by considering the learners' necessities, such as the relevant teaching materials based on the teaching material and learner characteristics, and the relevance with the social environmental background (Hamdani, 2011). An electronic module is an effort to present the self-regulated learning materials systematically in the form of a lesson unit. This module is useful to reach a certain learning objective. The realization of this electronic module applies electronic format (Sugianto, 2013).

This research describes the learners' mathematics literacy based on self-regulated learning with problem-based learning assisted with an electronic module.

METHOD

The researchers promoted this research at Public Vocational High School 4 Kuningan. This descriptive research applied a qualitative approach. The samples were 20 tenth graders of TOKR 1 in the academic year 2022/2023. The researchers took the samples with a purposive sampling technique. The researchers took the subjects based on the mathematics literacy test results and self-regulated learning questionnaire. Table 1 shows the research subject selection criteria.

Table 1. The Research Subject Selection Criteria

The Interval	Categories
$x < \bar{x} - s$	Low
$\bar{x} - s \leq x \leq \bar{x} + s$	Moderate
$x > \bar{x} + s$	High

Remarks:

$\bar{x}$: the mean scores

s: the standard of deviations

x: the obtained scores

The researchers obtained the data about self-regulated learning from the questionnaire while the mathematics literacy from the mathematics literacy test, TLM.

The researchers reduced, displayed, triangulated, interpreted, and concluded the data. Then, the researchers checked the data validity with credibility, transferability, reliability, and confirmatory tests (Sugiono, 2017). The researchers checked the credibility with methodological and source triangulations. Then, the researchers examined the transferability by describing the mathematics literacy of the learners in terms of problem-based learning with the assistance of an electronic module systematically and comprehensively. The researchers checked the reliability by taking the learners' data about self-regulated learning and mathematics literacy patterns. Then, the researcher confirmed the results by associating the research results and the available theory. Then, the researchers also confirmed the research results with experts or supervisors.

RESULTS AND DISCUSSIONS

The researchers used three instruments, such as the questionnaire of learners' self-regulated learning, the mathematics literacy test, and the interview to obtain the mathematics literacy skill and self-regulated learning descriptions. Then, the researchers arranged the questionnaire to identify the learners' self-regulated learning. The test was a written test to identify the learners' mathematics literacy based on the indicators. The researchers interviewed the research subjects to ensure the identification results of the self-regulated learning and the mathematics literacy of the learners.

The researchers described literacy based on three categories of self-regulated learning, such as high, moderate, and low. The applied indicators were seven: communication, mathematizing, representation, reasoning, and argument, devising strategies for solving problems, using symbolic, formal, and technical language and operation, and using mathematics tools. the researchers found 4 learners with high self-regulated learning category, 12 learners with moderate self-regulated learning, and 4 learners with low self-regulated learning. Then, the researchers chose two learners from each category as the qualitative subjects for further literacy descriptions.

The researchers found some mathematics literacy components with excellent mastery, such as representing; using symbolic, format, and technical language and operation, and using mathematics tools.

Learners with moderate self-regulated learning could perform excellent mathematics literacy. From the seven measured components, the researchers found two components with extremely excellent mastery: reasoning and argument; and devising strategies to solve problems. Four components with excellent mastery were communication, mathematizing, representation, using symbolic, formal, and technical language and operation. Then, the researchers only found a mathematics literacy component with average mastery: using mathematics tools. The learners encountered various problems and hindrances while performing the indicators, such as carelessness while calculating or using the symbols. The most significant hindrance occurred since the learners could not understand the concept of verbal problem conversion into a correct mathematics model.

Learners with low self-regulated learning had low mathematics literacy. The learners could only master one component: using symbolic, formal, and technical language and operation. On the other hand, the learners could not perform excellently in communication, mathematizing, representation, reasoning and argument, and devising strategies for solving problems. using mathematics tools. The most observable hindrances from those six components were low self-regulated learning, inadequate conceptual understanding, and inadequate strategy management to solve the problems. Besides that, the learners could not illustrate the given information with proper mathematical tool skills.

Learners with low mathematics literacy require problem-solving habituation with various mathematics literacy questions variety. Sugiman & Kusumah (2010) explain that problem-solving comprehension requires real problems as the trigger to promote the mathematization process and to develop the mathematics form. PISA, cited in Wardani et al. (2011), recommends teachers improve the school learning process as the indicators of mathematics literacy by improving the reasoning portion, problem-solving, argumentation, and communication.

The indicator of communication for learners with high self-regulated learning is - the capability of interpreting the question and relevant statement based on the given problems. On the other hand, learners with moderate self-regulated learning could interpret the questions and the statements based on the given

problems correctly. However, they could not completely write the given items and could not solve the problems accurately. Learners with low self-regulated learning could averagely interpret the relevant questions and statements with the problems. However, they committed many mistakes that hindered the problem-solving process.

The current research results are in line with the previous studies about PBL to solve problems. Previous studies, from various educational levels, found that PBL could develop the learners' mathematics communication so they could use their mathematics ideas, understand mathematics problem-solving, and express the ideas and solutions in writing or spoken modes (Riasari, 2018; Rizqi, 2016).

The indicator of mathematizing refers to highly self-regulated learning with the capability of creating a mathematics model and interpreting the model into real problems completely. On the other hand, learners with moderate self-regulated learning could make excellent mathematics models although they could not smoothly reinterpret the model into the original problems. Learners with low self-regulated learning could averagely make the mathematics model but they could not interpret the mathematics model into the original problems.

Based on the indicator of representation, the learners with high and moderate self-regulated learning could illustrate the problems verbally with adequate mathematics models. On the other hand, learners with low self-regulated learning could not illustrate the problems verbally with the mathematics model because they could not understand the given and the questioned information.

Based on the indicator of reasoning and argument, learners with high self-regulated learning and excellent reasoning skills could explore and associate the elements and make conclusions. However, learners with low self-regulated learning could not reason the problems properly and solve their problems. They committed some mistakes while calculating. This problem made the learners could not conclude accurately. Faiz et al (2019) found that high self-regulated learning led to high achievement. Mathematics reasoning becomes the factor of mathematics learning success.

Based on the indicator of devising a strategy to solve problems, learners with high and moderate self-regulated learning could design the strategy and solve problems orderly. They could also solve the problems accurately and carefully. On the other hand, learners with low self-regulated learning could not design a strategy to solve problems orderly and correctly. Nurvicalesti (2019) found some learners with high self-regulated learning categories could not design the problem-solving design because they were not habituated to mathematics literacy problems. Novalia & Rochmad (2017) also found that learners with high mathematics literacy were habituated to problems with concrete and procedural answers.

Based on the indicator of using symbolic, formal, and technical language and operation, the researchers found the learners could perform excellent formal and symbolic language and operation. Learners with moderate self-regulated learning could use symbols and formal language but they could not operate the simplification technique. Learners with low self-regulated learning could use the relevant symbols with the given questions.

Based on the indicator of using mathematics tools, the learners with high self-regulated learning could use the mathematics tools correctly and accurately. On the other hand, learners with moderate self-regulated learning could only use rulers as mathematics tools. Learners with low self-regulated learning could not utilize the mathematics tools to create illustrated tables based on the problems.

The researchers also found that self-regulated learning did not always master some mathematics literacy but most mathematics literacy. Thus, the learners should receive some learning model support to accommodate their learning, such as problem-based learning assisted with electronic modules. The learners could explore mathematics literacy from the teaching materials on the electronic module and problem-solving activities. Learners with self-regulated learning had some characteristics, such as (1) having a more structured learning program, (2) having a preference for joining learning problems with the provision of teaching materials and clear learning mechanism, and (3) having an incapability to promote self-evaluation (Rusman, 2018).

From 20 learners as the subjects, the researchers found that mathematics literacy based on self-regulated learning was varied. Some learners with the same self-regulated learning and mathematics literacy had different mathematics literacy patterns.

CONCLUSION

Based on the analysis and the discussion, the researchers found that the learners' mathematics literacy based on self-regulated learning with problem-based learning and electronic module assistance was varied. The achievements of the subjects based on the highest TLM result were - learners with high self-regulated learning. The learners could understand and master six indicators excellently. The researchers also found learners with moderate TLM results and moderate self-regulated learning. The subjects could understand and master four indicators excellently. The last result was - learners with low TLM results and low self-regulated learning. The subjects could only understand and master two indicators excellently. The researchers did not find learners with high TLM but low self-regulated learning or vice versa.

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