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The Mathematical Literacy of Vocational Students in Discovery Learning Using E-Worksheet

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Abstract

The aim of this study was to find out the level of mathematics literacy skills of vocational students in discovery learning using e-worksheets. The research method used is a mix method with a research focus on the mathematical literacy skills of vocational high school students specifically in spatial abilities of geometric transformation material in discovery learning with e-worksheet assisted product assessment. The subjects of this study were students of XI class of Automation and Office Management of SMK Negeri 1 Demak. The qualitative data analysis was carried out by analyzing mathematical literacy skills in terms of students' spatial abilities. The quantitative data were tested by using the One Sample t-test, Paired Sample t-test, and Independent Sample t-test. The results showed that e-worksheet using discovery learning was able to develop students 'mathematical literacy abilities, gave positive responses to students. This study also found that students' spatial abilities would be relevant to their level of mathematical literacy skills.

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INTRODUCTION

United Nations Educational, Scientific, and Cultural Organization (UNESCO) uses the slogan "Literacy for all". Every human being has the right to be "literate" because by literating humans make individuals, families, and communities more empowered in improving their quality of life (UNESCO, 2014). The mathematical literacy is an individual's ability to formulate, use, and interpret mathematics in various contexts. This includes mathematical reasoning and using mathematical concepts, procedures, facts, and tools in explaining and predicting phenomena. This helps individuals recognize a role that mathematics is useful in life and make good decisions that are needed by individuals (OECD, 2013).

The mathematics literacy ability of Indonesian students at PISA 2012 shows that Indonesian students are at the level under 2 with an achievement of 75,7%. This percentage is the highest of the 66 participating countries, but for PISA questions level 5-6 it only reaches 0.3%. This data shows that most Indonesian students are only able to interpret and recognize situations in contexts that require direct inference, sort relevant information from a single source and use a single representation method, work on basic algorithms, use formulas, carry out simple procedures or conventions (OECD, 2013). The factor causing the low mathematical literacy skills of Indonesian students at the international level is they are not used to solve mathematical problems with characteristics such as PISA and TIMSS questions because there is still a lack of math teachers who provide math problems with contextual substance, demanding reasoning, argumentation and creativity in solving them (Wardhani and Rumiyati, 2011).

Data on students' spatial abilities and mathematics scores in learning geometry transformation material at SMK Negeri 1 Demak from two classes of Office Administration expertise package (Automation and Office Management / OTKP) is still not satisfactory. The results of daily tests of the transformation geometry material show that the average learning outcome of each material is still below the specified minimum completeness criterion (KKM), it is 65. The average learning outcome on translation material reaches 62. Although the average is the most high compared to other materials, but the average is still below the KKM. The next study result was dilatation with an average is 56, reflection material is 45 and rotation is 43. Among the four materials, the most difficult ones were related to reflection and rotation. Based on interviews with several students, the answer was that students tend to find it difficult because they have to remember many reflection and rotation formulas; moreover, they have to remember the matrix that corresponds to the desired reflection or rotation.

Some of the factors that cause students' low mathematical literacy skills include during the mathematics learning process, the emphasis is mostly on cognitive aspects and final results. The discovery process, reasoning, the ability to solve problems does not get maximum attention and encouragement.

Improving the process of learning mathematics in schools, especially at the level of the portion of reasoning, problem solving, argumentation, and communication can be done through the discovery process. The learning process with discovery encourages students to be really active in discovering themselves or through a process of mentoring so that it is as if students find mathematical concepts, rules and formulas. Through this learning, new things for students are expected to be found in the form of concepts, theorems, formulas, patterns, rules and the like using their own understanding (Mawaddah & Maryanti, 2016: 76). This discovery process is also called discovery learning. In discovery learning, the teacher prepares a problem for students to investigate, and provides procedures and resources, but does not tell them about the expected results (Song and Looi, 2012: 131).

The discovery learning process is one part of the constructivism approach. Amineh & Asl (2015) stated that in a constructivist classroom, teachers admit that students will build their areas of understanding from various context-based interactions from different perspectives and experiences. This learning activity makes learning meaningful (Buyung & Nirawati, 2018). With the constructivist class provokes the empowerment of students' knowledge within them, sharing strategies

and solutions, critical thinking about the best way to solve each problem in order to gain new knowledge.

Discovery learning in Queensland Australia shows that teachers help direct students to predict their thinking structures through the discovery process, where in their learning the teacher plays a role in encouraging students to predict solutions, take action (sense-making), self-monitoring and make conclusions (Goos, 2004). Other research states that during discovery learning, it requires special attention from teachers to students and it is necessary to emphasize authentic problems and reflect collaboratively with students Menezes, et.al. (2012). Discovery learning is also able to train students' mathematical literacy skills (Sari, 2020).

The discovery process is supported by the method of assessing daily student learning outcomes in class where test questions / exams should measure standard technical skills, reasoning abilities, problem solving and communication are given in a balanced manner. It is not only the examination; the authentic assessment is needed to provide an overview of student learning development. Product Assessment is one of the authentic assessments where students make a work that is appropiate with the competencies being studied (Masrukan, 2014). The product assessment is often used for students in vocational high schools, especially productive subjects, although it can be applied in other subjects according to the characteristics and needs of these subjects. On the other hand, E-Worksheet is used as a practice tool for students in this study. This e-worksheet is a worksheet used to help students build internet-based geometric transformation concepts that can be opened via an android, laptop or computer.

The purpose of this study was to find the level of students' mathematical literacy skills that is evaluated from students' spatial abilities in discovery learning assisted by product assessment and assisted by E-Worksheets.

METHOD

This research approach uses a mix-method approach that is a combination or combination of quantitative and qualitative research concurrently. This research was conducted at SMK Negeri 1 Demak with the population in this study were students of class XI. Two classes were randomly taken as the samples that were divided into experimental groups, called Discovery Learning using E-Worksheets and a control group, called Discovery Learning. The research subjects explored their mathematical literacy abilities in terms of spatial abilities in discovery learning using E-Worksheets by taking several students who represented spatial ability levels. There are two students from high, medium, and low spatial abilities. The characteristics explored were students who were not quiet, open; so it was easy to conduct interviews.

The data were collected using an instrument of mathematical literacy ability tests, a test of the students' spatial abilities, observation sheets, interviews, and documentation. The data were analyzed quantitatively and qualitatively. Thus, the validity of the data was obtained from the triangulation process of data sources.

RESULTS AND DISCUSSIONS

The Mathematical Literacy Skills of Vocational Students

The conditions of the mathematics literacy skills of students of SMK Negeri 1 Demak in pre and post discovery learning learning using e-worksheets are shown in table 1 below.

Table 1. The Mathematical Literacy Skills of Vocational Students

No	Information	*Discovery Learning* using E-Worksheet		*Discovery Learning*	
		Pre	Post	Pre	Post
1	The Amount of Students	36	36	35	35
2	Average	38.97	77.75	39.91	71.29
3	Deviation	9.92	90.48	9.18	81.26
4	Variant	98.31	9.51	84.26	9.01
5	Maximum	53	97	59	88
6	Minimum	19	53	22	50

Based on table 1, it is clear that discovery learning using e-worksheets can improve the mathematics literacy skills of vocational students.

The results showed that the average achievement of students' literacy skills in the indicator 1 which is a level 1 question, namely determining the number pairs of an object's shift in the experimental group has reached 93,8 with 83% of students answering correctly, while in the control group it reaches 91,4 with 77% of students answering correctly. At level 2, which is represented by indicators 2 and 3, the ability of students to determine translation results and determine the results of reflection, it shows that the average literacy ability achievement in the experimental group is 88,6 with 65% of students answering correctly, while in the control group it reaches 83,9 with 57% of students answering correctly.

Indicator 4, which is drawing on the Cartesian coordinates of the object's position and image, which is level 3 literacy ability, gives an idea that the average literacy ability achievement in the experimental group reached 82,6 with 60% of students having answered correctly, while in the control group it reached 77,9 with 49% of students answering correctly. The indicator number 5, which is level 4 literacy, is that students can determine the center of rotation, the size and direction of rotation of an object being rotated, which shows the average achievement of 79.9 with 43% of students answering correctly in the experimental group. Whereas, in the control group the average was 75,7 with 34% of students answering correctly.

The average mathematical literacy ability for level 5 which is represented by indicator number 6. It is about determining the rotation result of the rotation of an object; besides, indicator number 7 about drawing the dilatation result of an object in the experimental class is 72,9 with 36% of students who answered correctly, whereas in the control class the average literacy ability was 58,2 with 4% of students who answered correctly.

Indicator number 8 is using a scale factor which is a comparison of the dilatation results of an object which is the ability at level 6 to illustrate that the average literacy ability in the experimental group is 43,1 with 3% of students who answer correctly in the experimental group the average. The average literacy ability for level 6 is 40,7 but none of the students answered correctly.

In general, the post-test results of students' mathematical literacy skills in discovery learning using e-worksheets and product assessments for the experimental class and discovery learning with performance appraisals in the control class in terms of each literacy ability level can be presented in the diagram in Figure 1 below.

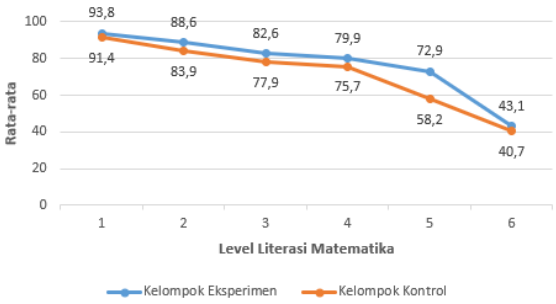

Figure 1. The Avergae of Mathematical Literacy Skill

Figure 1 shows that the average of mathematical literacy skill in the two groups is same relatively at problem solving level 1, 2, 3, and 4. When they have done the question number 5 and 6 the average is quite sharp; however, it is seen that a sharper decreasing that is shown by the control group compared to the experimental group.

Several important findings related to the learning process and student activities in learning are summarized in 2 important research findings.

1) First, the stimulation stage.

The teacher provokes students by providing stimulation in the form of contextual examples that students often encounter in their daily lives, especially related to their current major. For reflection material, Office Administration students are prepared to master their work later both in terms of performance and job content. In terms of performance, office vocational students are expected to appear good, attractive, and polite. Starting from here, the teacher provides stimulation for reflection material with their habit of reflecting. During the learning process, the students were also asked to think about the content of the work they would do, such as editing a logo or company office header. These students were provoked to associate header and logo editing activities such as enlarging or reducing them with the

content of math material, namely dilation. Seeing the usefuless of the mathematical content in their later work, these students seemed enthusiastic and enthusiastic in learning each material. The teacher's performance in using stimulation at the beginning of learning is very relevant to the job prospects of vocational school students later; this has led to the development of mathematical literacy skills of the Office Administration students. As mentioned by the OECD (2013), they mathematical literacy skills prepare each individual to be ready to solve problems in their work.

2) Second, the collecting and data processing stages

At this stage, the teacher becomes a companion facilitator and student guide in collecting data, analyzing data and group discussions as well as class discussions. Meanwhile, students use initial knowledge from stimulation and inducement questions from the teacher, students discuss to build new knowledge collecting and analyzing data related to this geometric transformation material. The teacher's performance in this activity is in the good category, it can be seen that the scores on the observation sheet are in the 3-5 range. The role of the teacher in this study is in accordance with the role of the teacher in discovery learning where it provides the opportunity for students to collect as much relevant information as possible to prove whether their expectations are true or not and assist students in processing data and information (Kemdikbud, 2014: 45).

Students' activities during learning activities using discovery learning also increased at each meeting and were always in the high or good category. This is indicated by the increasing number of students who are directly involved in discussions, both group discussions and class discussions are shown by the increasing average score of student activity observations in each meeting.

E-worksheets as a complement to their student activities make students more challenged to carry out learning activities as shown by student responses related to e-worksheets that are considered to help understand the material shows 82,2 in the high category. This is in accordance with the words of Barana and Marchisio (2016), with e-learning students can access learning resources and activities at the pace according to the wishes of students according to student needs.

The activity of making and assessing products is also one of the factors that makes students more challenged to collectively present an attractive product, for example a simple batik design that involves a geometric transformation process in the image. The experience in making this product makes students deeper into the concepts related to geometric transformation material. This is reflected in the student response that the product assignment is very helpful in understanding the material with a response score of 78.9 in the high category. As Ulya (2012); Rahayu (2016) states that product assessment is used to increase creativity and attract students' interest so that it provides a good learning experience.

In short, the whole discovery learning using e-worksheets with applied product assessments has a good quality learning process.

The Mathematical Literacy Skill in terms of Spatial Skill

There are six research subjects consisting of 2 researches subjects of high category of spatial skill; it is E-04 and E-13. Besides, 2 researches subjects of medium category in spatial skill in E-18 and E-28, and 2 research subjects of low category spatial skill in E- 02 and E-23. Based on the results of solving mathematical literacy skills and interviews, it can be analyzed mathematical literacy skills in terms of students' spatial abilities.

The pretest results show that in general mathematical literacy skills are still at level 1 and 2. This is understandable because students are not familiar with PISA questions as Susanti & Syam (2017) stated that the ability of students in Indonesia tends to be at level 2.

Level 1 shows that students can answer questions in a common and known context. The aal relevant information is available with clear questions, identify information and complete routine procedures according to explicit instructions, and take actions according to the stimulus given. Whereas at level 2 students can interpret and recognize situations in contexts that require direct inference, sort relevant information from a single source and use a single representation, work on basic algorithms, use formulas, carry out basic procedures or provisions,

and provide direct reasons and do literal interpretation. (OECD, 2013).

In addition, students at high spatial skill levels do not show a tendency to be able to master high levels of literacy, this is also in accordance with Verdine, et.al (2017) which states that *visuospatial* ability does not relate with mathematics achievement at the beginning of the class, but can predict mathematics achievement at the end of class.

Post-test results after learning showed an increase in mathematical literacy skills and the most students are able to solve mathematical literacy problems at levels 1, 2, 3, and 4. Some students are able to solve mathematical literacy problems at levels 5 and 6.

The E-04 students who are high spatial skill after participating in discovery learning using e-workhseet with product assessment can reach level 6 mathematical literacy. Although the seventh problems have few errors due to inadequate in reading of the problems. This shows that students can conceptualize and generalize by using information based on modeling and review in a complex situation. As in problem 8, the questions are not explicitly asked. This student is able to translate what was asked by taking advantage of the change in size on the ordered photo. These students are able to connect different sources of information flexibly and translate them, like think and reason mathematically. Operationally, these students are able to apply their understanding in depth accompanied by technical mastery of mathematical operations, formulate and communicate what is found and are even able to interpret and argue well (OECD, 2013).

The E-13 students who have high spatial skill are able to achieve level 5 mathematical literacy very well. The student is also able to reach level 6 but not perfect because it is less able to apply a deep understanding of mathematics that are shown by the absence of the relationship between changes in the size of a shape and changes in area. E-18 students with moderate spatial abilities are able to achieve literacy level 5 well. At level 6 literacy, students are less able to solve problems because they are less able to apply the deep understanding of mathematics as indicated by the absence of the relationship between changes in the size of a flat shape and changes in area.

The two students indicated that the high spatial ability factor could affect mathematical literacy skills after learning. As research states that one's spatial abilities can have an impact on mathematics learning achievement (Tambunan, 2018). This is also reinforced by research that has been held by Khoir (2019) which states that students with high visual-spatial intelligence tend to be able to complete all indicators of mathematical literacy.

The E-28 students who are students in the medium spatial skill category who has been able to achieve literacy level 4 well. These students can work effectively with the model in concrete but it is complex situations can be obstacles or assumptions. At level 5, students have not been able to work using broad thinking and reasoning, and correctly connect their mathematical knowledge and skills in the situsation faced. This is indicated by the students who have not shown the relationship between arc length that is the path or distance traveled by rotated ships avoids reefs.

The E-23 students who are students in the low spatial skill category, has been able to reach literacy level 4. These students can work effectively with models in concrete but complex situations where there are obstacles or assumptions; while, the E-02 students in the low spatial ability category were only able to reach the level 3 literacy.

Based on the descriptions of the six students with various levels of spatial skill, it can be stated that students with high spatial skills achieve an increase to levels 5 and 6. In students with moderate spatial skill, it has increased to levels 4 and 5, while those who are in low spatial skill have increase to level 3 and 4. Based on these findings, it seems that students' spatial skills have a significant influence on mathematical literacy skills in learning. It is with literacy skills reviewed in '*space and shape'* content and '*change and relationship'* with Geometry Transformation material. This is in line with Xie, et.al (2020) which states that the relationship between spatial ability and mathematical ability in the geometric domain has a strong enough relationship.

The Responses of Vocational School Students to Discovery Learning Using E-Worksheets

The responses of students to discovery learning using e-worksheet by assessing product can be seen at the result of questionnaire that is shown in the table 2.

Table 2. The responses of Students to Discovery Learning Using E-Worksheet

Interval	Criteria	Frequency	Percentage
20 ≤ % score ≤ 36	Very Low	0	0
36 < %score ≤ 52	Low	0	0
52 < %score ≤ 68	Adequate	5	13.9%
68 < %score ≤ 84	High	22	61.1%
84 < %score ≤ 100	Very High	9	25.0%
Total		36	100 %

Table 2 shows that most of students (61,1%) give the high response, the others give the high response (25%) and adequate (13,9). This data shows that most of students give the very high response in discovery learning using e-worksheet.

The description of each component of the students' response can be seen from the average response of the five aspects in Table 4.

Table 4. The Average Students' Respons to Discovery Learning Using E-Worksheet by Assessing Product

No	Aspects	Average	% Score	Criteria
1	Learning Situation	4.01	80.15	High
2	Learning Tools	3.89	77.73	High
3	Assessment	3.86	77.11	High
4	Character of Convidence	3.74	74.81	High

Table 4 shows that the highest average students' responses to the aspect of the situation in learning is reaching 80,15 in the high category. In addition, students also felt that they gave a high response to the existence of the discovery-learning component using e-worksheets with a percentage that reached 77,73. The high category responses were also given by students related to the assessment in learning; it is 77,71. In addition, students also have self-confidence by giving high responses with an achievement score; it is 74.81.

CONCLUSION

The discovery-learning using e-worksheet by product assessment has good quality. This can be seen from the learning process and results. The learning process has a good quality and it is effective. It can be indicated by (1) the average student response to learning is in the high category; (2) the value of students' mathematical literacy skills with discovery learning using e-worksheets with product assessment gets higher scores than *KKM*; (3) the average mathematical literacy skills of students with discovery learning using e-worksheets with product assessment increased significantly; (4) the mathematical literacy skills of students of class XI *OTKP* 1 *SMK Negeri* 1 Demak in discovery learning using e-worksheets with product assessment experienced level increase. Students who are high spatial skill have increased to levels 5 and 6. The students who are moderate spatial skill; it has increased to levels 4 and 5; whreas, those at low spatial skill have increased to levels 3 and 4.

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