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Mathematical Representation Ability of XI Grade Students of Vocational High School (SMK) in *Connected Mathematics Project with Schoology Based on Student' Independence*

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Abstract

The present study aimed to describe the mathematical representation ability of vocational high school (SMK) students based on students' autonomy. This research applied a mixed method with concurrent embedded design. The subject was accounting, and institution students grade XI of SMK N 2 Pekalongan 2020/ 2021 academic year. The result showed high self-reliance students achieved three ability aspects in mathematizing representing ability. The medium students' ability created and used the representation to organize, take a note, communicate, and mathematize ideas. However, the two other aspects got ample category. The low students' ability was not able to choose, apply, and represent the material to solve the problem, while the two other aspects were categorized as capable.

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INTRODUCTION

The globalization era is marked by advanced science and technology-forcing qualified human sources to have the knowledge, competition desire, and strong character. The educated person without skill can be defeated by a skillful human source (Masrukan, 2016). In the implementation of education, mathematics is a compulsory subject. So, it can be a strategic place to fulfill qualified human sources. Mathematic subjects aimed to develop students' critical thinking. It was very needed so that the students understand the concept and apply it in all situations (Hutagaol, 2013).

One of the purposes of mathematics subject was for students to have the ability to solve the problems, design mathematical models, finish the model, and interpret the solution. The students can communicate the idea of symbols, tables, diagrams, or other media to elaborate on the problem or condition (BSNP, 2006). NCTM (2000) explained the mathematics purposed five developed competencies: 1) mathematical communication, 2) mathematical reasoning, 3) mathematical problem solving, 4) mathematical connection 5) mathematical representation.

In line with the mathematics learning objective, it was undeniable that understanding a mathematical concept and solving mathematical problems required an ability that can express mathematical ideas in finding solutions related to the mathematical problems encountered. The ability here meant mathematical representation ability.

The representation is a model to represent a certain situation or a problem so that it can be easier to decide the solution (Neria and Amit, 2004). Gagatsis *et al* (2003) elaborated representation is a tool to represent mathematical ideas such as tables, graphics, and equations. NCTM (2000) explained that the standard of mathematical representation ability allows students to (1) Create and use mathematical representation to organize, take a note, and communicate ideas. (2) Choosing, implementing, and interpreting a mathematical representation to solve a problem. (3) Using the representation to model and interpret physical phenomena, social and mathematics.

This research adopted NCTM standard: (1) The ability to create or use the representation to organize, take a note, and communicate mathematics ideas. (2) The ability to choose, apply and interpret for solving mathematical problems. (3) The ability to use representation to model and interpret physical phenomena, social and mathematics.

Mathematical representation ability is students' mathematical ideas that are produced to solve the problem. Good mathematical representation ability can help students in modelling and interpreting mathematical problems to gain a solution (Hidayah et al, 2018). NCTM (2000) elaborated representation is needed for the students to understand the mathematical concept and relation. The representation makes the students communicate mathematical approach, argument, and self-understanding and others, introduce related concepts, and apply mathematics to solve the contextual problem through modelling. It showed that representation is a crucial part of mathematics learning. Unfortunately, the students' representation ability is low (Hudiono, 2005). In the initial test, the students could not create correct mathematical representation and did not use the correct mathematical equation in quadratic equation. Learning is a changing process of original attitude through exercise and experience. In the teaching and learning process, a teacher consciously teaches and guides the students to interact with learning sources to gain the expected goal (Trianto, 2014). Connected Mathematics Project was a learning model that emphasized mathematical tasks to support the students in developing mathematical knowledge, understanding, skills, and awareness in mathematics and other disciplines (Damaryanti *et al*, 2017; Lestari, 2017; Harahap, 2020). It opened students' opportunities to develop their ideas, knowledge, and opinion so that it can increase their mathematics ability (Wahyuningsih, 2017).

Lappan *et., al* (2002) elaborated *Connected Mathematics Project* helped the students to grow the ability to discuss effectively related to the presented information, such as graphics, symbols, numeric, and verbal, and used the representation accurately. The main aim of *the Connected Mathematics Project* was for the students can use mathematical representation statements to solve the problem. Connected

Mathematics Project steps consisted of *launching a problem, exploring, and summarizing* (Rohendi and Dulpaja, 2013)

Education is developed based on technology and information. A professional teacher is forced to have expert teaching ability, and integrate material with technology (Aminah and Rochmad, 2020). During Covid 19 pandemic, learning activities change dramatically. Learning activities are commonly used with distance learning (PJJ) or online learning (Sadikin and Hamidah, 2020). Distance learning was conducted through social media applications or websites based. In the distance learning infrastructure is *Learning Management System* (LMS). It has functions such as time limitation and problem-solving ability, and helps students to learn independently (Muhson, 2010). LMS is a web-based system that allows the teachers and students to share the material, send the data, finish the task, and communicate it online (Lonn and Teasley, 2009).

Schoology is a *Learning Management System* platform that combines social media, so it has high flexibility, is easy to use, and is accessible for the students (Wardono *et al*, 2018; Fahmi, 2020. Schoology helps students to interact with the teachers. So the learning process can be conducted in and out of the school. This facility can be accessed anytime and everywhere. It stimulated the students to be independent in their learning that was related to mathematical representation Aminoto, 2014).

The learning stage of *the Connected Mathematics Project* with Schoology was: 1) Launch: in this stage, the students got the information about the learning objective, tools, and materials needed that were focused on problem-solving activities based on a mathematical representation. The students joined Schoology to observe the problems, materials, and tasks and discussed them or asked the teacher if the students found the difficulty. 2) *Explore*: The students were supported to use Schoology as an alternative learning source. The students tried to correlate the initial knowledge with the important information to decide the solution and solve the problem. 3) *Summarize*: The students reviewed the solution to solve the problem by using the requested representation. Each group of students resents the result to the Schoology so that it can be used to learn at home.

Education has a function not only to develop students' abilities but also to develop students' character. Indonesian ministry of education and culture (2013) explained that the learning process must be interactive, inspirational, fun, challenging, and motivated the students to be active, create ideas, be creative, be independent with their passion, and developed physically and psychology.

Independency is an attitude and behavior that does not depend on other people in finishing the tasks (Pintrich, 2000; Ramly, 2010; Jumaisyaroh, 2014; Suhadi, 2018). Independency is no effort to separate the students and the teachers, but the students can ask, discuss or ask for explanations from others. The crucial thing about self-reliance is students' ability improvement in the teaching and learning process. At the end of the process, the students did not depend on teachers, supervisors, friends, or others.

Based on the explanation above, the present study aimed to describe mathematical representation ability based on students' abilities.

METHODS

The present research adopted a mixed method with *a concurrent embedded strategy* where quantitative was a premier method. Both methods were applied together with different quantities (Sugiyono, 2020). The quantitative research aimed to know the learning process quality in the Connected Mathematics Project through Schoology, while the qualitative study aimed to analyze mathematical representation ability. Quasi-experimental with *nonequivalent posttest-only control group design was applied in quantitative research*. This research is conducted in SMK Negeri 2 Pekalongan for XI Accounting and Institution 2020/ 2021 academic year. The subject consisted of XI Accounting 1 as the experimental class and XI accounting 3 as the control class, and initial data used final examination odd semester. The initial data was tested with a normality test, homogeneity test, and resemblance test to know the subject of ability.

The researcher used only experimental class for qualitative research and purposive sampling for selecting the subject. The subjects were selected based on the students' independence and were divided into three groups. The groups were students with high, medium, and low self-reliance. Two students were

selected from each group to analyze their mathematical representation ability.

The quality of learning in this study was measured in three stages. (1) The validity consisted of the validity result of learning devices with a good minimum category. (2) The practicality included the results of observing teacher activities and student responses in the minimum good and high categories. (3) the effectivity contained the final test results of mathematical representation where the experimental class was better than the control class using the average difference test. By using the proportion test, the passing grade proportion of the experimental class was better than the control class.

Mathematical representation ability based on students' independency was analyzed based on the document tests and interviews result. Miles and Huberman in Sugiyono (2020) covered the data reduction, data presentation, and conclusion.

RESULTS AND DISCUSSIONS

Based on initial analysis data, the two-sample classes were normally distributed populations. It has a similar variant or homogenous, and there was no average difference in mathematic ability in the two groups. In the validity stage, the researcher prepared the tools and instruments that were validated by an expert. It achieved a very good category in the lesson plan, independent questionnaire, and TKRM question gained > 4,20. Syllabus, learning source, worksheet, learning execution, and students' response questionnaire got good category with 4,10 until 4,20 of the score.

The results of the validator's assessment of learning tools and research instruments are drawn in table 1.

Table 1. The Validator Assessment Result of Learning Tools and Research Instrument

Instruments	Average Score	Category
Syllabus	4.17	Good
Lesson Plan	4.25	Very
Learning Source	4.10	Good
Work Sheet	4.10	Good
Self-reliance	4.27	Good
Questionnaire	4.25	Very
TKRM questions	4.20	Good
Learning Execution	4.10	Very
Student Response		Good
Questionnaire		Good
		Good
Average	4.18	Good

Based on the results of the learning tools assessment by expert validators in Table 1, the average assessment of expert validators is in a good category. It means that the learning tools are valid to use in research.

The practicality stage was an observation of learning implementation and students' response questionnaire. Learning is declared qualified if the observation result toward learning execution gained good minimum category and achieved high students' response. The observation result of learning execution can be seen in table 2.

Table 2. The Result of Learning Implementation Assessment

No	Implementation	Average Score	Criteria
1	Meeting 1	3.82	Good
2	Meeting 2	3.95	Good
3	Meeting 3	4.03	Good
4	Meeting 4	4.11	Good
5	Meeting 5	4.13	Good
	Average	4.01	Good

Learning implementation results based on table 2 can be seen in meeting 1 with an average score of 3,82, meeting 2 gained 3,95, meeting 3 achieved 4,03, meeting 4 got 4,11, and meeting 5 got an average score of 4,13. These results are included in the good category.

The average score of five meetings included in the good category. It meant that the researcher was successful in implementing the Connected Mathematics Project through Schoology. Nowadays, a professional teacher is a teacher who masters teaching ability, material ability, and integrated technology ability. (Aminah dan Rochmad, 2020). Furthermore, students' response questionnaire in the Connected Mathematics Project through Schoology gained 78,50%, or it was

stated in the high category. It showed teaching and learning process was well conducted.

In the effectivity stage, the normality test was applied for the last data. The significance score achieved 0,695 > 0,05. It can be concluded that the population's last data were normally distributed. The learning quality is determined based on the mastery learning standard test. The learning quality is determined based on mastery learning standard assessment.

The average of minimum passing standard test with an error rate 5% with dk = 32 – 1 = 31 obtained ttable = 1,70 dan t count = 5,685. So that t count> ttable or H0 was rejected and H1 was accepted. It can be concluded the average mathematical representation ability in the experiment class achieved a 62 score (The minimum student's passing grade was 62).

Based on the classical completeness test, it was obtained that zcount= 2.04 was greater than ztable = 1.64, with a significance level of 5%, so that H0 was rejected. It meant that the experiment class achieved a classical completeness test that was decided more than 75% of students achieved the passing grade.

The results of the average difference test of students' mathematical representation abilities were obtained t count = 4.18 with a significance value of 0.000 <0.05, which means that H1 was significantly accepted. It can be stated that the average students' ability in mathematical representation with the Connected Mathematics Project through Schoology was better than the students who got the materials with PBL.

The results of the different proportion test with the z test with a significance level of 5% were obtained z count= 3.010 and z table= 1.645. z count > z table so that H0 was rejected and H1 was accepted. The mastery proportion in the students' ability with Connected Mathematics Project through Schoology was more than the proportion in PBL learning.

Based on the explanation above, the learning was qualified by applying the Connected Mathematics Project through Schoology. Because of (1) the validity stage, the result of the validator expert was a good minimum category. (2) The practicality test, the observation result of learning process achieved good category and students' response toward learning process 78,50% declared high category. (3) In The effectivity stage, students' mathematical representation ability in the experiment class achieved learning mastery of more than 62, and the mastery proportion gained 75%. (4) Students' mathematical representation ability in the class experiment was better than in the control class. The average score in the experiment class was higher than the control class, and the mastery proportion in the experiment class was higher than in the control class.

Connected Mathematics Project through Schoology stimulated students to create the idea in all shapes of representation that consisted of visual representation, equation or mathematical expression, and verbal representation. Wardhani and Rumiarti (2011) explained that the students need training in critical thinking and solving the problem so that the students' ability in mathematical representation can increase. Using Schoology as a distance learning platform makes the students braver in expressing their idea, asking, and giving opinions (Sadikin and Hamidah, 2020). Kuo et al (2014) explained that online learning stimulates students' awareness and self-reliance because of the learning activities applied to the student's center. Furthermore, this process can create students' responsibility and build learning autonomy.

The analysis of Mathematical representation ability in the Connected Mathematics Project through Schoology was divided into three groups based on students' self–reliance. This group was high self-reliance students, middle self-reliance, and low self-reliance. The 32 students can be seen in table 3.

Table 3. Students Self-Reliance Group

No	Group	Total of Students	Percentage
1	Low	4	13%
2	Medium	21	66%
3	High	7	21%

Based on the self-reliance questionnaire, two students from each group were selected. The students were chosen based on the initial test and with several criteria, such as the students can communicate their opinion and their idea. E-20 and E-30 were the representative of high-reliance students, E-16 and E-

14 for middle reliance students, and E-3 and E-13 were the representatives of low self-reliance.

The interview result can be concluded that in creating aspects using representation, high-reliance students were able to write the information and the question, to use picture representation or visuals very well. In the mathematical equation modeling aspect, high-reliance students can write and answer mathematic equations accurately. In analyzing aspects, high-reliance students were able to answer correctly and made an accurate conclusion. The following figures were one of the students' answers in the high-reliance category.

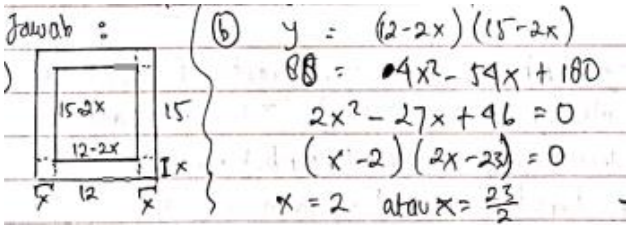

Figure 1. The answer sheet of E-20 Subject (High-reliance category)

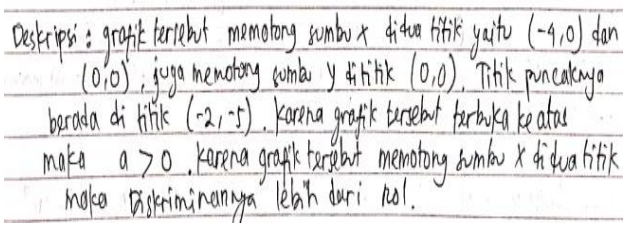

Figure 2. The answer sheet of E-30 Subject (High-reliance category)

The students with middle independence, in the aspect of creating or using appropriate representations, students were able to write down what was known and asked, using an image or visual representations. In the implementation aspect of modeling mathematical equations, students with moderate independence were quite able to write mathematical equations correctly even though there were still some basic errors such as being inaccurate in answering questions related to variables. In the analyzing aspect of translating mathematical representations, in solving the mathematical equations, students with middle self-reliance were quite capable of doing calculations correctly but not quite right in writing a conclusion. The following figures were one of student work with middle self-reliance as shown in Figure 3 and Figure 4.

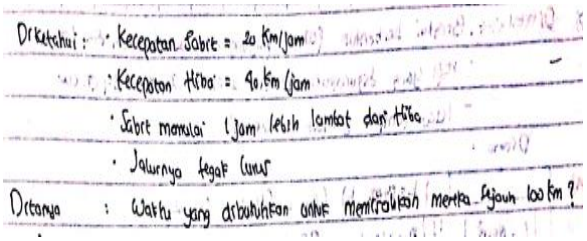

Figure 3. The answer sheet of E-6 Subject (Middle-reliance category)

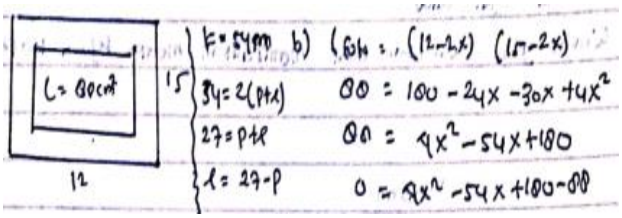

Figure 4. The answer sheet of E-14 Subject (Middle-reliance category)

In the aspect of creating or using appropriate representations, the students with low independence were able to write down what is known, asked questions, and used an image or visual representation but had not provided complete information. In the aspect of using or modeling mathematical equations, students with low independence were quite able to write mathematical equations correctly. Unfortunately, the students had not been able to translate the images into mathematical representations. In analyzing aspects or translating mathematical representations, the students with low self-reliance were less able to calculate correctly and were not precise in writing the conclusion. The following was one of the students' work results with low independence as shown in Figure 5 and Figure 6.

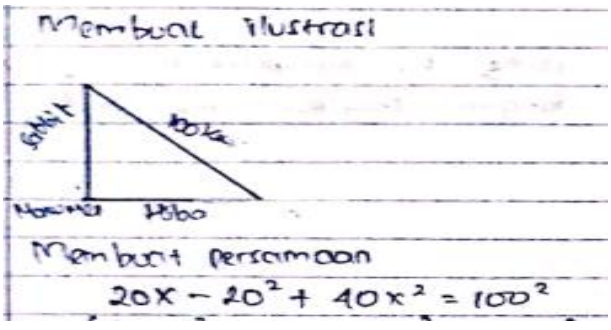

Figure 5. The answer sheet of E-3 Subject (Low-reliance category)

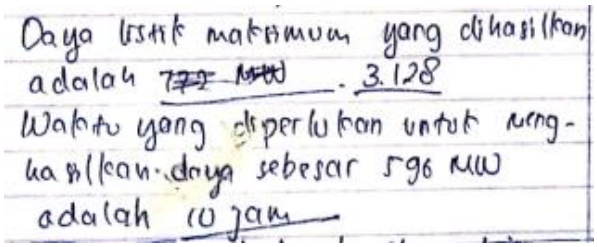

Figure 6. The answer sheet of E-13 Subject (Low-reliance category)

Based on the discussion, students with high independence have better mathematical representation skills than students with middle and low self-reliance. This result was in line with Mayasari & Rosyana (2019) stated that self-reliance had a linear relationship to students' mathematical problem-solving abilities. Sumarmo (2004) also explained that independence improved problem-solving skills so that mathematical representation skills as an inseparable part of problem-solving in mathematics will increase. Desmita (2009) also revealed that students with high self-reliance were able to think more complexly and based on analytical patterns.

CONCLUSION

Based on the analysis and the discussion, it can be concluded that students' mathematical representation based on students' autonomy became a crucial point, especially in the problem solving of verbal questions. The teachers must pay attention to students' independence in learning mathematics. So that the teachers know the strengths and the weakness of the students. The teachers can maximize the students' abilities and improve the students' weaknesses.

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