Capability analysis of student mathematical representation viewed from self-regulated learning

N Hidayati¹, *, B Usodo¹ and S Subanti²

¹Department of Mathematics Education, Sebelas Maret University, Jl. Ir. Sutami 36 A, Jebres , Surakarta, Jawa Tengah 57126, Indonesia
²Department of Statistics of Mathematics and Natural Science, Sebelas Maret University, Jl. Ir. Sutami 36 A, Jebres, Surakarta, Jawa Tengah 57126, Indonesia

*noorhidayatiadinda@student.un.ac.id

Abstract. This study aims to analyze the ability of students' mathematical representation in terms of Self-regulated Learning. This study focuses on the ability of visual representation, symbolic representation, and verbal representation. This study used a qualitative approach with test data collection techniques, questionnaires, and interviews. The data analysis technique used is the analysis technique according to Miles and Huberman through the phase of data reduction, data representation, and conclusion drawing. Students with SRL who are high in representation have lower grades than medium and low SRL. The ability of verbal and symbolic representation of high SRL students has superior value from medium and low SRL. Indicators of mathematical representation can be achieved maximally by high SRL students. Students who have SRL are currently, the ability of visual representation is superior to high SRL students, symbol representation has a lower value than low SRL. So it can be concluded that SRL students are having difficulties in writing mathematical symbols. Low SRL students have advantages in visual representation. Indicators that can be achieved by SRL students are low only at the drawing stage. Low SRL students still have difficulty in expressing their abstract ideas in the form of mathematical representations.

1. Introduction
Mathematics is one of the fields of study that has an important role in education, this can be seen from every level of school starting from the level of elementary, secondary, high school to university. Many students have difficulty learning mathematics. Students assume mathematics is a frightening and boring subject [1]. The weakness of students in all aspects of mathematical content is the thinking about the quality of mathematics learning and because students' mathematical representation abilities are still low. This is because students still have difficulty in using representations in learning mathematics. Therefore, students must be able to express their ideas in certain ways to solve problems. The form of interpretation of students' thinking about a problem, which is used as a tool to find a solution to the problem is called representation [2].

NCTM reveals that there are 5 mathematical abilities, one of which is representation ability [3]. The National Mathematics Teachers Council (NCTM) identifies the ability to translate among mathematical representations as important skills for learning and doing mathematics [3]. Representation is a kind of configuration process for presenting something in different situations involving the identification, selection and delivery of ideas [4]. Everything that students do to externalize and show their work is
called representation [5]. Good representational skills are the key to finding the right solutions to solving problems. Thus, mathematical representation plays a major role in solving mathematical problems [6]. Representational skills are the key to finding the right solutions to solving problems. The ability of representation facilitates students to understand, communicate, and connect mathematical concepts [7,8]. Thus, mathematical representation plays a major role in solving mathematical problems [9].

Besides the ability of representation, students' confidence in their ability to express ideas also contributes to one's success in solving a problem [10]. Yuningrih explains that students who learn independently will be able to find appropriate learning strategies, manage their own learning activities, improve learning activities by providing feedback during learning, and train themselves to improve their own academic performance [11]. To associate several concepts in mathematics or with other fields of science, students' learning independence is needed in solving the problems to be faced [12]. The active process where students set their main goals in learning, controlling and regulating the abilities they have, motivation and behavior to achieve goals in learning is called Self-Regulated Learning (SRL) [13]. Self-regulated learning (SRL) is defined as learning activities that take place more driven by their own willingness, own choice and responsibility of learning [14].

SRL is the ability of a student to realize his will or desire in a real way without depending on others, in this case students are able to do their own learning, can determine effective learning, and be able to carry out independent learning activities [15]. Chen explains that students who learn independently will be able to find appropriate learning strategies, manage their own learning activities, improve learning activities by providing feedback during learning, and train themselves to improve their own academic performance [16]. Self-regulated learning (SRL) can help students get used to learning better and strengthen their learning abilities, implement learning strategies to improve academic performance, monitor their performance, and evaluate their own academic skills [17].

In solving the problems related to mathematical representation, several errors are often found so that there is a need for mathematical representation ability analysts seen from the mistakes made by students. In addition to see how much influence the independence of learning on the mistakes made by students in solving the problems of mathematical representation abilities. Analysis is a form of investigation of an event, analysis also aims to find out the actual situation that occurs, while error is a form of deviation from something that is considered true. It can be concluded that error analysis is a form of investigation or research conducted to determine errors in an event. The purpose of this study is: analyzing the ability of mathematical representation in terms of Self-Regulated Learning.

2. Method
The research design used is a qualitative method with a descriptive approach. In this research, it describes the mathematical representation of students in terms of Self-Regulated Learning. This method is done by analyzing students' written tests and interviews with students The research was conducted in junior high school Al Kautsar PK Sukoharjo Central Java. The study population was all 7th grade students of Ibrahim. The subjects in this study were 3 students with high, medium and low Self-Regulated Learning. The selection of subjects in this study used a purposive sample technique. Analysis was carried out on 3 students with high, medium and low Self-Regulated Learning. The classification is based on the Kersey Self-Regulated Learning questionnaire.

The data in this study are based on the results of written examinations about representation and interviews. Then the data is processed in such a way that it can be concluded how the ability of the mathematical representation of each student. The data analysis technique used in this study refers to the Miles and Huberman models, namely data reduction, data display, and conclusion [18]. The credibility test of the data that is carried out is by using triangulation technique that is looking for the compatibility of data sourced from the results of the representation sheet and interview.

3. Result and discussion
Grouping students based on the provision of the Self-Regulated Learning (SRL) questionnaire was conducted before the implementation of the learning process. SRL is grouped into three categories,
namely SRL high, SRL medium, and SRL low. Based on the results of the SRL questionnaire analysis data obtained are shown in Table 1.

| SRL    | Frequency | Presents |
|--------|-----------|----------|
| High   | 8         | 25%      |
| Medium | 15        | 46.88%   |
| Low    | 9         | 28.12%   |
| Total  | 32        | 100%     |

Based on the analysis of student questionnaire scores, students are divided into three categories, namely high, medium and low categories. Data shows that there are 8 students (25%) in the high category, 15 students (46.88%) in the moderate category, and 9 students (28.12%) in the low category. Then, the researcher determined the subject of 3 students who had SRL high, medium and low. Based on Table 1 and recommendations from the teacher, the selection of research subjects in each category one student to analyze the ability of mathematical representation. Students selected to be the subject of research are RN students with high SRL category, UM students with SRL category while BF students with low SRL category.

The following is presented a figure that states the acquisition of scores obtained by each group of students based on Self-Regulated Learning.

![Figure 1. Average student score graph based on SRL.](image)

From figure 1, the score of high SRL category students is superior to the Symbolic Representation indicator compared to the medium SRL and the low SRL category. In the medium and low category SRL is superior to the Visual Representation indicator than in the high SRL category. In the SRL category high is also superior in the Verbal Representation indicator from the medium and low SRL category. This shows the visual representation indicator in the medium and low category SRL group in presenting better data or information in the form of images than SRL is high. Indicators of symbolic representation in the SRL category are high in writing completion steps with words that are better than the other two categories. Meanwhile, the verbal representation indicators in the SRL group are high in making the equation or mathematical model of a given task also better than the other two categories. High SRL students have no difficulty in solving a problem by expressing abstract ideas in the form of mathematical representation and can achieve all indicators of mathematical representation to the maximum. The results of this research are similar to the results of other relevant studies which state that the representation abilities of students are included in the low category \([19,20]\).

Students who have medium SRL abilities in this study manipulate numerical calculations so that they get the right answers. Students who have medium ability SRL tend to use experiments and errors in determining formulas that meet problem situations. He continued to show his expertise in guessing
which formulas could fulfil the equation to produce the correct answer. Students who have medium SRL abilities are able to solve problems, although there are still some mistakes. Based on the results of the study, information was obtained that in most problems involving the use of representations in the form of images, medium SRL students are able to express their mathematical ideas in the form of images completely and correctly. When solving problems involving mathematical symbols, students with medium SRL are unable to find mathematical models, students can answer correctly even though they cannot use mathematical models appropriately. And when solving problems in the form of written text, students can explain mathematically and in writing. This medium SRL students are experiencing difficulties in writing mathematical symbols.

Low SRL students still experience difficulties in a problem by expressing their abstract ideas in the form of mathematical representation. Indicators of mathematical representation that can be achieved by SRL students are low only at the drawing stage, not maximal especially when using written words or texts students have not been able to maximize prior knowledge. This shows that in this study stating that low SRL students are only interested in mathematical questions related to drawing and easy math problems, because they believe they will succeed and tend to avoid difficult tasks, which will make them. This is consistent with the results of other relevant studies which state that students with low representation skills show a lack of skills to generate ideas, ask questions and respond to other people's questions or opinions [8].

Some examples of students' answer to mathematical representation ability test can be seen in Figures 2, 3, and 4.

![Figure 2. Students' answer in the category of high SRL.](image)
Figure 3. Students' answer in the category of moderate SRL.

Figure 4. Students' answer in the category of low SRL.

Figure 2 depicts students in the level category. Figure 1 depicts students in high-level SRL categories where students are able to make mathematical ideas in pictures, able to make mathematics and write calculation steps by written words / texts. Figure 3 illustrates students in the moderate SRL category. Where students are able to make mathematical ideas in pictures, able to make mathematics but cannot write a step in writing with written words / texts. This result is relevant to the results of Rahmawati's research proving students who have moderate representation abilities are better able to represent problems in a symbolic form of verbal [21]. Figure 4 illustrates students in the low SRL ability level category where students are able to make mathematical ideas in pictures but cannot make mathematical equations and write complete steps with written words / texts. These results are relevant to the results of Sahendra's research stating that students with low representation ability only use one form of representation based on learning experience [22].
4. Conclusion

Students with SRL who are high in representation have lower grades than medium and low SRL. The ability of verbal and symbolic representation of high SRL students has superior value from medium and low SRL. Indicators of mathematical representation can be achieved maximally by high SRL students. Students who have SRL are currently, the ability of visual representation is superior to high SRL students, symbol representation has a lower value than low SRL. So it can be concluded that SRL students are having difficulties in writing mathematical symbols. Low SRL students have advantages in visual representation. Indicators that can be achieved by SRL students are low only at the drawing stage. Low SRL students still have difficulty in expressing their abstract ideas in the form of mathematical representations.

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