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Students' Mathematical Representation Ability in Word Problems with Learning Cycle 7E Based on Cognitive Style

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Abstract

This study aims to describe students' mathematical representation ability in word problems with learning cycle 7e based on cognitive style. The research method is a mixed method with a sequential explanatory model. The population of this study was students of class XII SMA Negeri 7 Semarang in the academic year 2020/2021 with class XII MIPA 3 as the experimental class, and class XII MIPA 2 as the control class. The data were collected using tests, documentation, questionnaires, observations, and interviews. The quantitative data were tested using the average test, the proportion test, the average difference test, the different proportions test, and the linear regression test, while the qualitative data were tested with data validity, data reduction, data representation, and draw a conclusion. Students with field-independent category were able to present ideas or information from a representation, create equations or mathematical models (mathematical ideas) from representation that had been made, complete tasks involving mathematical equations or models, write representations of solving mathematical problems in words. Students with field-dependent category were able to present ideas or information from a representation, create equations or mathematical models (mathematical ideas) from the representations that had been made.

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INTRODUCTION

Mathematics is a tool to expand the power of mind and intelligence of reason, which sharpens the mind and makes it creative. Human development and culture depend on the development of mathematics (Yadav, 2017). NCTM (2000) defines that the standards of mathematical ability are problem-solving, reasoning and proof, communication, connection, and representation.

One of the general goals of learning mathematics in schools is mathematical representation ability. Mathematical representation ability is closely related to mathematical communication ability and problem-solving that is linear with the standard content of the 2013 curriculum as described in Permendikbud Number 64 years 2013 (Kemendikbud, 2013) for the XII grade level of SMA/MA, it is stated that one of the competencies that must be completed by students is the ability to communicate mathematical ideas clearly and effectively.

According to Godino & Font (Adnan et al., 2019), mathematical representation is a sign or sign configuration, an object that can present something else to symbolize, mark, encode, describe an object. The objects which is represented can be varied according to the context or use of the representation. While according to Supandi et al (2018) the abstraction of mathematical concepts, and mathematical representations are important to make it easier for students to solve difficult mathematical problems. NCTM (2000) defines that representation standards that must be completed in learning mathematics are being able to choose, implement, and translate among mathematical representations to solve problems. Indicators of mathematical representation according to Zhe (2012) are: (1) visual representation, present data or information in the form of diagrams, graphs, or tables; (2) verbal representation, write the steps to complete a mathematical task in words; (3) symbolic representation, making an equation or mathematical model of mathematical problems. Meanwhile, NCTM (2003) in the standard section 5, Thompson et al (2012) indicate that the standard of mathematical representation is if students are able to (1) use representations to make mathematical models and physical, social, and mathematical phenomena; (2) create and use representations to organize, record, and communicate mathematical ideas; (3) selecting, applying, and translating mathematical representations to solve problems. The indicators in this study are: (1) the ability to present ideas or information from a representation; (2) creating mathematical equations or models (mathematical ideas) from the representations that have been made; (3) completing tasks involving mathematical equations or models; and (4) writing representations of solving mathematical problems in words.

The aim of learning mathematics and basic mathematical abilities have not been fully realized because based on the results of a preliminary study at SMA Negeri 7 Semarang, it was revealed that as many as 48% of students were wrong in working on mathematical representation problem in word problems. The error was because students were lacking in symbolic representation abilities. There were several factors that influenced students in learning to develop their mathematical representation abilities, one of them was the student's cognitive style.

Word problems are problems that are presented in the form of a meaningful narrative that can be understood and answered mathematically based on learning experiences related to situations experienced by students in everyday life (Verschaffel et al., 2020; Wong et al., 2007). Meanwhile, Chapman (2006) states that word problems in schools are usually presented in the form of symbols, images, or mathematics, or a combination of them. According to Sumarwati et al (2019), word problems are questions that are presented in the form of symbols and mathematical notation. Based on the opinions above, word problems are problems in the form of meaningful stories that can be presented in a meaningful narrative form and can be measured, understood, and answered mathematically.

Cognitive style is a process of control or style about self-management, as a situational intermediary to determine conscious activity so that it is used to organize and regulate, receive, and disseminate information and ultimately determine behavior by a student (Bassey, 2009). Cognitive style is a characteristic of individuals in using their cognitive functions (Desmita, 2012). The same opinion expressed by Witkin (1977) that cognitive style is the uniqueness of students in learning. Cognitive styles are divided into two categories: (1) field-independent; and (2) field-dependent. This cognitive style reflects a person's analytical way of interacting with his environment. To determine the field-dependent and field-independent cognitive styles, instruments that have been developed by scientists such as GEFT (Group Embedded Figure Test) are needed.

The ability enhancement of mathematical representation based on students' cognitive style in solving mathematics on word problems requires innovative cooperative learning. According to Huda (2013), learning cycle 7e is a learning model that involves students to be active, experience themselves, reflect on the findings they have obtained, and interpret their findings against the initial scheme they already have, and predict their findings in new situations. (Asni Maulina et al., 2018; Tinungki, 2015) states that the application of the learning cycle 7e model provides opportunities for students to discuss and interact with each other, increasing student learning activities so that students' mathematical abilities have better improvement compared to another cooperative learning model.

In addition to the learning model, the learning approach is also important in efforts to deliver material to students. According to Hamruni (2012), approach is a rule that underlies the thinking about how learning methods are applied based on certain theories. The scientific approach is a learning step designed so that students actively build concepts, principles through observing, formulating problems, formulating hypotheses, collecting data with various techniques, analyzing data, drawing conclusions, and communicating (Hosnan, 2014).

The scientific approach has the characteristics of student-centered learning, involving science skills in building concepts, involving cognitive processes to stimulate the development of students' thinking skills. The implementation of a scientific approach to learning has principles on student-centered learning, providing more opportunities for students to assimilate and accommodate concepts, supporting students' thinking skills, and training students to communicate.

Based on the background, this research aims to describe the students' mathematical representation ability in word problems with learning cycle 7e based on students' cognitive style.

METHODS

This research method is a mixed method with a sequential explanatory model. The design in this study is posttest control group design. The population of this study was students of class XII SMA Negeri 7 Semarang in the academic year 2020/2021. The sample in this study was students of class XII MIPA 3 as the experimental class which given treatment by learning cycle 7e with scientific approach, and the control class was students of class XII MIPA 2 which given treatment by problem-based learning model with scientific approach. The sampling technique was purposive sampling. The research subjects were selected by two students representing field-independent and field-dependent cognitive styles in the experimental class.

The quantitative data were collected using tests, while the qualitative data were collected using documentation, questionnaires, observations, and interviews. Quantitative data analysis techniques started from item analysis, initial data analysis, then hypothesis testing. The initial data analysis was to determine whether the two sample groups had the same initial ability, and it was found that the initial abilities of the students of the two classes were the same. While the hypothesis testing was including the individual mastery test, the classical mastery test, the proportion test, the average difference test, and the linear regression test. Before testing the hypothesis, test conditions were carried out, including a normality test using the Kolmogorov-Smirnov test and a homogeneity test using the Levene test by SPSS 25.0. Qualitative data analysis techniques were using qualitative descriptive methods including data validity, data reduction, data presentation, and drawing conclusions.

RESULTS AND DISCUSSIONS

The learning quality measurement was seen from three stages: the planning stage, the implementation stage, and the assessment stage. At the planning stage, research instruments and learning tools have been validated, which are presented in Table 1 below.

Table 1. Validation Results

Research Instruments	Mean	Category
Syllabus	4,2	Good
Lesson Plan	4,1	Good
Student Worksheet	4,1	Good
Mathematical Representation Ability Test	4,2	Good
Implementation Sheet	4,2	Good
Questionnaire	4,3	Very good
Interview Guidelines	4,7	Very good

Based on the results above, it can be concluded that the learning tools and research instruments are included in the good and very good categories so that the learning tools and research instruments are suitable for research.

The quality of the learning implementation stage is seen from the observation of the implementation of learning according to the lesson plans and student response questionnaires. The learning implementation is qualified if the results of the observation of the learning implementation are at least included in the good category and at least 75% of students give positive responses. The results showed that the average score of 4.30 on the learning implementation was included in the very good category. Meanwhile, the results of the student response questionnaire showed that as much as 80% gave positive responses. Therefore, it can be concluded that the implementation stage is good.

The quality of the assessment stage is seen from the effectiveness of learning cycle 7e with a scientific approach to mathematical representation abilities. (Prabawa, 2017) reveals that the effectiveness of a lesson is an indicator of the success of the learning carried out. Before testing the effectiveness, a prerequisite test was carried out, namely normality and homogeneity tests using SPSS 25.0. Based on the tests, the data of the population were normally distributed and homogeneous. Furthermore, results of the means of the average test using the t-test, with $\alpha = 0{,}05$ were obtained $t_{count} = 10{,}854 > 1{,}689$, meaning that students who were subjected to the learning cycle 7e model with a scientific approach were more than 73. The classical completeness test with z test was obtained $z_{count} = 3{,}46 > 1{,}64$. It means that the proportion of completeness of students who were subjected to the learning cycle 7e model with a scientific approach was more than 75%. The average difference test using the t-test was obtained $t_{count} = 2{,}16 > 1{,}669$ which means that the average mathematical representation ability of students in the experimental class was higher than the mathematical representation ability of students in the control class. The proportional difference test with the z test was obtained $z_{count} = 1{,}386 > 0{,}917$, meaning that the proportion of students' mathematical representation abilities in the experimental class was more than the proportion of students' mathematical representation abilities in the control class. The effect of cognitive style test on students' mathematical representation ability with linear regression test obtained a significance value $= 0{,}000 < 0{,}05$. The regression equation was $Y = 0{,}994\,X + 81{,}66$ meaning that the effect of cognitive style on students' mathematical representation abilities was 81,6%. Other variables effected students' mathematical representation ability for 18,4%.

This shows that the success of the applied learning model is supported by the right approach and method. (Nur et al., 2020) in his research explained that there was an increase in mathematical representation ability of students who received learning cycle 7e.

Hanifah's (2016) research states that learning using a scientific approach affects in the form of an increase in the ability of mathematical representation. Learning that uses a scientific approach can lead students to be able to find their own solutions from the information that students already have. (Ramziah, 2018; Safrin et al., 2018) show that the scientific approach is effective and giving a contribution to increase students' mathematical representation. Analysis of mathematical representation abilities taught by learning cycle 7e with a scientific approach based on cognitive style is divided into two, namely field-independent and field-dependent cognitive styles.

To determine students' cognitive style, the GEFT (Group Embedded Figures Test) was used which was adopted from Dyer & Osborne (1996). Based on the results of the GEFT scale analysis of 36 students of class XII MIPA 3 SMA Negeri 7

Semarang, it was obtained data distribution and the percentage of students based on the cognitive style which is presented in Table 2.

Table 2. GEFT Results

Criteria	Amounts	Percentage
Field-Independent	22	61%
Field-Dependent	14	39%
Total	36	100%

Based on Table 2, the number of students with field-independent cognitive style was 22 students with a percentage of 61%, and students with field-dependent cognitive style were 14 students with a percentage of 39%. Based on the GEFT test scale analysis, 4 research subjects were selected to be further investigated regarding the mathematical representation ability. The following is a description of mathematical representation ability based on students' cognitive styles in word problem.

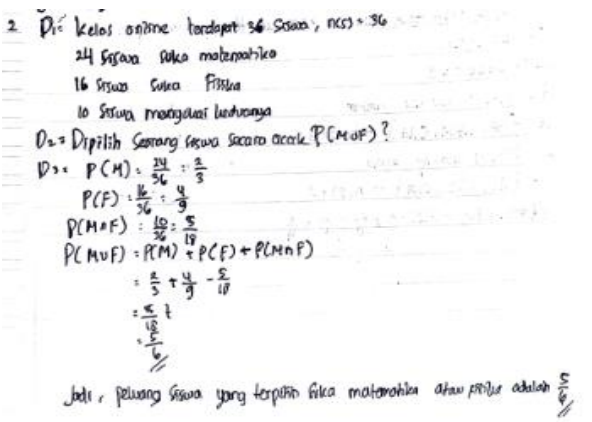

Figure 1. Example of Student with Independent Cognitive Style Work Solving TKRM Problems.

Based on Figure 1, students with field-independent cognitive style complete all stages of completion on the indicators of mathematical representation ability correctly. Students with field-independent cognitive style (1) were able to complete indicators of the ability to present ideas or information from a representation, (2) were able to complete indicators of making mathematical equations or models (mathematical ideas) from well-made representations, (3) were able to complete indicators of completing tasks by involving mathematical equations or models, (4) were able to complete indicators of writing representations of solving mathematical problems in words. This is in accordance with Junita (2016) research that students with field-independent cognitive style are able to answer the mathematical representation ability test properly.

Students with field-independent cognitive style can clearly restate ideas or information from a representation of a problem, can clearly change word problems into mathematical models and consistently use concepts in using the mathematical model to solve mathematical problems. Students with field-independent cognitive style are also able to rewrite the results of solving problems into words. Students with field-independent cognitive style can understand the information on the problem and combine it with the knowledge they have and tend to be influenced by internal cues so that the correct working strategy is obtained. This finding is in line with research by Janah et al (2021) which states that students who have field-independent cognitive style show consistency in using mathematical concepts, and can easily organize perceptions, and can immediately separate apart from its unity. A research by Tyas et al (2016) shows that students who have field-independent cognitive style have the ability to receive information analytically even though they have differences in problem-solving habits. According to Al-Salameh (2011) the nature of the skills represented in students who have field-independent cognitive style allows these students to overcome problem situations, this causes the possibility of failure and feelings of frustration, increases self-confidence, and increases academic achievement motivation.

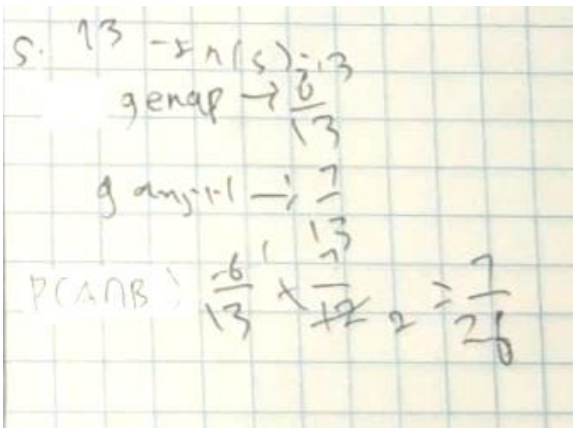

Figure 2. Example of Student with Dependent Cognitive Style Work Solving TKRM Problems.

Based on Figure 2, students with field-dependent cognitive styles cannot complete all the stages of completion that exist in the indicators of mathematical representation ability. Students with field-dependent cognitive style (1) there were several students with field-dependent cognitive style who were able to complete indicators of ability to present ideas or information from a representation, (2) were able to complete indicators of making mathematical equations or models (mathematical ideas) from representations that has been made even though it was incomplete, (3) some students with field-dependent cognitive style were able to complete indicators of completing tasks by involving mathematical equations or models, (4) were able to complete indicators of writing representations of solving mathematical problems in words even though they were not complete. This is in accordance with research by Deviana & Pramartha (2020) which shows that students who have field-dependent cognitive style are still difficult to express their ideas into mathematical symbols so that students who have field-dependent cognitive style find it difficult to represent the problem.

Some students with field-dependent cognitive style can clearly restate ideas or information from a representation of the problem, some field-dependent students have not been able to convert word problems into mathematical models and have not been consistent in using concepts so they cannot use the mathematical model correctly to solve mathematical problems. Some students with field-dependent cognitive styles have not been able to rewrite the results of solving problems into words. Students with field-dependent cognitive styles are not perfect in understanding the information on the questions and fail to obtain the correct working strategy because the material concept is not good. This finding is in line with Vendiagrys & Junaedi's (2015) research which shows that students who have field-dependent cognitive style can understand verbal statements of problems, but cannot convert them into mathematical models, are more global in receiving information, are easily influenced by distractors.

CONCLUSION

Based on the analysis and discussion, it was obtained that the results of the description of students' mathematical representation abilities based on cognitive style showed various results. Differences in students' cognitive styles become important, especially when encountering difficulties in solving word problems. Therefore, teachers must pay attention to the cognitive style of each student in learning mathematics, so that teachers understand the weaknesses and strengths of students and can take advantage of students' strengths and can improve students' weaknesses.

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