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The Numeracy Ability of Field Dependent Students in Solving Well Structured Problems

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Abstract. Numeracy is an individual's ability to formulate, identify, understand and implement the basics of mathematics in various contexts that individuals need in everyday life. numeracy is closely related to solving mathematical problems. The problems experienced by students with field dependent cognitive style are still low mathematical problem solving abilities. The purpose of this study was to describe the student's numeracy skills with field dependent cognitive style in solving well-structured problems. This research is a qualitative research with the researcher as the main instrument. The supporting instruments are the Group Embeded Figure Test (GEFT), numeracy test, and interview guide. The results showed that students with field dependent cognitive style had good numeracy skills in the aspect of counting and numeracy relations. However, students' numeracy skills in the aspect of arithmetic operations still need to be improved.

Key words: Numeracy, Field Dependent, Well Structured Problem

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INTRODUCTION

Advances in Information and Communication Technology (ICT) are growing rapidly in the 21st century. Therefore, skills are needed to deal with these advances. One of the skills that must be possessed is literacy. In making it happen, education is one of the means to train student literacy. In the traditional view, literacy is defined as the ability to read and write simple short statements about an individual's life. Along with the times, literacy is not only the ability to read, but also related to intellectual abilities, and knowing how to research and solve complex problems. Therefore, literacy is fundamental for individuals to be able to participate in society and achieve their goals in their work and life. (Jailani et al., 2020)

There are six basic literacy skills that must be mastered, namely: (1) language literacy, (2) numeracy literacy, (3) scientific literacy, (4) digital literacy, (5) financial literacy, and (6) cultural and civic literacy. Mastery of these six literacys needs to be balanced with developing critical thinking skills in problem solving, creativity, communication, and collaboration (Kemendikbud, 2017). Numerical literacy is one of the basic literacy that must be mastered by students. Numerical literacy is related to individual skills in formulating, identifying, understanding and implementing the basics of mathematics in various contexts that are needed by individuals in everyday life (Ojose, 2011).

The facts on the ground show that the numeracy skills of students in Indonesia are still relatively low. Based on the results of the 2015 Program for International Student Assessment (PISA) study, Indonesian students are ranked 72 out of 79 test-taking countries. The test results show that the average score of students is 371 in reading, 379 in mathematics, and 396 in science. This achievement of scores is below the average of 79 PISA participating countries, which is 487 for reading ability, and 489 for math and science ability (OECD, 2017). According to Suryapuspitarini, et al (Suryapuspitarini et al., 2018), the low numeracy literacy is caused by the tendency of students to learn mathematics by memorizing formulas without understanding the concepts. This has an impact when students face varied math problems even with the same concept, students feel confused in solving them and think the questions are difficult.

OECD (OECD, 2017) defined numeracy as knowledge and skills in: (1) using a variety of numbers and symbols related to basic mathematics to solve practical problems in various contexts of everyday life (2) analyzing information presented in various forms. (graphs, tables, charts, etc.) (3) use these interpretations to predict and make decisions. Based on this definition, someone who has good mathematical literacy skills has a sensitivity to which mathematical concepts are relevant to the phenomenon or problem he is facing. From this sensitivity then proceed with problem solving

using mathematical concepts.

Numeration consists of three aspects, namely counting, numeration relations, and arithmetic operations (Purpura, 2009). Counting is the ability to verbally count an object and the ability to identify the number of objects. Numerical relations are related to the ability to distinguish the quantity of an object such as more, less, taller, or shorter. Meanwhile, arithmetic operations are the ability to perform basic mathematical operations in the form of addition and subtraction. The three aspects of numeracy literacy that have been described previously are basic aspects in learning mathematics that are important to be introduced from an early age until children enter the lower grades (Jordan et al., 2009).

According to NCTM (2000), numeracy literacy is closely related to mathematical problem solving. Without problem solving, the benefits of learning mathematics are limited. Why? because the core of learning mathematics is problem solving (Pangesti, 2018). Gagne (Kirkley, 2003) defined problem solving as the process of synthesizing various concepts, rules or formulas to solve problems. Therefore, the problem solving process is closely related to the way students think to apply the knowledge they have previously into the new situations they face.

Problems are classified into well structured problems and ill structured problems. Chen & Li (Chen & Li, 2015) define well structured problems as having a single answer, optimal solution methods, and structured goals. Problem solving using well structured problems usually involves problem representation, finding solutions and implementing solutions. Meanwhile, Ill Structured Problem is defined as a problem that has a clear purpose that allows a solution with several answers and ways of solving it.

A well structured problem is a constrained problem with a convergent solution that involves applying a number of rules and principles within well-defined parameters. In solving a well structured problem, it is necessary to apply a number of concepts, rules, and principles learned to a limited problem situation. Greeno (1978) calls problems transformation problems, consisting of a well-defined initial state, a known objective state, and a constrained set of logical operators (Jonassen, 1997). According to Pulgar (2020), well structured problems require the use of a limited number of rules and principles, along with a set of procedures that are well organized and limited to a specific purpose. These tasks have predictable actions that are often used to solve similar problems.

Characteristics of well structured problems (Jonassen, 1997): 1) present all elements of the problem, 2) presented to students as a well-defined problem with possible solutions (problem parameters specified in the problem statement), 3)involves the application of a limited number of rules and principles set in predictive and prescriptive settings with well-defined, constrained parameters, 4) involves concepts and rules that appear organized and well structured in a knowledge domain that also appears to be structured and predictable, 5) have correct and convergent answers, 6) have a known and understandable solution in which the relationship between the decision choice and all problem states is known or probabilistic, 7) have a preferred and defined solution process.

In the process of literacy and numeracy, each student has a different thought process in solving the problems at hand. The way a person receives, responds, processes information and organizes it based on the experiences he has experienced is called cognitive style. Oyedeji (Badru, 2015) defined that cognitive style as a term used by cognitive psychologists to describe the way individuals think, perceive and remember information or their preferred approach to using that information to solve problems. Witkin (1977) classifies cognitive styles into Field Independent (FI) and Field Dependent (FD). An individual with FD cognitive style prefers to consider one pattern as a whole, it is difficult to concentrate on one element in one case or to analyze the pattern in another. In contrast, individuals with the FI cognitive style can reach more discrete parts of the overall pattern and analyze the pattern into its components. Individuals with FI cognitive style tend to learn independently by formulating learning goals to be achieved and are more concerned with motivation and reinforcement from themselves (Sutama et al., 2021).

According to Tinajero,et al (Tinajero et al., 2008), field-independent individuals are characterized by trust in internal references and in their own criteria, tend to assume an analytical approach to information that allows them to break it down. into component parts and restructure it according to their needs. This seems to allow some spontaneous operations using the information, such as classifying it or

generating related conclusions and hypotheses. As a consequence, individuals with a field-independent style are considered active processors. Meanwhile, according to Baker & Dwyer; S.Y. Chen, Magoulas, & Macredie; Reliable & Herrington (Tinajero et al., 2012), field dependent individuals are more sensitive to external cues and therefore tend to take information exactly as it is presented to them, and in an attempt to capture the structure of this information, they usually pay attention to its global aspects. This tendency is a hindrance to intellectual tasks that demand a focus on isolated elements in the perception or symbolic whole as in depriving the perception of tasks that are used as a measure of cognitive style or on those that involve restructuring information.

Previous studies found that individuals with field dependent cognitive style (FD) have difficulty solving mathematical problems. Individuals with field independent learning styles have problem solving abilities that tend to be better than subjects in the field dependent category (Hendriani et al., 2016; Prabawa, 2017). A review of several studies related to cognitive style, it was found that students' thinking processes in solving mathematical problems in students with field independent cognitive styles were better than students with field dependent cognitive styles (Izzatin et al., 2020). The same result was found by Nicolaou and Xistouri that field independent students were better at solving problems and more complex in problem-posing, when compared to field dependent students. According to Nicolaou and Xistouri, further research is needed to investigate the environment and the factors that may affect the learning and understanding of students with field dependent cognitive styles (Nicolaou & Xistouri, 2011).

The previous discussion shows that the mathematical problem solving ability of students with field dependent cognitive style is still low. Problem solving in everyday life is closely related to numeracy literacy. Therefore, it is necessary to study in more depth how the field dependent student numeration process in solving a problem. In this study, the problems given to students were in the form of well structured problems.

METHOD

This research was conducted on eighth grade students of SMPN 1 Mejobo for the academic year 2020-2021. Subject selection is limited to only 3 students who have a field dependent cognitive style. From the 3 selected students, the results of the problem ability test were analyzed related to students' numeracy ability on comparative material. In-depth interviews were conducted to confirm students' answers and get more in-depth information about students' reasoning processes. Based on these subject selection steps, the subject selection technique in this study was purposive sampling.

The instrument in this study consisted of the main instrument, namely the researcher himself and supporting instruments in the form of: 1) Group Embeded Figure Test (GEFT) which was used to identify students' cognitive styles, 2) Numerical literacy test on comparative material, which was used to see students' numeracy abilities, and 3) interview guide, which was used to dig deeper into the numeracy process of students in solving comparison problems.

Cognitive style data analysis was carried out by calculating scores on the results of students' answers, then determining the categories of students' cognitive styles. Meanwhile, data analysis of problem solving abilities and interviews refers to the component of numeracy literacy which aims to see the numeracy process of students in solving problems in the form of well structured problems. The steps include (1) Data Reduction, (2) Data Presentation, and (3) Conclusion Drawing.

RESULTS AND DISCUSSION

The study was conducted on three students who have a field dependent cognitive style. Subjects consisted of students with high, medium, and low abilities. They were selected based on the results of the cognitive style test that had been done previously, namely the Group Embeded Figure Test (GEFT). The assessment of students' numeracy skills in solving well structured problems refers to three aspects of numeracy according to Purpura (2009), namely aspects of counting, numeracy relations, and arithmetic operations.

The numeracy ability test question consists of two questions with the first question being an direct proportion and the second question being an inverse proportion. The following is an analysis of the results of the answers of the three subjects related to the numeration process in solving well structured problems:

Question 1 (Direct Proportion)

The problems given are as follows:

Manda is an "Alamanda" bakery seller. Every day Manda makes bread to meet customer demands. Every time she makes bread dough, Manda mixes 30 grams of butter into 125 grams of flour. If Manda wants to make bread with the same recipe using 750 grams of flour, then determine how many grams of butter Manda needs?

S1 Subject's numeracy ability

The results of the answers to the first problem of the S1 subject can be seen in the following picture:

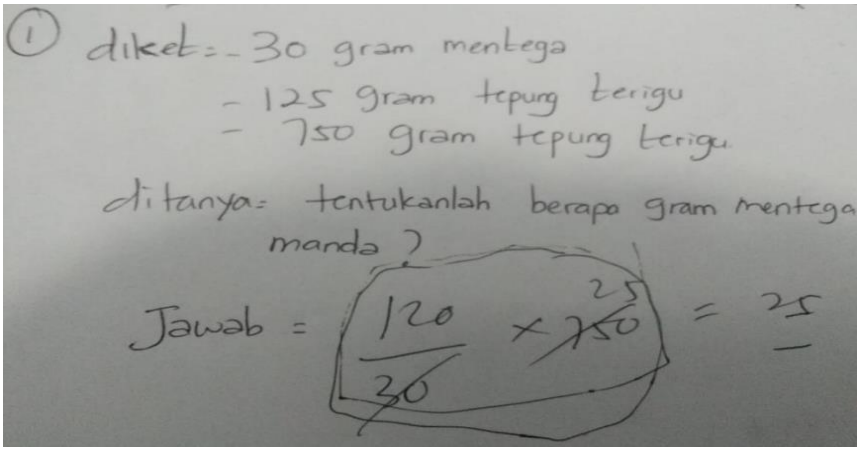

Figure 1. S1 subject's answer to question 1

Based on the test answers, S1 subjects were able to correctly identify the amount or amount of each ingredient. Thus, the numeracy aspect of the S1 subject is good. The results of the interview showed that students were able to compare dough 1 and dough 2 by showing that dough 2 was more because the flour used was more so that the butter needed in dough 2 was also more. This shows that the aspect of the numeracy relation of the S1 subject is in the good category. In the process of solving it, the subject of S1 uses a multiplication strategy in the context of this problem but students are still not precise in determining the ratio so that the results obtained are not correct. S1 has used the concept of multiplication as a problem-solving strategy but is still not right in placing multiplication components that involve fractions. Students are less precise in making the ratio between flour and butter in the two doughs. The results of the answers also show that the subject of S1 is still wrong in doing calculations. The analysis was strengthened by the results of interviews, it was obtained information that the subject of S1 had difficulty in determining the arrangement (in this case the quantifier and denominator) in the comparison ratio. Based on the results of the analysis, the arithmetic operation aspect of the S1 subject is still not good.

S2 Subject's numeracy ability

The results of the answers to the first problem of the S2 subject can be seen in the following picture:

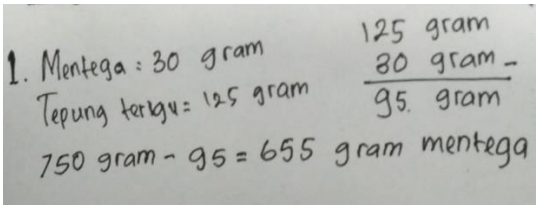

Figure 2. S2 subject's answer to question 1

Based on the test answers, S2 subjects were able to correctly identify the amount or amount of several materials. The answer does not state the amount of flour used for the new dough. However, after the interview, the S1 subject was able to identify well the amount of each ingredient. Thus, the numeracy aspect of the S1 subject is good. The results of the interview showed that subject 2 was able to compare the weight of the two doughs. S2 is able to determine which dough is more and understands that the second dough will also require more ingredients. This shows that the aspect of the numeracy relation of the S2 subject is in the good category. However, students still use subtraction strategies so that the results of the completion are less precise. Based on the results of the interview, the subject used the concept of reduction in solving the problem. S2 did not think to use the concept of ratio in solving this problem. Based on the results of the analysis, the arithmetic operation aspect of the S1 subject is still not good.

S3 Subject's numeracy ability

The results of the answers to the first problem of the S3 subject can be seen in the following picture:

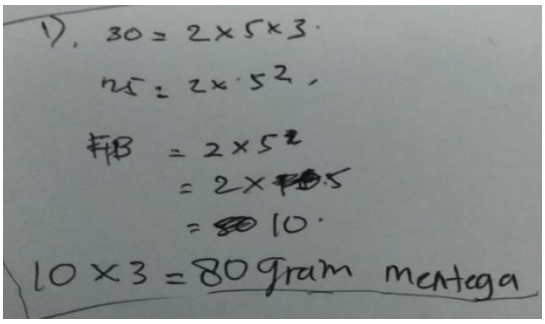

Figure 3. S3 subject's answer to question 1

Based on the answer, the subject of S3 is not right in solving the problem. There is an error in the concept used. Based on the results of the interview, the subject was able to identify the amount of each ingredient. Subjects can also mention aspects of quantity, related to more or less components. However, students do not know the concept of comparison to solve it. Students think that to solve the problem, the concept of the Greatest Common Factor (GCF) can be used. This shows that the numeracy aspect and numeracy relation of S3 subjects are good, but still low in arithmetic operations.

Question 2 (Inverse Proportion)

The problems given are as follows:

To build a multi-storey building, a building contractor takes 15 months with a lot of 120 workers. For some reason, the contractor wanted his work to be accelerated by 3 months. If everyone's ability to work is the same and for the project to be completed on time, how many workers must be added?

S1 Subject's numeracy ability

The results of the answers to the first problem of the S1 subject can be seen in the following picture:

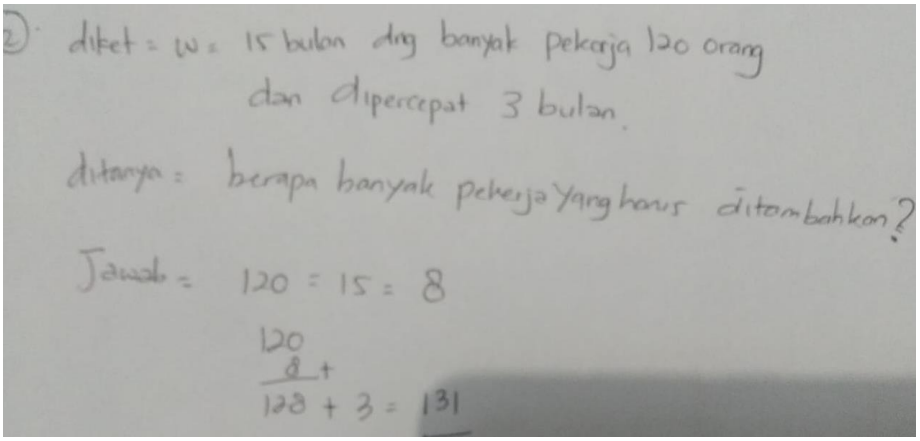

Figure 4. S1 subject's answer to question 2

Based on the answers of the subjects S1 can identify the length of time and the number of workers. While the results of the interview showed that the subject of S1 was able to mention more and fewer components. S1 subjects can also understand that to complete work faster, workers must be added. This shows that the numeracy skills in the aspect of counting and numeracy relations are good. However, students are still wrong in using the concept of ratio to solve problems. Students still use the concept of addition. The results of the interviews showed that students forgot the formula used in the concept of inverse comparison of values so that students could not solve the problem correctly. Thus, the numeracy ability of S1 subjects in the aspect of arithmetic operations is still not good.

S2 Subject's numeracy ability

The results of the answers to the first problem of the S2 subject can be seen in the following picture:

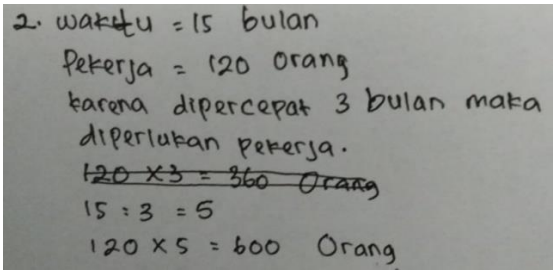

Figure 5. S2 subject's answer to question 2

Based on the answer of the subject S2 is not

appropriate in solving the problem. There is an error in the concept used. Based on the results of the interview, the subject of master's degree can identify the length of time and the number of workers. S2 subjects can also mention the quantity aspect, related to more or less components. However, students do not know that the way to solve it is by using the concept of inverse prportion. The results of the analysis show that the numeracy skills in the numeracy aspect and the numeracy relation of the master's degree subjects are good, but still low in arithmetic operations.

S3 Subject's numeracy ability

As for the answer sheet for the S3 subject, the subject did not answer question number 2. Based on the results of the interview, students were able to identify the length of time and the number of workers. S3 subjects can also name fewer or more components. However, students said that if time was accelerated, the number of workers needed would also decrease. Due to the wrong understanding of the concept, students are not able to answer questions about the comparison of turning values correctly. The results of the analysis show that the numeracy skills in the numeracy aspect and the numeracy relation of the S3 subjects are good, but still low in arithmetic operations.

The basic principle of numeracy literacy is contextual. Thus, the questions created to explore students' numeracy literacy are related to students' daily lives through story questions. Through problems that are closely related to everyday life, students will more easily understand and reason to solve these problems. Through story questions, children not only learn to practice their numeracy literacy skills but also learn to practice basic literacy in the form of reading comprehension. This is because students' ability in analytical thinking and problem solving indirectly correlates with children's reading comprehension abilities (Holmes & Dowker, 2013).

The results of the qualitative analysis showed that subjects with field dependent cognitive style had good numeracy skills in the aspect of counting and numeracy relations. However, students' numeracy skills in the aspect of arithmetic operations still need to be improved. This shows that the numeracy skills of students with field dependent cognitive style are still not as expected.

The results showed that students with field dependent cognitive style experienced problems during the numeracy process. In understanding the questions, field dependent students tend to be less systematic and do not sort out the important parts. This is shown when students are asked questions about the purpose of the question, students tend to reread the question. In understanding the problem, students need guidance from others in order to find the strategy used to solve the problem. Difficulties in the numeracy process are seen when students are less able to determine whether problem solving uses the concept of value comparison or turning point. According to Setiawan (Setiawan et al., 2020), the characteristics possessed by students with field-dependent cognitive style tend to look at complex situations globally without identifying the key elements of these complex situations. Students with a field-dependent cognitive style experienced more mathematical anxiety, were less active in classroom learning, were less accurate, had more errors in algebraic thinking, and were better at verbal information than analytical actions.

CONCLUSION

In this research, the analysis of students' numeration process is based on three aspects of numeracy, namely counting, numeracy relations, and arithmetic operations. The results of the qualitative analysis showed that the numeracy skills of students with field dependent cognitive style on the aspect of counting and numeracy relations were good. Meanwhile, the aspect of arithmetic operations still needs to be improved. Good mentoring and the use of learning methods that support the characteristics of students with field dependent cognitive style will be able to develop students' numeracy skills.

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