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Analysis of Mathematical Problem-Solving Ability in Terms of Multiple Intelligence, Cognitive Style and Learning Style of Junior High School Students

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Abstract

This study aims to describe: (1) the mathematical problem-solving ability of Sleman Regency's JHS students, (2) whether there is a difference in students' mathematical problem-solving ability in terms of multiple intelligence, (3) whether there is a difference in students' mathematical problem-solving ability in terms of cognitive style, (4) whether there is a difference in students' mathematical problem-solving ability in terms of learning style, and (5) whether there is an interaction between multiple intelligences, cognitive style and learning style. The research method used is a survey method with a quantitative approach. The research population is JHS students in the 2023/2024 school year in Sleman. The sample is 434 students, determined using a stratified proportional random sampling technique. The instruments used were a mathematical problem-solving ability test, a GEFT test, a multiple intelligence questionnaire, and a learning style questionnaire. The data analysis is descriptive statistics to determine students' mathematical problem-solving ability level and inferential statistics using a three-way ANOVA test to describe students' mathematical problem-solving ability's differences in terms of multiple intelligence, cognitive style and learning style, and to describe the interaction between multiple intelligences, cognitive style and learning style. The analysis showed that: (1) the mathematical problem-solving ability average score of Sleman's JHS students is 53.49 which is in the moderate category, (2) there is no difference in students' mathematical problem-solving ability in terms of multiple intelligence, (3) there is a difference in students' mathematical problem-solving ability in terms of cognitive style, (4) there is no difference in students' mathematical problem-solving ability in terms of learning style, and (5) there is no interaction between multiple intelligence, cognitive style and learning style of students.

Keywords: *Cognitive Style; Learning Styles; Mathematical Problem-Solving Ability; Multiple Intelligences*

Introduction

The 21st-century skills that students must master in learning are critical thinking and problem solving, creativity, communication skills, and the ability to work collaboratively, or what is known as 4c (Partnership for 21st Century Learning (P21), 2015). This is in line with mathematical abilities, which are part of mathematical power or doing math (mathematical skills) that must be mastered by a student, namely representation abilities, problem-solving abilities, understanding and proof, connections, and communication abilities (NCTM, 2000).

Learning in Indonesia refers to the learning process standards regulated by Permendikbudristek Number 16 of 2022 which includes learning planning, learning implementation, and learning process assessment. One of the assessments of students' mathematics abilities on an international scale is carried out by the Program for International Student Assessment (PISA). One of the contents of PISA (Program for International Student Assessment) is that mathematics emphasizes problem-solving content and students' abilities to apply their new knowledge (Pulkinen & Rautopuro, 2022; Nur & Palobo, 2018).

Problem-solving in mathematics is the process of applying previously acquired mathematical knowledge to new, unfamiliar situations (Hartono, 2014). Problem-solving skills are important because these skills are used by students when they later do a job in a new environment, face problems they have never encountered before and apply them to unrelated or non-specific content (Csapo & Funke, 2017).

The mathematical problem-solving abilities of junior high school students in Indonesia are still relatively low (Utami & Wutsqa, 2017; Nasution *et al.*, 2019). The results of PISA 2018 showed that in Indonesia only 0.4 % of students were able to reach level 5 (steps in problem-solving skills) (OECD, 2019). In the results of PISA 2022, Indonesia's score decreased due to the Covid-19 pandemic. However, even though Indonesia's score decreased, Indonesia's ranking appeared to increase, namely at 68th out of 81 countries.

In addition, the results of the National Mathematics Examination can also describe students' problem-solving abilities. Based on the results of the National Mathematics Examination for Junior High Schools in the DIY academic year 2018/2019, it shows that students' problem-solving abilities in Sleman Regency are still low, namely 69.50. In addition, the average ASPD Mathematics score in Sleman Regency in the 2020/2021 and 2021/2022 academic years was also low, namely 39.29 and 39.14, respectively.

Problem-solving skills can be improved through learning geometry (Chairani, 2013). In addition, according to NCTM (2000) in studying geometry, students analyze the characteristics of geometric shapes and make mathematical arguments about geometric relationships such as visualization, spatial reasoning, and geometric modeling to solve problems. However, based on the facts, students still have difficulty in solving problems related to geometry (Sholihah & Afriansyah, 2017). The 2000/2001 PISA assessment showed that students' abilities were still low in geometry, especially in understanding space and shape.

Students' ability to solve problems is influenced by several personal factors. One of the personal factors that influences students in solving mathematical problems is intelligence (Natsir & Munfarikhatin, 2021; Baharullah *et al* ., 2022, Wati & Pujiriyanto, 2022). Based on the research results of Wati & Pujiriyanto (2022), show that logical-mathematical, spatial-visual, and intrapersonal intelligence simultaneously have a significant effect on mathematical problem-solving abilities with an influence of 30.3 %. However, not many teachers pay attention to the tendencies of students' intelligence in learning (Setiawan, 2019). The diversity of intelligence possessed by students is called multiple intelligence. Each student has varying levels of comprehension, absorption, thinking power and intelligence, both students in one class and school.

There are nine intelligences that a person has, namely linguistic, visual and spatial, kinesthetic, intrapersonal, interpersonal, logical and mathematical, musical and naturalist intelligence (Gardner, 2011). McKenzie added that existential-spiritual intelligence as *multiple intelligence*. The characteristics of the diversity of intelligence possessed by each student cause different abilities in reasoning, defining, describing and solving a mathematical problem not only regarding theoretical and procedural concepts contained in textbooks or explanations by teachers, but can be solved through the inspiration of ideas and opinions of each student that they have. Each student has varying levels of comprehension, absorption, thinking power and intelligence, both students in one class and school.

The differences in intelligence possessed by each person affect him/her in daily life to process data. Therefore, the steps a person takes in estimating and thinking will also vary. The various variations that exist in each human being in processing this data are called cognitive styles (Tisngati, 2015). Students' mathematical problem-solving abilities can be seen from several dimensions, one of which is cognitive style.

Cognitive style is one of the important variables that can influence students' problem-solving (Mefoh *et al.,* 2017; Wang & Li-Jun *et al.,* 2003). However, the facts in the field show that students' cognitive styles have not been given much attention so all students' cognitive styles are the same (Hasanah, 2018). Ulya (2015) argues that there is a significant positive relationship between cognitive style and students' problem-solving abilities. A person's cognitive style influences him/her in solving mathematical problems, especially mathematical problems related to geometry (Winarso & Dewi, 2017). In line with this, Perdikaris (2011) stated that cognitive style is used as a mediator of students' geometry performance and as a tool to understand other things in the development of geometry.

Cognitive styles are divided into several types, namely *field-dependent* and *field-independent* cognitive styles, impulsive and reflective cognitive styles, perceptive and receptive cognitive styles, and intuitive and systematic cognitive styles (Volkova & Rusalov, 2016). *Field-dependent* (FD) and *field-independent*(FI) are the most popular cognitive styles (Mefoh *et al* ., 2017). FI and FD are characteristics of cognitive styles characterized by general ways of thinking, problem-solving, learning and relating to others (Abrams & Belgrave, 2013). This definition explicitly describes that FI and FD cognitive styles are related to a person's problem-solving performance. Pithers (2006) said that there is a strong relationship between FI-FD cognitive styles and problem-solving performance, where the solution depends on the utilization of critical elements in a context different from the original context in which it is presented.

Students' cognitive styles are very important to consider in the learning process so that students can solve mathematical problems (Son & Fatimah, 2020). Although much research has been done on FI and FD cognitive styles, there is still little attention paid to these types of cognitive styles in relation to specific areas of mathematics such as problem-solving and mathematical operations (Nicolaou & Xistouri, 2011).

The differences in the level of intelligence and problem-solving of students are caused by several factors, one of which is the learning style used by students (Ariansyah, 2017). Learning style is one perspective that requires attention. Learning style is the easiest step that belongs to every human being in taking, organizing, and summarizing the information obtained (Amin & Suardiman, 2016).

The appropriate learning style is the key to a person's success in learning. However, not all types of learning styles are well facilitated in the learning process (Maula & Fitri, 2024). Therefore, there is a need for variation in the learning process and direction so that students can find the learning style that suits them so that the purpose of learning can be achieved smoothly. The diversity of student learning styles is grouped into three types, namely visual, auditory, and kinesthetic learning styles. By using the appropriate learning style, students' problem-solving abilities can be maximized (Purwaningsih & Ardani, 2020).

Based on the explanation above, it can be concluded that there are still students who have problem-solving abilities in the low category. Although the results of the previous initial survey that has been conducted have described data on mathematical problem-solving abilities in general, to improve the quality of learning that supports mathematical problem-solving abilities, teachers, practitioners or researchers need to conduct more specific mapping related to students' mathematical problem-solving abilities and other factors that influence them to complement the previous survey specifically at the regional level and the variety of factors that influence students' mathematical problem-solving abilities.

The factors to be analyzed in this study are *multiple intelligence,* cognitive style and students' learning style. Thus, this study aims to obtain the latest mapping results related to mathematical problem-solving abilities reviewed from multiple *intelligence, cognitive* style and learning style of junior high school students in Sleman Regency. Sleman Regency was chosen as a place for survey research because it is one of the regencies in the Special Region of Yogyakarta Province which is known as a city of education and is a benchmark for national education. In addition, there has been no research on mathematical problem-solving abilities reviewed from *multiple intelligence, cognitive* style and learning style of junior high school students.

Method

The research method used is a survey method with a quantitative approach. The population of this study was all students of State Junior High Schools in Sleman Regency, Special Region of Yogyakarta Province in the 2023/2024 academic year totaling 24,012 students. The sample used was 434 students determined based on the stratified proportional random sampling technique. This study was conducted in 14 public junior high schools in Sleman Regency from May 1 to May 31, 2024. The independent variables in this study were *multiple intelligence, cognitive* style and student learning style. The dependent variable is students' mathematical problem-solving ability.

Data collection techniques consist of tests and non-tests. Test instruments consist of mathematical problem-solving ability tests and Group Embedded Figure Tests. Non-test instruments consist of *multiple intelligence questionnaires and* learning style questionnaires. Instrument validity consists of content validity and construct validity. Content validity using expert judgment. Construct validity on non-test instruments using CFA. Instrument reliability using Cronbach's Alpha.

The data were analyzed using descriptive statistics aimed at determining the level of students' mathematical problem-solving ability. To see the level of junior high school students' mathematical problem-solving ability, the following steps can be taken: calculating the respondents' problem-solving ability scores on the mathematical problem-solving ability test instrument; calculating the average respondent score; and determining the category level of each student's problem-solving ability based on the respondent's average score. The assessment criteria for making categorization conclusions are presented in the table below.

Table 1Categories of Mathematical Problem Solving Ability

Score Interval	**Interval**	**Category**
$M + 2\,SD \leq \bar{X} \leq Max$	$91 \leq \bar{X} \leq 100$	Very high
$M + SD \leq \bar{X} < M + 2\,SD$	$72 \leq \bar{X} < 91$	Tall
$M \leq \bar{X} < M + SD$	$53 \leq \bar{X} < 72$	Currently
$M - SD \leq \bar{X} < M$	$35 \leq \bar{X} < 53$	Low
$Min \leq \bar{X} < M - SD$	$0 \leq \bar{X} < 35$	Very low

The data were also analyzed using inferential statistics using a three-way ANOVA test to describe the differences in students' mathematical problem-solving abilities in terms of *multiple intelligence, cognitive* style and students' learning styles, as well as to describe the interaction between *multiple intelligence*, cognitive style and students' learning styles.

Results and Discussion

Results

Based on the research results, the problem-solving abilities of junior high school students in Sleman Regency in general at each level are presented in the following table.

Table 2. Description of General Mathematical Problem Solving Ability

Description	**School Level**			
	Tall	**Currently**	**Low**	**Overall**
Average	70.45	52.14	40.36	53.49
Category	Currently	Low	Low	Currently
Standard Deviation	13.65	16.51	14.08	18.64
Highest possible score	100	100	100	100
The lowest possible score	0	0	0	0
Highest score obtained	100	81.82	72.73	100
Lowest score obtained	27.27	9.09	9.09	9.09

In general, the average problem-solving ability of junior high school students in Sleman Regency is 53.59 with a standard deviation of 18.64. Furthermore, the highest score obtained by junior high school students in Sleman Regency is 100, while the lowest score achieved is 9.09. Thus, based on the previously determined problem-solving ability category, in general, the problem-solving ability of junior high school students in the Sleman Regency is in the moderate category.

Each school level has a different average. Students at the high school level have the highest average of 70.45 and are included in the medium category. This is different from students at the medium and low school levels, where each has an average of 52.14 and 40.36 respectively, which are included in the low category. The highest score achieved by students at the high school level is 100, while at the medium and low school levels, the maximum scores achieved are 81.82 and 72.73 respectively. Furthermore, the lowest score obtained by the high school level is 27.27 and the lowest score obtained by the medium and low school levels is 9.09. The percentage and frequency of the number of students in each category of problem-solving ability at each school level can be seen in the following table.

Table 3. Percentage and Frequency of the Number of Students in Each Category of Mathematical Problem Solving Ability

School Level	**F**	**Problem Solving Skills Category**					**Amount**
	%	**Very high**	**Tall**	**Currently**	**Low**	**Very Low**	
Tall	*F*	2	66	41	12	1	122
	%	1.64	54.10	33.61	9.84	0.81	100
Currently	*F*	0	29	49	78	16	172
	%	0.00	16.86	28.49	45.35	9.30	100
Low	*F*	0	4	25	61	50	140
	%	0.00	2.86	17.86	43.57	35.17	100
Overall	*F*	2	99	115	151	67	434
	%	0.46	22.81	26.5	34.79	15.44	100

The information obtained based on the table above is that there are 2 students from a total of 434 students who reach the very high category and come from high-level schools. Furthermore, in the high problem-solving ability category, the number of students from high, medium and low strata are respectively 66, 29, and 4 students with percentages of 54.10%, 16.86%, and 2.86%. In the medium problem-solving ability category, the number of students from high, medium and low strata are respectively 41, 49, and 25 students with percentages of 33.61%, 28.49%, and 17.86%. In the low problem-solving ability category, the highest percentage was obtained by students in the middle school strata, which was 45.35 % with a total of 78 students, while in the very low problem-solving ability category, there was only one student from the high strata with a percentage of 0.81% and most students in the very low category came from the low strata, which was 50 students with a percentage of 35.17%. Furthermore, overall, the number of students included in the very high category was 2 students, the high category was 99 students, the middle category was 115 students, the low category was 151 students, and the very low category was 67 students. Of the 434 total students as samples, the majority of students were in the low category with a percentage of 34.79 %, and in the very high category, they occupied the lowest percentage, which was 0.46%.

Students' problem-solving abilities are measured using four indicators, namely, 1) writing down/mentioning known information and questions asked, 2) determining the plan/strategy that will be used to solve the problem (making an example in mathematical symbols), 3) solving the problem using the planned strategy (making a mathematical model), and 4) re-checking the solution that has been obtained.

Discussion

1) Mathematical Problem-Solving Ability

Students' ability in the first indicator, namely writing/mentioning known information and questions asked, reached the moderate category. In this case, students have not been able to implement the information in the question as a provision for solving the problem. Students have difficulty interpreting the information in the questions provided to solve the problem, and most students are still unable to determine the sufficiency of the information in the questions. This is similar to Newman's opinion (White, 2005) who argues that students who can read the words in the question are not necessarily able to understand the mastery of the words in the question. The second indicator, namely determining the plan/strategy that will be used to solve the problem (making an example in mathematical symbols/symbols is in the moderate category. Newman (White, 2000) argues that students who can understand what is asked in the question, are not necessarily able to recognize the pattern/operation needed to solve the problem in the question in question. The inability of students to determine the plan/strategy to be used can be seen in students when they are wrong in determining the formula or concept that will be applied in solving the problem in question.

Based on the results that have been presented previously, the indicator of solving problems using planned strategies (making mathematical models) and re-checking the solutions that have been obtained is in the low category. The third indicator, namely solving problems using planned strategies (making mathematical models) obtained the smallest percentage compared to other indicators. Students have difficulty when asked to make mathematical models. Not a few students find it difficult to analyze the truth contained in the problem and then connect it with the appropriate mathematical concept so students make mistakes in transforming the problem into a mathematical model (Sari & Wijaya, 2017).

Next, the fourth indicator, namely re-checking the selected solution, reaches the low category. Students' abilities in this indicator are seen when students substitute the results obtained or choose another formula. Students are confused about substituting the results obtained, let alone finding another formula.

2) Mathematical Problem Solving Ability According to Multiple Intelligence

Based on the results of the overall data analysis, it can be obtained that there is no difference in students' problem-solving abilities according to their type of intelligence, either between students with dominant linguistic, mathematical and logical, visual and spatial, musical, interpersonal, intrapersonal, kinesthetic, naturalist intelligence or dominant existential intelligence. This means that students' problem-solving abilities are not influenced by the type of intelligence they have. This finding is in accordance with research by Sumadi *et al* ., (2020) which shows that students with different multiple intelligences have different ways of solving problems, but there are also similarities. Each student with different multiple intelligences has almost the same problem-solving abilities, so that as a reference in each student's thinking ability, cannot only be seen from one type of aspect (Putra & Sumadi, 2018).

The results of inferential data analysis show that there is no difference in problem-solving abilities of students with different bits of intelligence, but the results of descriptive data analysis show that the percentage of problem-solving abilities in order from the highest is students with dominant naturalist intelligence; mathematics and logic; existential; intrapersonal; music; interpersonal; visual and spatial; linguistic; and kinesthetic.

Naturalist intelligence includes the ability to relate to nature clearly and sensitively; to recognize and classify living things, objects, features, and patterns; and to use the information acquired productively. A mathematics curriculum that is linked to naturalist intelligence uses as many natural objects and as much time in nature as possible. This curriculum provides a unique opportunity to foster a sense of wonder at the mathematical patterns found in nature. Naturalist intelligence achieves the highest problem-solving ability and falls into the moderate category. This is in accordance with the research results of Sumadi *et al.,* (2020) which stated that students with dominant naturalist intelligence can go through all four stages of Polya's problem-solving. Students with dominant naturalist intelligence have been able to understand the problems to be solved by doing the following: reformulating; determining the strategy to be used to solve the problem; implementing the predetermined strategy; and rechecking what has been done.

Mathematical and logical intelligence is the potential to understand cause and effect and manipulate numbers, quantities, and operations, as used in mathematics, reasoning, logic, problem-solving solving and recognizing patterns (Nelson, 1998). The problem-solving ability of students with mathematical and logical intelligence is included in the moderate category. Students with this intelligence can reach the moderate category on the indicator of writing/mentioning known information and questions asked and on the indicator of determining the plan/strategy to be used to solve the problem (making an example in mathematical symbols), while on the indicator of solving problems using the planned strategy (making a mathematical model) and on the indicator of re-checking the solutions that have been obtained are included in the low category. This finding is in accordance with the research of Elisa, EA (2017) which provides information that students with dominant logical and mathematical intelligence can identify the problems faced and implement steps to solve the problems. In addition, according to Kurniawati & Kurniasari (2019) students with logical and mathematical intelligence can translate problems into mathematical language, namely through the measurement process, using symbols and geometric representations, besides that students can also compile steps to find solutions using the mathematical concepts of their choice in solving problems.

Existential intelligence can be defined as the ability to conceptualize or answer deeper or bigger questions about human existence, such as the meaning of life, why are we born, why we die, and what is consciousness. Students with this intelligence have a better level of intelligence in solving mathematics in cognitive processes and different levels of knowledge because students can conceptualize deep questions. Overall, students' problem-solving abilities in the study were classified as moderate. This is similar to research by Sumadi *et al*., (2020) which shows that students with existential intelligence can build meaning about the problems to be solved, namely by reformulating; determining the strategy to be used in solving the problem; implementing the strategy that has been determined; re-examining everything that has been done. This refers to the opinion of McKanzie (2005), who stated that students with this intelligence have confidence in new learning.

Intrapersonal Intelligence has significant implications for the mathematics curriculum. A curriculum designed to facilitate metacognitive perspectives will emphasize personalized experimentation with diverse and meaningful problems (Willis & Johnson, 2001). Students who have high levels of intrapersonal intelligence have better self-knowledge than other students. Students who are less aware of their strengths and weaknesses are less likely to adapt to different situations and regulate their learning in them (Pintrich, 2002). Overall, the problem-solving abilities of students with intrapersonal intelligence are classified as moderate. Rochim *et al* ., (2023) stated that students with intrapersonal intelligence in solving arithmetic series problems can complete all stages of problem-solving with confidence and efficiency. Students show good self-confidence and effective time management. The ability of students with intrapersonal intelligence on the indicator of re-check the solutions that have been selected in this study is categorized as low. This is in line with research conducted by Mahfiroh *et al.,* (2021) which states that students with intrapersonal intelligence have not been able to write problems using other methods, so students have not been able to re-check the results of problem-solving properly.

Musical intelligence is defined as the potential for musical thinking, hearing, recognizing, and remembering patterns, such as singing, identifying sounds, and remembering melodies and rhythms. In this study, the problem-solving abilities of students with musical intelligence were overall in the moderate category. Students with musical intelligence achieved the moderate category in every indicator of mathematical problem-solving ability except for the third indicator, namely using planned strategies (creating mathematical models). This is in line with research by Sumadi (2023) which states that students who have musical intelligence can understand problems and make plans. However, at the stage of implementing the plan, students were able to explain the six criteria for critical thinking, but the explanations presented did not make sense and were not appropriate to the conditions of the problem being faced. Then, at the re-checking stage, students can fulfill focus, situation, clarity and overview.

Interpersonal intelligence is the potential to work with others, as used in understanding people, leading and organizing others, communicating, and resolving conflicts. In relation to mathematical performance, learning methods designed to enhance interpersonal intelligence focus on collaboration between students. Interpersonal intelligence indicates the ability to understand the motives and desires of others, and to work effectively with others (Kuswana, 2013; Sutarman & Mulyati, 2019; Yavich & Rotnitsky, 2020). Some interpersonal skills include social awareness, empathy, leadership, communication, and teamwork (Widarto, 2011; Paolini, 2020). Peer tutoring allows students with more advanced math skills to help those with less advanced skills, resulting in improvements for both (Wills & Johnson, 2001). Overall, the problem-solving abilities of students with interpersonal intelligence in this study were classified as moderate. Students with this intelligence get moderate categories on the first and second indicators. However, in the third and fourth indicators, students only achieved the low category. Students have difficulty in using the planned strategy (creating a mathematical model). Students are also not able to re-check the solutions that have been obtained properly. This is in line with research conducted by Rochim *et al* ., (2023) which states that students with interpersonal intelligence will first read the questions carefully. Students can write down information about what is known and asked and provide data fluently during interviews. Students mention and explain mathematical models or ideas correctly using arithmetic series formulas. The problem-solving strategy used is a deductive strategy. Despite rechecking the answers, the algebraic operations and conclusions given are incomplete.

Visual and spatial intelligence is the potential to represent the spatial world internally in one's mind as used in reading maps and graphs, drawing, solving mazes, puzzles, imagining and visualizing (Nelson, 1998). Some aspects of mathematics also have spatial components and correlations between mathematics and visual and spatial skills (Fias & Fischer, 2005; Lachance and Mazzocco, 2006; Zhu, 2007). Visual-spatial intelligence also has a significant effect on mathematical problem-solving ability partially. The results of this study are consistent with several previous studies that found the same results (Akhmad, 2019; Battista *et al* ., 1982; Delgado & Prieto, 2004; Adams *et al* ., 2022). Overall, the problem-solving abilities of students with visual and spatial intelligence in this study are classified as low. Students with this intelligence can reach the medium category on the indicator of writing/mentioning known information and questions asked and on the indicator of determining the plan/strategy to be used to solve the problem (making an example in mathematical symbols). However, the indicator of solving problems using a planned strategy (making a mathematical model) only reaches the low category. Likewise, the indicator of re-examining the solutions that have been obtained is included in the low category. This is in line with research conducted by Ridwan *et al* ., (2022) which states that students with moderate spatial intelligence are only able to solve problems with Polya's two steps in solving problems. Students with moderate visual and spatial intelligence have not been able to complete the plan that will be used and have not been able to re-examine it either.

Linguistic intelligence encompasses a range of language skills, from sensitivity to the meaning of certain terms to the ability to use language in a variety of contexts. NCTM (1989) recognizes the importance of language in the curriculum and assessment standards for school mathematics, stating that discussing, reading, writing and listening to mathematics are important parts of learning and using mathematics to understand students' thinking strategies and assess their progress by explaining to teachers, parents, or other students about the facts they know well and the facts they need to practice. Overall, the problem-solving abilities of students with linguistic intelligence are in the low category. This is in accordance with research conducted by Sumadi *et al* ., (2020) which states that in the problem understanding indicator, students with dominant linguistic intelligence mention information that is known and asked that has problems, but what is written is incomplete.

Students with strong kinesthetic intelligence will use their body parts in their way to develop and express concepts. The overall problem-solving ability of students with kinesthetic intelligence is classified as low. This is in accordance with research conducted by Sumadi *et al* ., (2020) which states that students with dominant kinesthetic intelligence can only reach three stages of Polya problem-solving. In addition, according to Risnawati *et al* ., (2022) also stated that students with kinesthetic intelligence can identify problems by writing down what is known and asked, and can use formulas correctly, but have not been able to solve problems with various solutions. Students can write other solutions but they are not correct.

3) Mathematical Problem Solving Ability According to Cognitive Style

Based on the results of the overall data analysis, it can be obtained information that there are differences in students' problem-solving abilities according to cognitive style. This means that students' problem-solving abilities are influenced by their cognitive style. This is in accordance with research conducted by Muzaini (2016) which states that students with a *field-independent* cognitive style have better achievements compared to students with a *field-dependent cognitive style*. This is because students with a *field-independent* cognitive style in the learning process tend to do things that involve analytical abilities such as mathematics. This is different from *field-dependent students* who prefer things that involve interpersonal relationships such as social sciences, literature, or trade. *Field-independent* students have more self-confidence and have great and consistent belief in the choices they make, so they are not easily influenced by their environment compared to *field-dependent students.* Students with a *field-dependent* cognitive style often experience learning difficulties when analyzing problems.

Overall, the results of the study indicate that the problem-solving ability of students with a *field-dependent* cognitive style is classified as low, while students with a *field-independent cognitive style* can achieve problem-solving ability in the moderate category. The difference in student abilities can be seen in the indicator of re-checking the solutions that have been obtained, where FI students can reach the moderate category, while FD students are included in the low category. This finding is similar to a study conducted by Hobri *et al* ., (2020) which stated that the problem-solving abilities of FD and FI students can be seen in the stages of implementing solution strategies and re-checking, where FI students have better problem-solving abilities compared to FD students, while at other stages there is no difference. Pradiarti & Subanji (2022) stated that the mathematical problem-solving abilities of students with a FI cognitive style are classified as very good because they can meet all Polya problem-solving indicators by orienting themselves to the NCTM indicators, while the problem-solving abilities of students with an FD cognitive style are classified as poor because in understanding the problem and implementing the solution plan it is still not quite right.

FD students tend to view problems in general and accept parts/partials or contexts predominantly (Witkin, 1977). According to Tisngati (2015), FI students have the characteristics of reflective thinking, namely being able to filter and sort available information/knowledge and being able to consider it appropriately and actively in planning problem-solving. FI students think critically and analytically so that they can easily find patterns and group information appropriately.

FI students can meet all problem-solving indicators. Starting from understanding the problem, planning a solution strategy, implementing the solution strategy, and checking the results of the solution, however, FD students are less able to meet all indicators (Anthycamurty & Saputro, 2018; Arifin & Hidayah, 2019; Nurmutia, 2019). FD students tend to have a personality that sorts out easy things and has less ability because they are less active during the learning process (Wapner in Mefoh, Nwoke, Chukwuorji & Chijioke, 2017).

4) **Mathematical Problem-Solving Ability According to Learning Style**

Based on the results of the overall data analysis, it can be obtained that there is no difference in students' problem-solving abilities according to their learning style, either between auditory, visual, or kinesthetic learning styles. This means that learning styles do not affect students' problem-solving abilities. This finding is in accordance with research conducted by Sundayana (2016) which states that every student with a different learning style, whether auditory, visual, or kinesthetic learning styles, has the same mathematical problem-solving ability. In addition, Syahril*et al* ., (2021) also argue that mathematical problem-solving abilities are not related to the type of student learning style. Every student with different learning styles has the same tendency to solve problems.

The results of inferential data analysis showed no difference in the problem-solving abilities of students with different learning style intelligences, but the results of descriptive data analysis showed that the percentage of students' problem-solving abilities in order from the highest were students with kinesthetic, visual, and auditory learning styles. This finding is in line with the research of Umrana *et al* ., (2019) which states that students with different learning styles have different mathematical problem-solving abilities. Overall, the problem-solving abilities of students with kinesthetic learning styles are better than those of students with auditory and visual learning styles. The problem-solving abilities of visual, auditory, and kinesthetic students can be seen in the fourth indicator, namely re-checking the solutions that have been obtained, where students with auditory and visual learning styles are only able to reach the low category, while students with kinesthetic learning styles can reach the medium category.

5) **Interaction Between Multiple Intelligence, Cognitive Style and Learning Style on Students' Mathematical Problem Solving Ability**

The interaction between *multiple intelligence*, *cognitive* style, and learning style was tested using a three-way ANOVA test. The results of the analysis showed that there was no interaction between *multiple intelligence*, *cognitive* style, and learning style on students' mathematical problem-solving ability. Thus, between the types of multiple intelligences possessed by students, types of cognitive styles, or learning styles together did not provide a significant difference in students' mathematical problem-solving ability. In addition, based on data analysis, a determination coefficient (R2) was also obtained, which was 0.136. This can be interpreted that *multiple intelligence*, cognitive style, and learning style contributed 13.6% to students' mathematical problem-solving ability and 86.4% was influenced by other variables (besides *multiple intelligence*, cognitive style, and learning style).

Conclusions

Based on the results and discussions that have been described previously, the following conclusions were obtained: 1) The mathematical problem-solving ability of junior high school students in Sleman Regency is in the moderate category. The mathematical problem-solving ability of students on the indicator of writing/mentioning known information and questions asked is in the moderate category; the indicator of determining the plan/strategy that will be used to solve the problem (making an example in mathematical symbols) is in the moderate category; the indicator of solving problems using the planned strategy (making a mathematical model) is in the low category; and the indicator of re-checking the solution that has been obtained is in the low category, 2) There is no significant difference in students' mathematical problem-solving ability in terms of *multiple intelligence*, 3) There is a significant difference in students' mathematical problem-solving ability in terms of *field-independent cognitive style and field-dependent* cognitive style. The mathematical problem-solving ability of students with *field-independent* cognitive style is in the medium category, while students with *field-dependent cognitive style* are in a low category, 4) There is no significant difference in students' mathematical problem-solving ability in terms of learning style, 5) There is no interaction between *multiple intelligence*, cognitive style and students' learning style on students' mathematical problem-solving ability.

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