Global and Stochastic Analysis
Vol8 No. 2 (July-December, 2021)

MUK PUBLICATIONS
Open Access Publisher

EXPLORING METACOGNITIVE SKILLS OF UNIVERSITY STUDENTS IN SOLVING MATHEMATICS PROBLEMS BASED ON COGNITIVE STYLE

DJATMIKO HIDAJAT*, SITI MAGHFIROTUN AMIN, TATAG YULI EKO SISWONO

Abstract: This study aims to determine the university students metacognitive skills for mathematical problem-solving, based on cognitive style. Thirty-five university students at a private university, Sukoharjo, Indonesia, were selected, in order to complete the Group Embedded Figures Test (GEFT) and Mathematical Ability Tests. The result showed that university students were classified into two types of cognitive styles. Each group was interviewed by one university students, based on the results of solving problems. It was also observed that the two participantswere able to perform metacognitive activities, including planning, monitoring, evaluation, and prediction skills, according to the indicators of the (metacognitive) skills, which were reported not to be fully achieved. The two participants (field-independent and field-dependent) performed metacognitive activities, which includes, (1) writing down and stating the facts contained in the question, (2) checking the results according to the plan, (3) carefully evaluating the achievement of targets by examining the results obtained, in order to ensure the correctness of every step conducted and planned, (4) predicting and stating the conclusions reached, after solving the problem. Based on these results, it was suggested for researchers and lecturers that have related problems, to examine the involvement of metacognitive skills more deeply, in problem-solving.

Keywords:*cognitive style, metacognitive skills, mathematics problems*

Introduction

In recent days, great attention has been paid to problem solving in education. Its significance has been recognized not only at the national level (General Directorate of the Department of Education, 2020), but also at the international level (NCTM, 2000). Problem solving is the most important cognitive activity in everyday life (Jonassen, 2000; Verschaffel et al., 2020). Peter-Koop & Scherer (2012) explain that problem solving and thinking form an integral part of the core knowledge of mathematics. Since the early 1980s, the problem solving process has always been the main and fundamental area of research (Bayat & Tarmizi, 2010; Schoenfeld, 2007). In addition, problem solving is a cognitive process which requires a solution to a certain problem (Düşek & Ayhan, 2014; Holyoak, 1990; Jonassen, 2003; Sweller, 1988). Students must therefore have appropriate skills to solve problems, particularly with regard to the resolution of problems requiring 'metacognitive skills.' Metacognition is reported to be closely related to the learning process of mathematics, as well as playing an important role in problem-solving activities (Gurat & Medula, 2016; Jagals & Van Der Walt, 2016; Schoenfeld, 2016). The importance of metacognition for problem-solving was also acknowledged by (Artz & Armour-Thomas, 1992; Lee et al., 2001).

Metacognition includes cognitive processes that refer to higher-order thinking that involves active control of cognitive processes, including the fact that they affect mathematical learning or the conduct of students (Antonietti et al., 2000; Özsoy & Ataman, 2009; Susanto et al., 2020). The mastering of metacognitive skills will influence the achievement of math, particularly in solving mathematical problems, according to (Abdullah et al., 2017; Clarke et al., 2007; Tzohar-Rozen & Kramarski, 2014). This is supported by Desoete et al. (2001); Son et al. (2020), who demonstrate th at metacognitive abilities contribute to mathematical problem solving performance. Desoete (2008) also states that students metacognitive are more strategic and brilliant than those without these competencies.

Principally, the efforts to involve metacognitive skills into various learning activities are expected, in order to provide beneficial improvements to the quality of learning being carried out (Hargrove & Nietfeld, 2015; Smith & Mancy, 2018). Therefore, metacognitive skills have an important role in learning, due to increasing the educational activities and outcomes of university students, in order to have an impact on problem-solving. Moreover, metacognitive skills are an aspect of one-dimensional knowledge, which are interestingly needed for further study.

Previous studies have shown that metacognitive skills play an essential role in the solution of mathematical problems. The results of Jagals & Van Der Walt (2016) showed that metacognitive skills were needed for solving mathematical problems, because of their ability to foster awareness, especially through planning and monitoring. (Tachie & Molepo, 2019; Van der Stel et al., 2010), also showed that metacognitive skills contributed to learning performance, and were independent of intellectual abilities. Furthermore, Abdullah et al. (2017) showed that the level of student achievement in solving non-routine mathematical problems was very low. There were also significant differences in the metacognitive skills between students with different levels of performance in solving non-routine mathematical problems. The performance of students, whether or not successful, may be caused by a lack of metacognitive skills (Zhang & Seepho, 2013). These descriptions showed that metacognitive skills are important in the problem-solving process because they allow university students to control their cognitive processes.

Moreover, cognitive style influences problem solving. This is supported by Bendall et al. (2016); Mefoh et al. (2017); Trisna et al. (2018), differences in cognitive style may also affect learning outcomes and problems. The results Pathuddin et al. (2019) have shown a trend towards structured solutions, organization and re-structuring of new information and linking it to their expertise in independent cognitive fields. While students with field-dependent cognitive styles have unstructured and poorly structured functionality for problem resolution. In addition, new information is hard to restructure and relate to the information it already has.

A review of metacognition's role in mathematical problem solving should therefore take place after recognizing the importance of metacognition in mathematical problem solving. Furthermore, the role of metacognitive capacities in the solution of mathematical problems is missing from empirical studies. Most studies in the past considered solving mathematical problems with far less attention paid to cognitive style (Son et al., 2020). This study was therefore conducted to study the metacognitive skills of students in the resolution of cognitive-style mathematical problems. It focuses on the metacognitive skills of planning, monitoring, evaluation, and prediction (Desoete, 2008).

Based on previous studies, the difference in focus for this research is on the ability to use metacognitive skills of planning, monitoring, evaluation, and prediction to solve mathematical problems. The problem examined by this research, according to the explanation, is "How are the metacognitive skills of university students in solving mathematics problems based on cognitive style?"

Review of Literature

The application of metacognitive skills is reported to possess the form of task orientation, planning, monitoring, evaluation, and recapitulation. Veenman & van Cleef (2019), stated that these metacognitive skills were represented as a series of internalized self-instructions, passing orders across to students about what to do, as well as when, why, and how to carry out assignments. Metacognitive skills also controls cognitive processes, which consists of planning, monitoring, evaluation, and predictive attributes (Desoete, 2008; Veenman et al., 2006). Most studies are reported to only use three stages of metacognitive skills, as only a few investigated the four steps. Therefore, it is interesting to carry out these four processes, in the development of metacognitive skills. These processes involve planning, monitoring, evaluation, and predictive skills. The procedure in this study is observed to be associated with the stages of metacognitive skills. These procedures were often used by (Lioe et al., 2006), in linking problem-solving and metacognitive skills. Therefore, this resulted in the organization of problem-solving steps (Liljedahl et al., 2016; Lioe et al., 2006), and the stages of metacognitive skills (Desoete, 2008). Finally, the identification of university students metacognitive skills in problem-solving was adapted and compiled. These includes, (see Table 1).

Table 1.Identification of university students metacognitive skills in problem-solving

Metacognitive Skills	Activity
ning	ting down what is known and asked, determining problem-solving ctives, planning solutions, as well as looking for linkages and problems that been completed.
iitoring	ermining problem-solving results, checking the accuracy of steps, and yzing the feasibility of the processes being planned for implementation.
uation	lying other problems, as well as evaluating the achievement of goals.
liction	marizing and predicting the results of problem-solving detected

However, another aspect that is to be observed is the cognitive style.

The ability to solve an individual's mathematical problems is shown from various dimensions, one of which is the cognitive style (Son et al., 2020). These differences are reported to be observed in the strategies of solving mathematical problems, in terms of intelligence level, creative thinking skills, as well as methods to obtain, store and apply knowledge. Volkova & Rusalov (2016), stated that cognitive styles are divided into various types, namely field-dependent and independent, impulsive and reflective, as well as intuitive and systematic methods. However, the focus of cognitive style is field-dependent and independent, in this study. Globally, several researchers are very interested in examining the relationship between cognitive style dimensions and mathematical abilities (Chrysostomou et al., 2013). Even though much research has been carried out on both field-independent and dependent cognitive styles, few attention has been made to these cognitive styles, in terms of specific areas, such as problem-solving and mathematical operations (Nicolaou & Xistouri, 2011).

Field-independent cognitive styles tend to be independent and confident, compared to the dependent cognitive styles, which has been reported to rely on external influences (Son et al., 2020; Witkin et al., 1977). Interestingly, these cognitive style differences are found to exhibit metacognitive skills, which helps in solving mathematical problems, especially in drawing cubes. Educators are advised to consider the results of this study, due to its assistance in designing effective instruction about the slices of the cube.

Method

This study used a descriptive-exploratory research design to thoroughly explore the metacognitive skills of university students, in mathematical problem-solving, which was focused on "Cube Slices". The participants were thirty-five university students at private Universitiy, Sukoharjo, Central Java, Indonesia. This study was observed to use a purposive sampling method, in order to select the needed amount of participants (Miles, Huberman, & Saldaña, 2018). The participants were instructed to complete the Group Embedded Figures and Mathematics Ability Tests (GEFT & MAT), with solutions divided into two groups based on the scores. Therefore, two participants (field-independent and field-dependent) with similar abilities were interviewed. Furthermore, in order to explore the characteristics of each group, both participants were instructed to solve cube slice questions. Afterwards, task-based interview was conducted with one of the university students from each group.

The Group Embedded Figures Test (GEFT) was reported to have been adapted from an instrument developed by Witkin (Witkin et al., 1977). It consisted of three parts, which possessed 9 pictures (2 initial examples and 7 final exercises) for each categories, respectively. Furthermore, the questions used as a Mathematics Ability Test were adapted from the SBMPTN examination bank, for the 2019/2020 school year. In order to observe the process of metacognitive skills and record interviews, observation sheets were used. It consisted of several open-ended questions, which were used to explore metacognitive skills, in the process of solving mathematical problems. The instrument was also tested for validity and reliability before use, as validation of the question contents and interview sheets was carried out by two mathematicians and one educational expert. The criteria for the validity of the instruments included the feasibility of the test questions, content, language, and appropriate instructions, which were used to reveal the metacognitive skills process of university students. Due to these results, participants were instructed to solve a mathematical problem, namely a cube slice. The problem is presented in Figure 1 below.

> Given the cube ABCD.EFGH with U the midpoint of EH, V the midpoint of AE, and W the midpoint of AB. Draw the plane α through the points U, V, and W slicing the cube using the affinity axis.

Figure 1. Mathematical Problems

In order to analyze the data, the Group Embedded Figures and a Mathematics Ability Tests were initially provided. Their results obtained were recorded into two groups based on the GEFT score (field-independent ≥ 10 and field-dependent < 10), which ranged from 0-18, and that of Mathematics Ability Test (≥ 80). The Mathematics Ability Test (with≥ 80) group with a field-independent and dependent cognitive style, were used as the research participants. Afterwards, mathematical problems were provided to the university students, as they were being examined based on their reasons, when performing the process of solving the cube slice issue. Each participant was thoroughly observed, based on their metacognitive skills in solving problems. Afterwards, the triangulation process was carried out, in order to verify the data collected from the interviews. Triangulation was also carried out to confirm the results of students' answers. Moreover, the university students and researcher were coded as S-1 & P, respectively. Conclusively, the results of the metacognitive skills of the two university students in solving the mathematical problems, were also summarized.

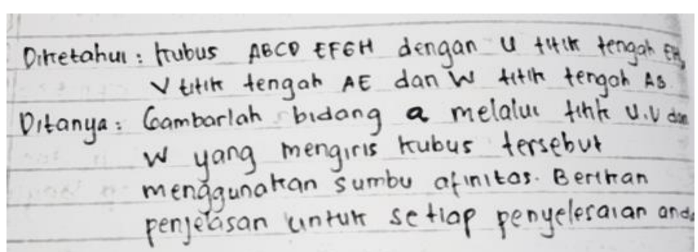
Results

Among the thirty-five university students that carried out the Group Embedded Figures Test, twenty had a score of ≥ 10, with the remaining fifteen obtaining < 10. However, in the Mathematics Ability Test, eighteen university students had a score of ≥ 80, with the remaining seventeen having < 80. After the provision of the GEFT and MAT scores to the university students, ten and eight of them (having a score of ≥ 80) were obtained into the field-independent and dependent cognitive styles, respectively. Among the eighteen potential participants that achieved the criteria, one candidate each with relatively similar abilities, were selected from both the field-independent and dependent cognitive styles, respectively. In order to discover more about the metacognitive skills of university students in solving mathematical problems, the following were the results of the interviews with two of these participants, where S-1 & S-2 are the field-independent and dependent cognitive styles, respectively.

Metacognitive Skills in the Problem-solving Process of S-1

Based on the fact that S-1 had written all details in the problem, this meant that the participant understood what was provided and should be discovered in the problem. From the university students' sheet, it was indicated that S-1 also stated the planning stage, as presented in Figure 2.

Planning Skills of S-1


Diketahui : kubus ABCD EFGH dengan U titik tengah EH, V titik tengah AE dan W titik tengah AB.
Ditanya : Gambarlah bidang α melalui titik U, V dan W yang mengiris kubus tersebut menggunakan sumbu afinitas. Berikan penjelasan untuk setiap penyelesaian anda

Translate Version

Given: Cube ABCD.EFGH with U the midpoint of EH, V the midpoint of AE, and W the midpoint of AB.

Asked: Draw a plane through points U, V, and W slicing the cube using the affinity axis. Explain each step of the completion.

From the results of the interview with S-1, conscious information that was predicted to be obtained from the problem was provided. However, the participant had a little difficulty in providing the information to be used in solving the problem. Based on the interviews with S-1, the following was obtained.

P: How did you determine what was provided and asked in the question?

S-1: S-1: Just reading and understanding the problem, as well as working on it according to the steps. However, a little confusion set in when I started drawing the cube pieces.

P: What made you believe that the goal to be achieved is correct?

S-1: The reason was that I already understood the problem and questions being asked.

P: To solve this problem, what knowledge did you use?

S-1: The knowledge of geometric shapes.

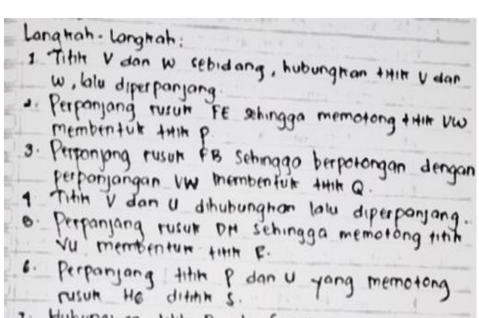
P: Regardless, is there any other knowledge that should be used to solve this problem?

S-1: Yes Sir, the knowledge of points, lines, and fields in Geometry.

Based on the description of metacognitive skills in understanding problems and making plans, S-1 identified questions by reading and understanding the problematic inquiries being asked. Based on the determination of problem-solving, S-1 convinced P that the goal to be achieved was actually due to understanding the problem and questions being asked. However, in completing the planning, S-1 was convinced that the assumed solution was correct, due to the fact that the meaning and direction of the problem had already been understood. S-1 also stated that the method used to solve the present problem was the knowledge of slices. The participant also stated that the alternative methods used in the problem-solving process were the basic knowledge of the geometry of points, lines, and planes. However, these were not optimal in the usage of skills. Based on individual knowledge, S-1 was observed to have determined the goal of the problem. Also, S-1 was observed to have discovered a connection with the problem, which had already been resolved. Therefore, based on metacognitive skills in solving geometric problems, S-1 was reported to have achieved the planning criteria.

Monitoring Skills of S-1

From the university students' sheet, it was indicated that S-1 also discussed at the monitoring stage, as shown in Figure 3.



Translate Version

Steps

1. Points V and W are a plot, connect points V and W, then it is extended.
2. Extending FE so that it intersects point VW at point P.
3. Extending FB so that it intersects the VW intersection at point Q.
4. The points V and U are connected, then extend.
5. Extending DH so that it intersects point VU at point R.
6. Extending points P and U that intersect HG at point S.

From the interview results with S-1, conscious explanations about the strategies to be used in solving the problem was provided. Interviews with S-1 were as follows,

P: Are you sure the strategy implementation procedure is correct?

S-1: Yes, of course, Sir, because it was carried out accordingly to what I had planned.

P: Are the results of solving the problem carried out correctly?

S-1: Yes Sir.

P: What is the reason for saying it?

S-1: The reason is that I believe the steps to solve it were conforming to my image and strategy.

P: How do you know that the strategy you are using is suitable for the question's objective?

S-1: I read the question over again, then reviewed the steps I had taken.

P: State your strategy procedure?

S-1: My strategy was to read and understand the problem, then draw the ABCD.EFGH cube. Afterwards, I think of each step used when drawing the slice of the cube, by using the affinity axis method. With that being carried out, I proceeded to double-checking.

P: After carrying out your strategic planning procedures, what did you do?

S-1: I double-checked the steps, in order to know whether they match what I drew or not. The result was the plane α, which is a hexagon that intersects the cube ABCD.EFGH.

In determining the problem-solving results, S-1 checked the results by conforming to what had been planned, because the steps carried out were correct and similar to the picture and strategy. Also, S-1 checked the troubleshooting stages, by re-reading the questions and examining the steps taken. S-1 also stated that the strategy used was to read and understand the problem first, then draw the cube shape ABCD.EFGH. Afterwards, the participant thought each step that was used when drawing the cube pieces, via the use of the affinity axis method. In analyzing the suitability of plans made with implementation, S-1 double-checked the steps to know whether they were similar to what had been drawn or not. Furthermore, S-1 stated that the result was in line with what was explained, due to obtaining the final answer, which was the α-field in the form of a hexagon that sliced the cube ABCD.EFGH. Also, S-1 was aware of using individual knowledge to re-check whether the problem-solving result corresponded to the stages provided. Conclusively, the participant was observed to have consciously re-checked the truth of the strategic planning implementation procedure, towards solving the problem presented.

Evaluation Skills of S-1

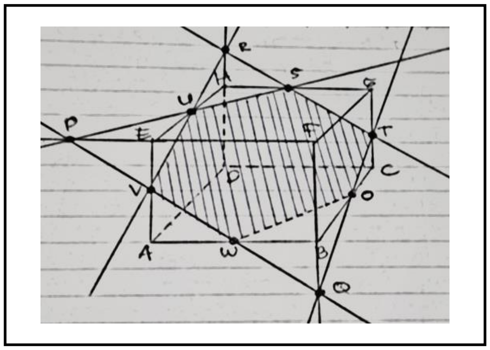


Figure 4. Answer of S-1

In the evaluation stage, S-1 was made to realize that the obtained results was as expected, with the participant not experiencing confusion in solving problems. Interviews with S-1 were as follows.

P: Do you have any other way to check the results of the solution?

S-1: No Sir, that was the only method I used to double-check the results of solving the problem.

P: Is the method you used to check your results correct?

S-1: As far as I know, it is correct, Sir. And this was through re-reading and double-checking the image of the cube slices, as well as the steps I carried out, in order to compare the similarities of the picture in an effective way.

P: What things did you check carefully and in detail, on the sliced cubes?

S-1: Generally, what I checked was the suitability of the steps, the drawing results, each point's location, the intersection of the lines, and the α plane that intersects the ABCD.EFGH cube.

P: Was there anything else that was carefully examined?

S-1: Nothing, that was all I carefully checked.

S-1 evaluated the goal achievement by carefully examining the results obtained, in order to ensure the correctness in each step taken, as well as have the knowledge about its conformity to the previously planned strategy. S-1 also stated that the parameters carefully checked was the steps' feasibility, drawing results, each points' location, intersection of the lines, and the α plane that sliced the ABCD.EFGH cube. Moreover, the participant also observed self-evaluation, in terms of problem-solving methods and main achievement.

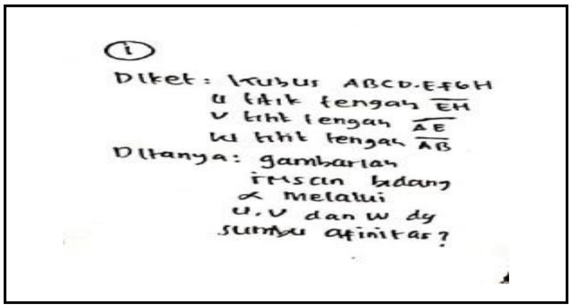
Prediction Skills of S-1

S-1 consciously believed that the steps used were in accordance with the concept, as well as correct due to being based on the experience learnt in drawing cubes, in the Capita Selekta course. Furthermore, the participant stated that the concepts used was the spatial intersection, as well as basic knowledge of points, lines, and planes in geometry. Also, S-1 predicted the outcome of solving problems by claiming the correct answer, based on the steps of the solution, drawing the pieces of the cube, the final result, as well as due to previous knowledge used in creating the slices of space. The participant also stated that the conclusions obtained after solving the problem (basic knowledge of points, lines and planes), should be accurately understood, because they are closely related to drawing spatial slices.

Metacognitive Skills in the Problem-solving Process of S-2

Based on the fact that S-2 had all the details contained in the problem, this meant that the participant understood what was provided and should be discovered in the problem. However, it was observed that S-2 was unable to explain a sketch of knowledge, which was related to the problem. The following showed the written results and interviews of S-2.

Planning Skills of S-2


(1)
Diket: kubus ABCD.EFGH
u titik tengah $\overline{EH}$
v titik tengah $\overline{AE}$
w titik tengah $\overline{AB}$
Ditanya: gambarlah irisan bidang α melalui u, v dan w dg sumbu afinitas?

Translate Version

Given: Cube ABCD.EFGH, U the midpoint of EH, V the midpoint of AE, and W the midpoint of AB

Asked: Draw a slice of the plane through points U, V, and W with the affinity axis?

Figure 5. Answer of S-2

Interviews with S-2 was presented as follows,

P: How did you determine what was provided and asked in the questions?

S-2: I read the guidelines/instruction questions and understood what was known.

P: What makes you believe that the goals achieved are correct?

S-2: Because I have read the instructions in the questions and understood them, as well as discovered what was meant.

P: Are you sure the complete plan to be used is correct?

S-2: Yes, sure Sir.

P: What makes you so sure?

S-2: Because the command of the questions was clear, with the goal or the final answer placed in the right destination.

P: To solve this problem, what knowledge did you use?

S-2: Geometry Sir.

P: What is the reason for saying Geometry?

S-2: In the Geometry lesson, there was a discussion in slices of space. This knowledge was then used to draw the slices of a cube.

P: Regardless, is there any other knowledge that was used to solve this problem?

S-2: No Sir.

S-2 thought about the methods to understand, by representing and writing them in sentences and symbols. The participant also identified the problem by reading the question instructions first, then understanding it as a whole. S-2 was also reported to have mentioned all the information in the provided questions. In determining problem-solving goals, S-2 ensured that the goals achieved were correct, by reading the instructions about the problem and understanding them, in order to achieve solutions. S-2 also stated that writing things that people have knowledge about, made it easier to understand the meaning of the problem. Based on the completion of plan carried out, the participant's planning solution assured correctness, because the command questions and results were right and clear. Also, S-2 stated that the method used to solve the problem was Geometry. However, S-2 was unable to provide an answer about other knowledge, which was likely to be used in the problem-solving process.

Monitoring Skills of S-2

At the monitoring stage, S-2 was sure that the results of the problem-solving that was carried out were correct. However, the participant did not realize that the written steps were not systematically sequential in drawing the slices of the plane, during the determination of the problem-solving result. S-2 also checked the results as planned, due to meeting the strategy implementation procedure. Also, the participant stated how the strategy used was discovered by the objectives of the problem, through the order of questions rules in solving the issue. It was also stated that the strategy used was to read and understand the problem first, write down what is known and asked, draw the ABCD.EFGH cube using the affinity axis method, and double-checking from start to finish. Furthermore, S-2 analyzed the suitability of the plans made with the results obtained, by double-checking from the beginning of the work (things that are known, steps, pictures, and final results).

Evaluation Skills of S-2

From the evaluation stage, S-2 correctly answered the question, and obtained the correct results based on the following answer sheet.

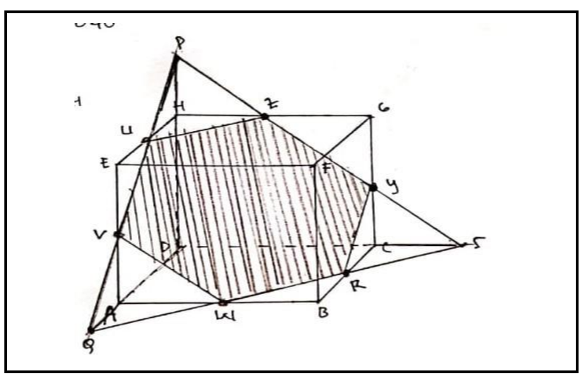


Figure 6. Answer the problem of S-2

S-2 answer and interview stated that there was no other way to check the problem-solving results conducted, than double-checking from the beginning of the work until the final result, which was a plane that cuts the cubes. S-2 also stated that the method used was correct, because it was often used when double-checking the problem-solving results, from the beginning to the end. Moreover, the participant evaluated the target achievement, by carefully examining the results obtained, in order to ensure the correctness of all the results of the work conducted. S-2 also stated that what was carefully examined was known, in terms of location of the points on the line, suitability of the steps with the pieces of the cube, and the cross-sectional planes formed on ABCD.EFGH.

Prediction Skills of S-2

S-2 predicted problem-solving by claiming the correct answer, based on the strategic plan used, solving steps, and the end result. It was also stated that the conclusion obtained after solving the problem, was due to the necessity to have basic knowledge of the relationship of points, lines, and planes, as well as accuracy in drawing spatial slices, especially in cubes. This meant that S-2 tended to need help, in order to solve the problems at hand.

Discussion

The aim of this study was to explore the metacognitive skills of university students about mathematical problems, via the investigation of their written answers and interview results on a problem-solving test (drawing cube slices). The results showed that both participants used their metacognitive skills. However, there were some inabilities to use those skills at certain stages of evaluation. For example, "I am unable to explain any other knowledge used for the same problem". This was due to the lack of strategic and procedural knowledge about cube slices, which seemed to be the main source of errors experienced by university students, in solving mathematical problems. Moreover, this lack of knowledge had been expressed by (Cardelle-Elawar, 1992), which stated that in most classrooms, lecturers tend to ignore this problem. Introduction at the beginning of learning mathematics is very important, because it helps the process of metacognitive skills. However, both participants were able to write down and state the facts contained in the questions. These problem-solving abilities related to metacognitive skills, were in line with the research (Jagals& Van Der Walt, 2016; Magno, 2010).

Subsequently, insight into the procedures the participants used in drawing the slices of the cube was acquired, at the monitoring skills stage. There were also differences in the participants' results and procedures regarding this acquisition. S-1 (field-independent) consciously guaranteed the correct solution steps, determined the results of solving the problems presented, and obtained confirmation from written answers. However, S-2 (field-dependent) did not realize that the written steps were not systematically sequential in drawing the cube slices and determining the result of solving the problem, even though the outcomes obtained are correct. Also, based on the use of monitoring skills, both participants checked the results against the plans made, in order to know whether they attained the strategy implementation procedures. Monitoring skills are defined as self-regulated control of cognitive attributes, which are used during actual performances, in order to identify problems, modify plans, and check the awareness of understanding, during task efforts. The activities of the two participants were in accordance with the statements by (Desoete, 2008; Son et al., 2020; Veenman& van Cleef, 2019).

The concept for starting a cube intersection was that, the intersect points of the plane and the object (cube) does not have to be a polygon. The intersections are likely to be empty (such as when the plane and the cube do not meet at all), single points (such as when the plane meets only the vertices of a cube), or line segments (such as when the planes meet only at the ends of a cube). In this case, the field does not fill the inside of the cube. Furthermore, polygons are likely to have three, four, five, or six sides (Gómez, 2009). Therefore, it was easier for university students to draw the slices of the cube, especially when making completion steps. This result was confirmed by the studies of Hargrove & Nietfeld (2015); Simons et al. (2020); Tian et al. (2018), which emphasized the importance of metacognitive knowledge, in mathematical learning that had been reported to have an impact on mathematics performance.

At the skill evaluation stage, the two participants evaluated the achievement of targets. Both of them carefully reviewed the results obtained, in order to ensure the correctness of each step conducted, and made sure it was in accordance with the previously planned strategy, as well as confirmed by written answers. This activity was in line with the study of Veenman et al. (2006), which stated that evaluation or monitoring activities were needed, in order to detect procedural and framework errors of action plans at the planning stage. However, it was observed that the differences in the results of the two participants were that S-1 had alternative methods of checking the results of problem-solving, with S-2 (field-dependent) having none. Even though there were different levels of education and age, this result was in line with the study by (Bayat & Tarmizi, 2010; Garrett et al., 2006), which stated that there were differences between the two study participants, which evaluated the outcomes of assessing right and wrong solutions. This result had implications for the usefulness of university students self-reviews, during mathematical problem-solving.

According to Desoete (2008); Kesici et al. (2011); Wang et al. (2021), prediction skills enabled learners to metacognitively anticipate task difficulties, making them work steadily and faster on difficult and easier tasks, respectively. Additionally, predictive skills also allowed learners to associate certain problem types, in order to develop intuitive knowledge about the conditions necessary for carrying out a task, and to distinguish between real difficulties in solving mathematical issues. Based on the combination of data possessed, students were invited to involve previously acquired knowledge with information obtained from the tests, which were ready to be used in imagining the possibilities that are to occur. Moreover, the results showed that the two participants were able to predict and draw conclusions, after solving the problem of slicing a cube.

Comparing performance metacognitive skills of university students field-independent and field-dependent cognitive syles.

Table 2. Equality and Diversity Metacognitive Skills Subject

MetacognitiveSkills	Equality	Diversity

MetacognitiveSkills	Equality	Diversity
ning	ting down and stating the facts ained in the problem	field-independent) had very few problems with information that were used to solve the lem. However, S-2 (field-dependent) was ole to explain the sketch of knowledge related e questions provided.
itoring	cking the results according to the , because it had met the strategy lementation procedure.	field-independent) guaranteed that the selected tion steps were correct, as they had the abilities letermine the results of solving the problems ented. However, S-2 (field-dependent) did not ze that the written steps are not systematically ential in determining the results of problem-ng.
uation	uating the achievement of targets, by fully examining the results obtained, rder to ensure the correctness of each taken, as well as to ascertain whether as in accordance with the previously ned strategy.	S-1 (field-independent) had another way to k troubleshooting results, with S-2 (field-endent) having none.
liction	ng the conclusions abtained after ng the problem	(field-independent) areless likely to need help solving problems. However, S-2 (field-endent) tended to require scaffolding, in order olve the present problems.

This study's discussion contained four types of metacognitive abilities, namely planning, monitoring, evaluation, and prediction skills. In this study, metacognitive skills in drawing cube slices were in line with successful problem-solving studies, although there were several phases that needed treatment. Therefore, before presenting the topic of sliced cubes, lecturers should ensure that university students have metacognitive and procedural knowledges, as well as experiences. These combinations were observed to have been able to contribute to the success of this study.

Conclusion

The main objective of this study was to explore the metacognitive skills of field-independent and dependent university students, based on cube slices. According to the descriptor/indicator of metacognitive skills, it was concluded that the two participants carried out relatively similar activities, which includes planning, monitoring, evaluation, and prediction skills. However, there were indicators that had not been fully achieved, by both participants. The following equalities were also derived from the two participants,

(1) Writing down and stating the facts contained in the question.
(2) Checking the results according to the plan, in order to determine whether they had met the strategy implementation procedure.
(3) Evaluating the achievement of targets, by carefully examining the results obtained, in order to ensure the correctness of every step taken and planned.

(4) Predicting and stating the conclusions attained, after solving the problem.

The insights observed in this study suggested some implications for the further development of a broader range of metacognitive skills, for university students. The results also had implications for teaching factual, procedural, and metacognitive knowledge, when solving problems. From the results and implications, useful considerations were also deduced, when designing the activities to draw cube slices in the preparation program for educators, especially lecturers. Based on the limitations of this study, data were observed to have resulted from a small-scale investigation, which included two different cognitive style university students, from thirty-five participants in one private university.

Recommendations

Further study on this issue was still needed, in order for a wider scope and different problems, even though both participants had achieved and fulfilled the metacognitive skill activity. However, treatment and teaching also still needed for university students, in order to maximize the use of their metacognitive skills. Therefore, observations of the educators' teaching process on mathematical problems provided interesting data, which were likely to be used by other educational practitioners. Also, this study is hereby recommended for researchers and lecturers that possess similar problems, in order to deeply examine the involvement of metacognitive knowledge in problem-solving.

References

Abdullah, A. H., Rahman, S. N. S. A., & Hamzah, M. H. (2017). Metacognitive Skills of Malaysian Students in Non-Routine Mathematical Problem Solving. *Bolema: Boletim de Educação Matemática*, *31*(57), 310–322. https://doi.org/10.1590/1980-4415v31n57a15

Antonietti, A., Ignazi, S., & Perego, P. (2000). Metacognitive knowledge about problem-solving methods. *British Journal of Educational Psychology*, *70*(1), 1–16. https://doi.org/10.1348/000709900157921

Artz, A. F., & Armour-Thomas, E. (1992). Development of a Cognitive-Metacognitive Framework for Protocol Analysis of Mathematical Problem Solving in Small Groups. *Cognition and Instruction*, *9*(2), 137–175. https://doi.org/10.1207/s1532690xci0902_3

Bayat, S., & Tarmizi, R. A. (2010). Assessing Cognitive and Metacognitive Strategies during Algebra Problem Solving Among University Students. *Procedia - Social and Behavioral Sciences*, *8*(5), 403–410. https://doi.org/10.1016/j.sbspro.2010.12.056

Bendall, R. C. A., Galpin, A., Marrow, L. P., & Cassidy, S. (2016). Cognitive Style: Time to Experiment. *Frontiers in Psychology*, 7, 1786. https://doi.org/10.3389/fpsyg.2016.01786

Cardelle-Elawar, M. (1992). Effects of teaching metacognitive skills to students with low mathematics ability. *Teaching and Teacher Education*, *8*(2), 109–121. https://doi.org/10.1016/0742-051X(92)90002-K

Chrysostomou, M., Pitta-Pantazi, D., Tsingi, C., Cleanthous, E., & Christou, C. (2013). Examining number sense and algebraic reasoning through cognitive styles. *Educational Studies in Mathematics*, *83*(2), 205–223. https://doi.org/10.1007/s10649-012-9448-0

Clarke, D., Goos, M., & Morony, W. (2007). Problem solving and Working Mathematically:

an Australian perspective. *ZDM*, *39*(5–6), 475–490. https://doi.org/10.1007/s11858-007-0045-0

Desoete, A. (2008). Multi-method assessment of metacognitive skills in elementary school children: how you test is what you get. *Metacognition and Learning*, *3*(3), 189–206. https://doi.org/10.1007/s11409-008-9026-0

Desoete, A., Roeyers, H., & Buysse, A. (2001). Metacognition and Mathematical Problem Solving in Grade 3. *Journal of Learning Disabilities*, *34*(5), 435–447. https://doi.org/10.1177/002221940103400505

Düşek, G., & Ayhan, A. B. (2014). A Study on Problem Solving Skills of the Children from Broken Family and Full Parents Family Attending Regional Primary Boarding School. *Procedia - Social and Behavioral Sciences*, *152*, 137–142. https://doi.org/10.1016/j.sbspro.2014.09.170

Garrett, A. J., Mazzocco, M. M. M., & Baker, L. (2006). Development of the Metacognitive Skills of Prediction and Evaluation in Children With or Without Math Disability. *Learning Disabilities Research and Practice*, *21*(2), 77–88. https://doi.org/10.1111/j.1540-5826.2006.00208.x

General Directorate of the Department of Education, M. O. E. I. (2020). *Integrated curriculum for higher education*. Ministry of Education Indonesia.

Gómez, E. (2009). Activities for Students: Slicing a Cube. *The Mathematics Teacher*, *102*(6), 456–463. https://doi.org/10.5951/MT.102.6.0456

Gurat, M. G., & Medula, C. T. (2016). Metacognitive Strategy Knowledge Use through Mathematical Problem Solving amongst Pre-service Teachers. *American Journal of Educational Research*, *4*(2), 170–189. https://doi.org/10.12691/education-4-2-5

Hargrove, R. A., & Nietfeld, J. L. (2015). The Impact of Metacognitive Instruction on Creative Problem Solving. *The Journal of Experimental Education*, *83*(3), 291–318. https://doi.org/10.1080/00220973.2013.876604

Holyoak, K. J. (1990). Problem solving. In *Thinking: An invitation to cognitive science* (Vol. 3, pp. 117–146). http://reasoninglab.psych.ucla.edu/wp-content/uploads/2010/09/Problem-Solving.pdf

Jagals, D., & Van Der Walt, M. (2016). Enabling metacognitive skills for mathematics problem solving: A collective case study of metacognitive reflection and awareness. *African Journal of Research in Mathematics, Science and Technology Education*, *20*(2), 154–164. https://doi.org/10.1080/18117295.2016.1192239

Jonassen, D. (2003). Using Cognitive Tools to Represent Problems. *Journal of Research on Technology in Education*, *35*(3), 362–381. https://doi.org/10.1080/15391523.2003.10782391

Jonassen, D. H. (2000). Toward a design theory of problem solving. *Educational Technology Research and Development*, *48*(4), 63–85. https://doi.org/10.1007/BF02300500

Kesici, S., Erdogan, A., & Özteke, H. I. (2011). Are the dimensions of metacognitive awareness differing in prediction of mathematics and geometry achievement? *Procedia - Social and Behavioral Sciences*, *15*, 2658–2662. https://doi.org/10.1016/j.sbspro.2011.04.165

Lee, N. H., Cheong, A. C. S., & Yee, L. P. (2001). The Role of metacognition in the learning of mathematics among low-achieving students. *Teaching and Learning*, *22*(2), 18–30. https://repository.nie.edu.sg/bitstream/10497/279/1/TL-22-2-18.pdf

Liljedahl, P., Santos-Trigo, M., Malaspina, U., & Bruder, R. (2016). *Problem Solving in Mathematics Education*. Springer International Publishing.

https://doi.org/10.1007/978-3-319-40730-2

Lioe, L. T., Fai, H. K., & Hedberg, J. G. (2006). Students' Metacognitive Problem-Solving Strategies in Solving Openended Problems in Pairs. In *Redesigning Pedagogy* (Issue 1981, pp. 243–259). BRILL. https://doi.org/10.1163/9789087900977_018

Magno, C. (2010). The role of metacognitive skills in developing critical thinking. *Metacognition and Learning*, *5*(2), 137–156. https://doi.org/10.1007/s11409-010-9054-4

Mefoh, P. C., Nwoke, M. B., Chukwuorji, J. C., & Chijioke, A. O. (2017). Effect of cognitive style and gender on adolescents' problem solving ability. *Thinking Skills and Creativity*, *25*, 47–52. https://doi.org/10.1016/j.tsc.2017.03.002

NCTM. (2000). *Priciples and Standards for School Mathematics*. Reston, VA: NCTM.

Nicolaou, A. A., & Xistouri, X. (2011). Field dependence/independence cognitive style and problem posing: an investigation with sixth grade students. *Educational Psychology*, *31*(5), 611–627. https://doi.org/10.1080/01443410.2011.586126

Özsoy, G., & Ataman, A. (2009). The effect of metacognitive strategy training on mathematical problem solving achievement. *International Electronic Journal of Elementary Education*, *1*(2), 67–82. https://eric.ed.gov/?id=ED508334

Pathuddin, Ketut Budayasa, I., & Lukito, A. (2019). Metacognitive activity of male students: difference field independent-dependent cognitive style. *Journal of Physics: Conference Series*, *1218*(1), 012025. https://doi.org/10.1088/1742-6596/1218/1/012025

Peter-Koop, A., & Scherer, P. (2012). Early Childhood Mathematics Teaching and Learning. *Journal Für Mathematik-Didaktik*, *33*(2), 175–179. https://doi.org/10.1007/s13138-012-0043-9

Schoenfeld, A. H. (2007). Problem solving in the United States, 1970–2008: research and theory, practice and politics. *ZDM*, *39*(5–6), 537–551. https://doi.org/10.1007/s11858-007-0038-z

Schoenfeld, A. H. (2016). Learning to Think Mathematically: Problem Solving, Metacognition, and Sense Making in Mathematics (Reprint). *Journal of Education*, *196*(2), 1–38. https://doi.org/10.1177/002205741619600202

Simons, C., Metzger, S. R., & Sonnenschein, S. (2020). Children's metacognitive knowledge of five key learning processes. *Translational Issues in Psychological Science*, *6*(1), 32–42. https://doi.org/10.1037/tps0000219

Abdullah, A. H., Rahman, S. N. S. A., & Hamzah, M. H. (2017). Metacognitive Skills of Malaysian Students in Non-Routine Mathematical Problem Solving. *Bolema: Boletim de Educação Matemática*, *31*(57), 310–322. https://doi.org/10.1590/1980-4415v31n57a15

Antonietti, A., Ignazi, S., & Perego, P. (2000). Metacognitive knowledge about problem-solving methods. *British Journal of Educational Psychology*, *70*(1), 1–16. https://doi.org/10.1348/000709900157921

Artz, A. F., & Armour-Thomas, E. (1992). Development of a Cognitive-Metacognitive Framework for Protocol Analysis of Mathematical Problem Solving in Small Groups. *Cognition and Instruction*, *9*(2), 137–175. https://doi.org/10.1207/s1532690xci0902_3

Bayat, S., & Tarmizi, R. A. (2010). Assessing Cognitive and Metacognitive Strategies during Algebra Problem Solving Among University Students. *Procedia - Social and Behavioral Sciences*, *8*(5), 403–410. https://doi.org/10.1016/j.sbspro.2010.12.056

Bendall, R. C. A., Galpin, A., Marrow, L. P., & Cassidy, S. (2016). Cognitive Style: Time to Experiment. *Frontiers in Psychology*, *7*, 1786. https://doi.org/10.3389/fpsyg.2016.01786

Cardelle-Elawar, M. (1992). Effects of teaching metacognitive skills to students with low mathematics ability. *Teaching and Teacher Education*, *8*(2), 109–121. https://doi.org/10.1016/0742-051X(92)90002-K

Chrysostomou, M., Pitta-Pantazi, D., Tsingi, C., Cleanthous, E., & Christou, C. (2013). Examining number sense and algebraic reasoning through cognitive styles. *Educational Studies in Mathematics*, *83*(2), 205–223. https://doi.org/10.1007/s10649-012-9448-0

Clarke, D., Goos, M., & Morony, W. (2007). Problem solving and Working Mathematically: an Australian perspective. *ZDM*, *39*(5–6), 475–490. https://doi.org/10.1007/s11858-007-0045-0

Desoete, A. (2008). Multi-method assessment of metacognitive skills in elementary school children: how you test is what you get. *Metacognition and Learning*, *3*(3), 189–206. https://doi.org/10.1007/s11409-008-9026-0

Desoete, A., Roeyers, H., & Buysse, A. (2001). Metacognition and Mathematical Problem Solving in Grade 3. *Journal of Learning Disabilities*, *34*(5), 435–447. https://doi.org/10.1177/002221940103400505

Düşek, G., & Ayhan, A. B. (2014). A Study on Problem Solving Skills of the Children from Broken Family and Full Parents Family Attending Regional Primary Boarding School. *Procedia - Social and Behavioral Sciences*, *152*, 137–142. https://doi.org/10.1016/j.sbspro.2014.09.170

Garrett, A. J., Mazzocco, M. M. M., & Baker, L. (2006). Development of the Metacognitive Skills of Prediction and Evaluation in Children With or Without Math Disability. *Learning Disabilities Research and Practice*, *21*(2), 77–88. https://doi.org/10.1111/j.1540-5826.2006.00208.x

General Directorate of the Department of Education, M. O. E. I. (2020). *Integrated curriculum for higher education*. Ministry of Education Indonesia.

Gómez, E. (2009). Activities for Students: Slicing a Cube. *The Mathematics Teacher*, *102*(6), 456–463. https://doi.org/10.5951/MT.102.6.0456

Gurat, M. G., & Medula, C. T. (2016). Metacognitive Strategy Knowledge Use through Mathematical Problem Solving amongst Pre-service Teachers. *American Journal of Educational Research*, *4*(2), 170–189. https://doi.org/10.12691/education-4-2-5

Hargrove, R. A., & Nietfeld, J. L. (2015). The Impact of Metacognitive Instruction on Creative Problem Solving. *The Journal of Experimental Education*, *83*(3), 291–318. https://doi.org/10.1080/00220973.2013.876604

Holyoak, K. J. (1990). Problem solving. In *Thinking: An invitation to cognitive science* (Vol. 3, pp. 117–146). http://reasoninglab.psych.ucla.edu/wp-content/uploads/2010/09/Problem-Solving.pdf

Jagals, D., & Van Der Walt, M. (2016). Enabling metacognitive skills for mathematics problem solving: A collective case study of metacognitive reflection and awareness. *African Journal of Research in Mathematics, Science and Technology Education*, *20*(2), 154–164. https://doi.org/10.1080/18117295.2016.1192239

Jonassen, D. (2003). Using Cognitive Tools to Represent Problems. *Journal of Research on Technology in Education*, *35*(3), 362–381. https://doi.org/10.1080/15391523.2003.10782391

Jonassen, D. H. (2000). Toward a design theory of problem solving. *Educational Technology Research and Development*, *48*(4), 63–85. https://doi.org/10.1007/BF02300500

Kesici, S., Erdogan, A., & Özteke, H. I. (2011). Are the dimensions of metacognitive awareness differing in prediction of mathematics and geometry achievement? *Procedia - Social and*

Behavioral Sciences, *15*, 2658–2662. https://doi.org/10.1016/j.sbspro.2011.04.165

Lee, N. H., Cheong, A. C. S., & Yee, L. P. (2001). The Role of metacognition in the learning of mathematics among low-achieving students. *Teaching and Learning*, *22*(2), 18–30. https://repository.nie.edu.sg/bitstream/10497/279/1/TL-22-2-18.pdf

Liljedahl, P., Santos-Trigo, M., Malaspina, U., & Bruder, R. (2016). *Problem Solving in Mathematics Education*. Springer International Publishing. https://doi.org/10.1007/978-3-319-40730-2

Lioe, L. T., Fai, H. K., & Hedberg, J. G. (2006). Students' Metacognitive Problem-Solving Strategies in Solving Openended Problems in Pairs. In *Redesigning Pedagogy* (Issue 1981, pp. 243–259). BRILL. https://doi.org/10.1163/9789087900977_018

Magno, C. (2010). The role of metacognitive skills in developing critical thinking. *Metacognition and Learning*, *5*(2), 137–156. https://doi.org/10.1007/s11409-010-9054-4

Mefoh, P. C., Nwoke, M. B., Chukwuorji, J. C., & Chijioke, A. O. (2017). Effect of cognitive style and gender on adolescents' problem solving ability. *Thinking Skills and Creativity*, *25*, 47–52. https://doi.org/10.1016/j.tsc.2017.03.002

NCTM. (2000). *Priciples and Standards for School Mathematics*. Reston, VA: NCTM.

Nicolaou, A. A., & Xistouri, X. (2011). Field dependence/independence cognitive style and problem posing: an investigation with sixth grade students. *Educational Psychology*, *31*(5), 611–627. https://doi.org/10.1080/01443410.2011.586126

Özsoy, G., & Ataman, A. (2009). The effect of metacognitive strategy training on mathematical problem solving achievement. *International Electronic Journal of Elementary Education*, *1*(2), 67–82. https://eric.ed.gov/?id=ED508334

Pathuddin, Ketut Budayasa, I., & Lukito, A. (2019). Metacognitive activity of male students: difference field independent-dependent cognitive style. *Journal of Physics: Conference Series*, *1218*(1), 012025. https://doi.org/10.1088/1742-6596/1218/1/012025

Peter-Koop, A., & Scherer, P. (2012). Early Childhood Mathematics Teaching and Learning. *Journal Für Mathematik-Didaktik*, *33*(2), 175–179. https://doi.org/10.1007/s13138-012-0043-9

Schoenfeld, A. H. (2007). Problem solving in the United States, 1970–2008: research and theory, practice and politics. *ZDM*, *39*(5–6), 537–551. https://doi.org/10.1007/s11858-007-0038-z

Schoenfeld, A. H. (2016). Learning to Think Mathematically: Problem Solving, Metacognition, and Sense Making in Mathematics (Reprint). *Journal of Education*, *196*(2), 1–38. https://doi.org/10.1177/002205741619600202

Simons, C., Metzger, S. R., & Sonnenschein, S. (2020). Children's metacognitive knowledge of five key learning processes. *Translational Issues in Psychological Science*, *6*(1), 32–42. https://doi.org/10.1037/tps0000219

Smith, J. M., & Mancy, R. (2018). Exploring the relationship between metacognitive and collaborative talk during group mathematical problem-solving – what do we mean by collaborative metacognition? *Research in Mathematics Education*, *20*(1), 14–36. https://doi.org/10.1080/14794802.2017.1410215

Son, A. L., Darhim, D., & Fatimah, S. (2020). Students' Mathematical Problem-Solving Ability Based on Teaching Models Intervention and Cognitive Style. *Journal on Mathematics Education*, *11*(2), 209–222. https://doi.org/10.22342/jme.11.2.10744.209-222

Susanto, H. A., Hidajat, D., Hobri, & Jatmiko, D. D. H. (2020). Cognitive description of students in mathematics learning through lesson study. *Journal of Physics: Conference*

Series, *1465*(1), 012067. https://doi.org/10.1088/1742-6596/1465/1/012067

Sweller, J. (1988). Cognitive load during problem solving: Effects on learning. *Cognitive Science*, *12*(2), 257–285. https://doi.org/10.1016/0364-0213(88)90023-7

Tachie, S. A., & Molepo, J. M. (2019). Exploring Teachers' Meta-Cognitive Skills in Mathematics Classes in Selected Rural Primary Schools in Eastern Cape, South Africa. *Africa Education Review*, *16*(2), 143–161. https://doi.org/10.1080/18146627.2017.1384700

Tian, Y., Fang, Y., & Li, J. (2018). The Effect of Metacognitive Knowledge on Mathematics Performance in Self-Regulated Learning Framework—Multiple Mediation of Self-Efficacy and Motivation. *Frontiers in Psychology*, *9*(DEC), 1–11. https://doi.org/10.3389/fpsyg.2018.02518

Trisna, B. N., Budayasa, I. K., & Siswono, T. Y. E. (2018). Students' metacognitive activities in solving the combinatorics problem: the experience of students with holist-serialist cognitive style. *Journal of Physics: Conference Series*, *947*(1), 012072. https://doi.org/10.1088/1742-6596/947/1/012072

Tzohar-Rozen, M., & Kramarski, B. (2014). Metacognition, Motivation and Emotions: Contribution of Self-Regulated Learning to Solving Mathematical Problems. *Global Education Review*, *1*(4), 76–95. http://ger.mercy.edu/index.php/ger/article/view/63

Van der Stel, M., Veenman, M. V., Deelen, K., & Haenen, J. (2010). The increasing role of metacognitive skills in math: a cross-sectional study from a developmental perspective. *ZDM*, *42*(2), 219–229. https://doi.org/10.1007/s11858-009-0224-2

Veenman, M. V. J., & van Cleef, D. (2019). Measuring metacognitive skills for mathematics: students' self-reports versus on-line assessment methods. *ZDM*, *51*(4), 691–701. https://doi.org/10.1007/s11858-018-1006-5

Veenman, M. V. J., Van Hout-Wolters, B. H. A. M., & Afflerbach, P. (2006). Metacognition and learning: conceptual and methodological considerations. *Metacognition and Learning*, *1*(1), 3–14. https://doi.org/10.1007/s11409-006-6893-0

Verschaffel, L., Schukajlow, S., Star, J., & Van Dooren, W. (2020). Word problems in mathematics education: a survey. *ZDM*, *52*(1), 1–16. https://doi.org/10.1007/s11858-020-01130-4

Volkova, E. V., & Rusalov, V. M. (2016). Cognitive styles and personality. *Personality and Individual Differences*, *99*, 266–271. https://doi.org/10.1016/j.paid.2016.04.097

Wang, M., Binning, K. R., Del Toro, J., Qin, X., & Zepeda, C. D. (2021). Skill, Thrill, and Will: The Role of Metacognition, Interest, and Self-Control in Predicting Student Engagement in Mathematics Learning Over Time. *Child Development*, *92*(4), 1369–1387. https://doi.org/10.1111/cdev.13531

Witkin, H. A., Moore, C. A., Goodenough, D., & Cox, P. W. (1977). Field-Dependent and Field-Independent Cognitive Styles and Their Educational Implications. *Review of Educational Research*, *47*(1), 1–64. https://doi.org/10.3102/00346543047001001

Zhang, L., & Seepho, S. (2013). Metacognitive strategy use and academic reading achievement: Insights from a Chinese context. *Electronic Journal of Foreign Language Teaching*, *10*(1), 54–69

DJATMIKO HIDAJAT: POSTGRADUATE OF MATHEMATICS EDUCATION, UNIVERSITASNEGERI SURABAYA, SURABAYA, INDONESIA.
Corresponding author: djatmikohidajat16070936010@mhs.unesa.ac.id

SITI MAGHFIROTUN AMIN: POSTGRADUATE OF MATHEMATICS EDUCATION, UNIVERSITASNEGERI SURABAYA, SURABAYA, INDONESIA.
E-MAIL: Amin3105@yahoo.com

TATAG YULI EKO SISWONO: POSTGRADUATE OFMATHEMATICS EDUCATION, UNIVERSITASNEGERI SURABAYA, SURABAYA, INDONESIA.
E-MAIL: tatagsiswono@unesa.ac.id