J. Pijar MIPA, Vol. 17 No.5, September 2022: 666-673
DOI: 10.29303/jpm.v17i5.3391
ISSN 1907-1744 (Cetak)
ISSN 2460-1500 (Online)

ANALYSIS OF STUDENT MATHEMATICAL INVESTIGATIONS ABILITY ON TRANSFORMATION GEOMETRY IN TERMS OF COGNITIVE STYLE

Nina Muthmainnah*, Sri Subarinah, Amrullah, and Arjudin
Mathematics Education Department, Faculty of Teacher Training and Education Univesity of Mataram, Mataram, Indonesia
*Email: ninamuthmainnah6@gmail.com

Received: February 17, 2022. Accepted: April 2, 2022. Published: September 30, 2022

Abstract: Mathematical investigation is an activity that can encourage an experimental activity, collect data, make observations, identify patterns, make and test conjectures and make generalizations used to improve skills and develop students' mathematical thinking processes optimally. Different cognitive styles can affect students' ability to think and reason, especially in solving mathematical investigative problems. Therefore, this paper will examine mathematical investigations' ability in reflective and impulsive cognitive styles in qualitative descriptive analysis. The subjects in eleventh-grade senior high school at SMA Negeri 2 Mataram, Indonesia. Students were selected using a purposive sampling technique, and six students were selected as subjects in the interview consisting of three reflective students and three impulsive students. The instruments used are mathematical investigation tests, Matching Familiar Figure MFFT tests, and interview guidelines. The results showed that students with a reflective cognitive style were more thorough and systematic in writing down the answers to each point and always thought first in solving problems. Most students went through 4 stages of mathematical investigations: specialization, conjecture, generalization, and justification. While students with impulsive cognitive styles mostly managed to go through 3 stages of mathematical investigations, specialization, conjecture, and generalization, due to a lack of accuracy in solving questions and providing as simple answers as possible according to the question request.

Keywords: *Mathematical Investigation, Cognitive Style, Reflektive and Impulsive*

INTRODUCTION

In learning mathematics, students must be stimulated to search for themselves, conduct their investigations, find proof of a conjecture that they made themselves, and find answers to questions from friends or teachers [1]. A linguistic investigation is an investigation by recording facts: conducting reviews, experiments, and so on, to obtain answers to questions [2]. A mathematical investigation is an activity that can encourage an experimental activity (experimental), collect data, make observations, identify a pattern, make and test conclusions and conjectures and make generalizations [3].

This investigation is known to be included in the HOTS (Higher Order Thinking Skills) questions category. It is because students are required to understand, conclude, and connect with other data when looking for a solution to a particular problem, which in this case, is in line with the concept of the cognitive process of the investigation. Students are not only required to solve low-level problems using standard formulas but also must be able to reason using mathematical forms to solve high-level problems in everyday life. The form of the question can be seen in the olympiad questions. The ability of students to solve mathematical problems in Indonesia, especially in SMA Negeri 2 Mataram, still requires more mature improvement and development. It can be seen by the average score obtained by class XI students at SMA Negeri 2 Mataram, which is still relatively low and has not even reached the Minimum Completeness Criteria, which is 77.

Based on interviews conducted during initial observations with subject teachers in math class XI at SMA Negeri 2 Mataram, information was obtained that the cause of the low student scores was the lack of student activity. Students did not yet have a mature conceptual understanding, meaning they were rarely given practice questions that encouraged developing and analyzing abilities. Only a few students were able and willing to express ideas or ask the teacher about what was not understood. When given a question that is a little misleading, the students begin to have difficulty and cannot solve the problem. Moreover, suppose these questions hone higher-order thinking skills, such as HOTS questions. In that case, it is known that these schools rarely pass the Olympic selection, especially in the field of mathematics at the provincial, national, or even international levels. It proves that the ability of students to solve higher-order thinking questions is still lacking.

It happens because when students are faced with non-routine questions, they tend to be unable to work on these questions. Students are accustomed to working on questions that do not encourage analytical and critical abilities, which means students tend to memorize formulas without interpreting the material so that their abilities do not develop in solving mathematical

 ISSN 1907-1744 (Cetak)
ISSN 2460-1500 (Online)

problems. In addition, the results of Amin's research indicate that the investigative test given to the pre-action activities of students' mathematical investigative abilities in class XI IPA 1 of SMA Negeri 2 Watampone is still relatively low. Of 40 students' research subjects, the highest score was 29, and the lowest score was 11. So it can be concluded that all students who were research subjects and were given a pre-action test had low investigative abilities. In general, students do not meet the indicators of identifying problems, especially making predictions or conjectures for problem-solving, but when solving problems, students immediately begin problem-solving. Then, none of the students met these two aspects on the indicators of drawing conclusions or making interpretations [4]. Therefore, mathematical investigation is a very important activity to improve skills and develop students' thinking abilities optimally [5].

Mathematical investigation as a cognitive process is a process of mental activity in one's mind in solving problems, which includes four stages of the thinking process: specialization, conjecture, justification, and generalization [3]. By testing specific examples, specialization is an activity to examine a question [3]. Specialization is the selection of samples randomly to obtain appropriate questions systematically to prepare the basis for generalization and test them [6]. The first thing to do so that specialization activities are systematic is to write down the important points in the problem. Then navigate to a more specific problem to see the pattern. The second thing is drawing up a scheme or creating a picture to understand the pattern better. After these two things are done, it will be seen that the assumption that initially trying random examples leads to a simpler problem. Conjecture is the activity of making assumptions that give rise to patterns. In addition, conjecture is a reasonable statement that appears to be true but whose truth has not been confirmed. In other words, it has not been conclusively confirmed but is known not to contradict any examples or have consequences [6]. So, conjecture is the activity of articulating, testing, and modifying conjectures to form the core of this thought process. The thing to do after making an assumption is to test it (justification). Justification is an activity to prove the truth of a pattern or formula found previously. The justification put forward can be in the form of statements or questions that must be proven whether they are true or false. If the conjecture can be justified convincingly, it can be considered for generalization [7]. The final step in this stage of the mathematical investigative thinking process is a generalization. Generalization is made when the conjecture has been proven. That is, generalization is detecting patterns that lead to assumptions that appear true, explaining why the conjecture is true or justified and where the conjecture is likely to be true [6]. As a result, generalization can be defined as the activity of concluding a series of hypotheses that give rise to patterns and have been tested for truth [3]. The conclusions obtained are in the form of general formulas, which are then tested in examples of special cases that have been worked on. Therefore, mathematical investigations are useful for developing students' mathematical thinking processes and good mental habits. They also deepen students' understanding of mathematical material and challenge them to produce general mathematical knowledge [8]. Table 1 shows the indicators of students' cognitive processes in mathematical investigations.

Table 1. Indicators of Mathematical Investigation as a Cognitive Process

Cognitive Process	Indicators
Specializing	S1: Check out special examples S2: Tried some special cases S3: Making pictures S4: Make important notes S5: Simplifying assumptions S6: Make a systematic list to examine specific cases
Conjecturing	D1: Making and or changing assumptions D2: Formulating a hypothesis D3: Focusing attention on only one aspect of the problem
Justifying	J1: Using one part of the solution to complete the other J2: Eliminate irrelevant completion paths J3: Using representations/ patterns J4: Using inductive reasoning
Generalizing	G1: Making general formulations G2: Change the representation, if necessary G3: Testing the general pattern for the special cases it has worked on

In other words, style refers to the cognitive process that states how the information content is processed; in other words, style is the way a person uses his abilities [9]. It is often assumed that all students have the same cognitive style or the same learning style. That's not always the case, though. Different cognitive styles can affect students' thinking and reasoning ability to solve problems. The way students receive and respond to information is called cognitive style. Cognitive style is a process of control or style that is self-managed as a situational intermediary to determine conscious activity so that it is used by a learner to organize and regulate, receive and

 ISSN 1907-1744 (Cetak)
ISSN 2460-1500 (Online)

disseminate information, and ultimately determine behavior [10]. That is, the cognitive style consciously regulates how to receive and process information, which ultimately determines how a person behaves in obtaining that information. There are two classifications of cognitive style, namely: reflective cognitive style and impulsive cognitive style. Children with an impulsive cognitive style are quick to answer problems but not as careful, so the answers tend to be wrong. Children with reflective cognitive styles are slow at answering problems but careful or thorough, so the answers tend to be correct. Reflective children usually take a long time to respond but consider all available options and have high concentration while studying, while impulsive children lack concentration in class [11]. Reflective-impulsive cognitive style is a cognitive system trait that combines decision-making time and performance in high-uncertainty problem-solving situations [12].

Table 2. Differences in Reflective and Impulsive Students' Cognitive Styles

Reflective Student	Impulsive Student
More precise answer (accurate)	Quickly answer without looking first
Reflective to high IQ literature	Dislikes analogous problem answers
Strategic in solving problems	Opinions are less accurate
Think for a moment before answering	Using hypothesis scanning, which refers to only one possibility
Bring out various possibilities	Less strategic in solving problems
More mature argument	

Reflective-impulsive is the degree/level of the subject in describing the accuracy of the alleged problem-solving that contains uncertainty in the answer. Referring to the definition of reflective impulsivity, two important aspects must be considered in measuring reflective impulsivity: The first aspect of measuring reflective impulsivity is seen from the time variable used by students in solving problems. The second aspect is the frequency with which students give answers until they get the right answer. Suppose the aspect of time (a time variable) is divided into two, namely fast and slow. In that case, the aspect of frequency is divided into careful/accurate (frequency of answering little) and inaccurate/inaccurate (frequency of answering a lot). [13]. The study focused on students with reflective and impulsive cognitive styles for two reasons: (1) the proportion of students who had reflective or impulsive characteristics (73%) was greater than students who had fast and precise characteristics in answering or less accurate in answering, namely 27% [14]; (2) the proportion of reflective-impulsive children is 70% [12]. According to Kagan, as quoted by Warli, the differences in reflective students can be presented in Table 2.

Researchers in this study chose the transformation geometry material. The material was chosen because it allows students to solve a problem through mathematical steps such as trying random examples and making generalizations, which, in this case, are by the concept of mathematical investigative thinking processes. Knowledge of geometric transformations is very useful for students to build spatial abilities and geometric reasoning abilities and strengthen mathematical proofs [15]. These abilities can help students explore mathematical concepts such as the concept of congruence, symmetry, similarity, and so on. However, understanding the concept of transformation geometry is still difficult for students. Research reveals that students have difficulty understanding the concepts and variations that arise and difficulties in identifying transformations, including translation, reflection, rotation, and combinations of these transformations [16-17]. Therefore, it is necessary to research the ability of mathematical investigations to transform geometry material in terms of reflective and impulsive cognitive styles.

RESEARCH METHODS

The type of research used in this research is descriptive qualitative research, which aims to describe the ability of mathematical investigations to transform geometry material based on reflective and impulsive cognitive styles. Descriptive research describes a symptom of an event, an event that exists at present [18]. Qualitative research intends to understand the phenomenon experienced by research subjects using descriptions in the form of words and language, in a special natural context, and by utilizing various natural methods [19]. This research was conducted in November in the odd semester at SMA Negeri 2 Mataram in the 2021–2022 academic year. The subjects in this study were students of class XI-MIPA 1 of SMA Negeri 2 Mataram, who were selected using a purposive sampling technique. This class was chosen because it is a Mathematics and Natural Sciences major and has received transformation geometry material. Then, later on, the subject, six students were selected who were distinguished based on their reflective and impulsive cognitive styles as respondents in the interview. The six subjects consisted of three reflective subjects and three impulsive subjects to obtain unclear information during the research process. There are two data sources in this study, namely primary and secondary data. Primary data sources were obtained from students of SMA Negeri 2

Mataram. Secondary data is in the form of documentation, such as photos of activities, school records, or documentation as evidence of having carried out the research.

There are three data collection methods in this study: documentation, tests, and interviews. First, documentation is used to obtain data on student rosters, students' cognitive style test results, and mathematical investigation test results. Second, two tests are used: the MFFT cognitive style (Matching Familiar Figure Test), the mathematical investigation test, and the interview. The validity test used is the content validity test. The contents of the questions are reviewed using certain criteria by competent people in the relevant field. In this case, the experts are mathematics education lecturers. This review is often referred to as expert judgment [20]. Three instruments are used: the mathematical investigation test, the MFFT test (Matching Familiar Figure Test), and interview guidelines. First a mathematical investigation test that two experts have validated. This test is given to determine students' mathematical investigative abilities. The test sheet consists of 2 questions related to the material of transformation geometry and is adjusted to the cognitive process indicators from mathematical investigations. Second, the MFFT test (Matching Familiar Figure Test) was developed by Warli and has been tested for validity and reliability to determine students' cognitive styles [14]. The test consists of 13 questions, each containing one standard image and eight similar images, so students will be asked to identify which of the eight similar images is the same as the standard image. Third, from the MFFT cognitive style test, each student's cognitive style will be known, and third, interview guidelines to verify and confirm the data on the results of the mathematical investigation tests that have been tested on research subjects.

The results of the mathematical investigation test and the MFFT test were then corrected. Furthermore, students were grouped based on mathematical investigation tests in terms of reflective cognitive style and impulsive cognitive style, so the results showed that each cognitive style's investigative abilities differed. Then the interview was conducted, and the process was recorded and compiled as an interview transcript. The test results and interview transcripts were analyzed to determine the description of the student's mathematical investigative abilities based on their cognitive styles. The data analysis technique used is qualitative data analysis, following the concept of Miles and Huberman through three stages: 1) data reduction, 2) data display, and 3) concluding.

RESULTS AND DISCUSSION

Data collection starts with documentation in the form of a list of names of students who will be the research subjects. The students worked on the mathematical investigation test questions, then they grouped the results of the mathematical investigation tests and MFFT tests and conducted interviews with respondents who were selected based on the results of the mathematical investigation tests and cognitive style. To determine the ability of mathematical investigations to be obtained from the mathematical investigation test. The test consists of 2 description questions. Based on the indicators of mathematical investigation as a thinking process, there are four (4) stages that students must go through to be said to be able to solve mathematical investigation questions, including specialization, conjecture, justification, and generalization. The investigative test results were analyzed by calculating the percentage of each student who succeeded in going through each stage. The number of students who succeeded in each stage of the mathematical investigation and the percentages is listed in Table 3.

Table 3. Percentage of Mathematical Investigation Ability of Class XI-MIPA 1

Question	Investigation Stage	Number of Students	Percentage
Question 1	Specialization	14	40%
	Conjecture	31	89%
	Generalization	0	0%
	Justification	10	29%
	Justification of Generalization	25	71%
Question 2	Specialization	12	34%
	Conjecture	20	57%
	Generalization	17	49%
	Justification	3	9%
	Justification of Generalization	3	9%

Table 3, shows that information indicates that only a few students were able to complete all stages of the mathematical investigation. In response to question 1, there were no students who succeeded in going through the generalization stage and at least ten students who succeeded in going through the justification stage. In addition, in question 2, only a small number of students could go through the stages of justification and justification of generalizations, namely, three students each.

The student's cognitive styles were obtained from the MFFT test (Matching Familiar Figure Test). This test consists of 13 questions with eight variations of images plus two experimental examples used to determine the cognitive style of each student. The determination of cognitive style is calculated based on the

 ISSN 1907-1744 (Cetak)
ISSN 2460-1500 (Online)

median time distance data (t) and the median frequency data of students until they get the right answer (f). The median time between notes and median frequency of answering are used as limits for determining students with reflective or impulsive characteristics. In this study, they found four groups of students, consisting of group I (fast-accurate), who have the characteristics of being fast at answering problems and being careful and thorough so that the answers are always correct. Group II (Impulsive) students have the characteristics of being fast at answering problems but not being careful or thorough enough so that the answers are often wrong. Group III (Reflektive) students have the characteristics of being slow in answering problems and being careful so that the answers are always correct. Group IV (slow-inaccurate) children have the characteristics of being slow in answering problems and being less careful/less thorough so that the answers are often wrong. The measurement results according to the cognitive style of each student are presented in Table 4 as follows.

Table 4. Results of Measuring Cognitive Style for Class XI-MIPA 1 Students

No.	Types of Cognitive Style	Many Students	Percentage
1.	Fast-Accurate	8	23%
2.	Impulsive	10	29%
3.	Reflektive	13	37%
4.	Slow-Inaccurate	4	11%

Based on the results of student answers, information was obtained that the number of reflective students was 13 students (37%), impulsive students were ten students (29%), fast-accurate students were eight students (23%), and slow-inaccurate students were four students (11%). This shows that the proportion of students with reflective or impulsive characteristics is greater, namely 66%, compared to students who are fast and accurate in answering (fast-accurate) or slow and less accurate in answering (slow-inaccurate), which is 34%.

Then the students were grouped based on the mathematical investigation test in terms of their cognitive style so that the results showed that each cognitive style's investigative abilities differed. In the problem of 1 stage of specialization, conjecture, justification, and generalization, more reflective students could go through these stages more quickly than impulsive, fast-accurate, and slow-inaccurate students. In addition, in the problem of 2 stages of specialization, conjecture, generalization, and justification of generalization, more reflective students could go through these stages more quickly than impulsive, fast-accurate, and slow-inaccurate students. In the justification stages, reflective and impulsive students passed the stages more equally than fast-accurate and slow-inaccurate students. Then an interview was conducted to verify or confirm the data on the results of the mathematical investigation test tested on the research subject. In this case, the research subjects selected were six students as respondents who were distinguished based on their reflective and impulsive cognitive styles. The six students are S_{11}/Reflective, S_{24}/Reflective, S_{30}/Reflective, S_{23}/Impulsive, S_{17}/Impulsive, and S_{32}/Impulsive. Each subject was interviewed individually. Then the process was recorded and compiled as an interview transcript. Based on the results of the interviews, information was obtained that students could solve problems by using several appropriate ways to solve the problems given. However, there are still some students who are not careful in doing calculations, so they get the wrong results.

Subjects S_{24} and S_{30} in question 1 succeeded in going through the specialization, conjecture, and justification stages, while subjects S_{11} in the justification stage were able to go through that stage. Still, they were not very careful in determining the intersection point on the x-axis. In addition, the subject of S_{11} succeeded in going through the stages of specialization and pattern conjecture. The three subjects in question 1 could not go through the generalization stage because the process of making the general formula was divided into 2 points, namely points (c) and (f). At point (c), most of the subjects were able to make general formulas from the patterns found, but when asked to make further general formulas at point (f), the subjects were still wrong in forming the basic concepts of the formulas. Then in question 2, subjects S_{30} and S_{11} went through all stages of the investigation, including the stages of specialization, estimation, generalization, and justification. After being interviewed, information was obtained that both of them understood the pattern of questions seen in question 1, making it easier for them to work on question 2 with the same goal. It's just that at the justification stage, the two subjects did not prove the truth obtained because students were able to prove the truth in point (e) by way of replacing the value of n obtained in the general formula with numbers that indicate the extent to which the line can be translated into the previous point. So when it was found according to the pattern obtained previously, it was just a matter of time. Furthermore, subject S_{24} went through the stages of specialization, estimation, and generalization. Due to time constraints, subject S_{24} did not prove the truth of the graphs and equations obtained in the previous points and was still confused about how to do it.

In addition, the subject of S_{32} in question 1 succeeded in going through the specialization and conjecture stages. In the justification stage, S_{32} can prove the truth of the equations obtained by drawing a graph at point (d) and then at point (e). It's just that S_{32} can adjust the truth of the equations obtained in points (a) and (b). It's just that it's still incomplete. In addition, subjects S_{17} and S_{23} at the specialization stage did not succeed in drawing a graph if an equation was translated as far as three units, four units, and five units. After being interviewed, it turned out that the two subjects had forgotten how to draw using cut points. Subject S_{23} also has not been able to prove the truth of the equation obtained by drawing the graph at point (d) due to a lack of accuracy in determining the intersection point on the x-axis as in point (a), but managed to adjust the truth of the equation obtained at point (c) with points (a) and (b). However, in the conjecture stage, both of them managed to pass this stage. Similar to children with reflective cognitive styles, the three subjects with impulsive cognitive styles in question 1 could not go through the generalization stage because the process of making general formulas was divided into 2 points, namely points (c) and (f). At point (c), most of the subjects were able to make general formulas from the patterns found. However, when asked to make further general formulas at point (f), the subjects still misrepresented the basic concepts of the formulas and didn't even know how to do it. It only proves the correctness of the obtained equation, not invent a new general formula, especially in S_{32} in point (f). Then in question 2, subject S_{23} did not make it through the specialization stage because they were still wrong or not careful enough in determining the intersection point of each equation. In addition, the subject of S_{23} succeeded in going through the conjecture and generalization stages. S_{17} went through the stages of specialization, conjecture, and generalization. Then the subject of S_{32} succeeded in going through the stages of specialization and conjecture only. At the generalization stage, S_{32} does not work. At the justification stage, the three did not work because they were still confused about how to do it.

Mathematical Investigation Ability in terms of Reflective Cognitive Style

Based on the results of data analysis regarding mathematical investigative abilities and interview results, it was determined that students with reflective cognitive styles did not experience many difficulties in solving investigation problems involving transformation geometry material. Most of the reflective students succeeded in carrying out the four stages of mathematical investigation, including the stages of specialization, conjecture, generalization, and justification. It happens because, when doing investigative tests, most students collect answers when time is running out. It is in line with Kagan's statement that children with reflective cognitive styles are slow at answering problems but are careful or thorough so that the answers tend to be correct [13]. The relatively long time to solve this problem is why small-minded reflective students make mistakes because they use the time to think deeply when answering questions. At the specialization stage, before drawing a graph, students first explain how and at what point the line will shift. Then, at the conjecture stage, students systematically explain the patterns they find until they get the requested equation. Then, at the generalization stage, students can make general formulas, even to the point of continuing with advanced general formulas at the next level. And at the justification stage, students can write in detail about how to prove the truth of the patterns and formulas found previously.

Mathematical Investigation Ability in terms of Impulsive Cognitive Style

Most students with an impulsive cognitive style can only go through 3 stages of mathematical investigation: the specializing, conjecturing, and generalizing stages. At the specialization stage, when drawing graphs, impulsive students tend to draw graphs immediately without providing an explanation of how the lines on the graph are formed. At the conjecture stage, students can only guess by looking at the patterns found. Some just write down the constants and replace the x value with the requested unit in the known equation. In the generalization stage, some impulsive students succeed in making general formulas, and some cannot. Then, at the justification stage, some could not prove the truth of the patterns and formulas found earlier because they were still confused about what steps to take to solve them. It is in line with Kagan's statement that children with an impulsive cognitive style have the characteristics of being quick in answering problems but being less careful or thorough, so that the answers tend to be wrong [13]. It is what causes impulsive students to make more errors in answering because of a lack of accuracy in solving questions and providing as simple answers as possible in accordance with the question request.

Differences in Students' Mathematical Investigation Ability in terms of Reflective and Impulsive Cognitive Style

Based on the results of the analysis that has been carried out regarding the mathematical investigative ability in terms of reflective and impulsive cognitive styles, it was found that the mathematical investigative abilities of students with reflective cognitive styles were superior to those of students with impulsive cognitive styles. In addition, students with a reflective cognitive style are more systematic in writing down the answers to each point in solving problems than students with an impulsive cognitive style. It is supported by Kagan's statement, which says that reflective children usually take a long time to respond but consider all available options and have high concentration when learning. In contrast, children with impulsive cognitive styles lack concentration when learning in class [13]. It is also strengthened by the results of Rahmatina's research, which says that in the problem of flat wake, reflective subjects can create new and unique flat shapes, while some impulsive subjects can not. In addition, reflective subjects are flexible in making these flat shapes in two ways, while impulsive subjects are not. In the line equation problem, the reflective subject can make a line equation in a new way, while the impulsive subject is not. In addition, the reflective subject is flexible in making the equation of the line in two different ways, while the impulsive subject is not [21-22]. Based on this, it can be seen that students with a reflective cognitive style are superior to those with an impulsive cognitive style in mathematical investigation tests. The number can also see in reflective students who can go through every stage of mathematical investigation.

CONCLUSION

The mathematical investigative abilities of students with a reflective cognitive style are most successful through 4 stages of mathematical investigations, including specializing, conjecture, generalizing, and justifying. Students with a reflective cognitive style in working on each stage of mathematical investigations tend to be careful and thorough and provide systematic explanations for solving the problem. For example, before drawing a graph, first, provide an explanation of how and at what point the line will shift. Then provide an explanation related to the pattern found until you get the requested equation and explain in detail how to prove the truth of the patterns and formulas found previously. While students with an impulsive cognitive style mostly succeeded in going through 3 stages of mathematical investigation: specializing, conjecturing, and generalizing. Students with an impulsive cognitive style in working on each stage of a mathematical investigation are still less careful and tend to be unsystematic in solving the problem. For example, when drawing a graph, impulsive students tend to immediately draw a graph without explaining, then only guess by looking at the patterns found even at the time of estimation, only writing down the constants and replacing the value of x with the requested unit in the known equation, which some cannot. They cannot prove the truth of the patterns and formulas previously found because they are still confused about the steps in solving them. Impulsive students also give simple answers as much as possible according to the question request.

REFERENCES

[1] Turmudi. (2008). Landasan Filsafat dan Teori Pembelajaran Matematika Paradigma Eksploratif dan Investigatif. Jakarta: Leuser Cita Pustaka.

[2] Hoadley, S. (2020). The concept of competitive productivity (CP): a linguistic investigation. *Cross Cultural & Strategic Management*.

[3] Subarinah, S. (2021). Pemecahan Masalah dan Investigasi Matematik. *Mataram: Penerbit Duta Pustaka Ilmu.*

[4] Amin, A., Arsyad, N., & Minggi, I. (2015). Peningkatan Kemampuan Investigasi Matematika melalui Pemberian Proyek Matematika pada siswa kelas XI SMA Negeri 2 Watampone. *Beta , 8*, 30.

[5] Subarinah, S., Budayasa, I. K., & Lukito, A. (2018). Profil Proses Kognitif Siswa SMP dalam Investigasi Matematik. *Jurnal Ilmiah Profesi Pendidikan , 3*, 15-23.

[6] Mason, J., Burton, L., & Stacey, K. (2010). *Thinking Mathematically.* London: Pearson Education Limited

[7] Yeo, J. B. W. & Yeap, B. H. (2010). Characterizing the cognitive processes in the mathematical investigation. *Journal for Mathematics Teaching and Learning* ISSN 1473-0111.

[8] Nivera, G. C. (2012). Mathematical Investigation and Its Assessment: Implications for Mathematics Teaching and Learning. *The Normal Lights*, 6(*1*), 29-43

[9] Desmita. (2011). *Psikologi Perkembangan Peserta Didik.* Bandung: PT. Remaja Rosdakarya.

[10] Bassey, Sam. W & Umoren, G. (2009). *Bassey, S. W., Umoren, G., & Udida, L. A. (2007, February). Cognitive styles, secondary school students' attitude and academic performance in chemistry in Akwa Ibom State-Nigeria. In Proceedings of epiSTEME 2- International Conference to Review Research in Science, Technology and Mathematics Education, India.*

[11] Kagan, J. (1965). Impulsive and Reflective Children: Significance of Conceptual Tempo. Dalam Krumboltz, J.D (Eds.) *Learning and the Educational Process*. (hlm 133-161), Chicogo. Rand Mc Nally & Company.

[12] Rozencwajg, P., & Corroyer, D. (2005). Cognitive Processes in the Reflective-Impulsive Cognitive Style. *The Journal of Genetic Psychology*, 2005, 166(*4*), 451 – 463.

[13] Kagan, J. dan Kogan, N. (1970) Individual Variation in Cognitive Process. Dalam Mussan, P. (Edt.) *Carmichael's Manual of Child Psychology* (3rd ed. Vol. 1) Wiley New York

ISSN 1907-1744 (Cetak)
ISSN 2460-1500 (Online)

[14] Warli. (2013). Kreativitas Siswa SMP yang Bergaya Kognitif Reflektif atau Impulsif dalam Memecahkan Masalah Geometri. *Jurnal Pendidikan dan Pembelajaran , 20*, 190-201.

[15] Edwards, LD. (1997). "Explore Ring the Terrority before Proof: Students' Generalization in a computer Microworld for Transformation Geometry". *International Journal of Computers for Mathematical Learning*,1:187-215.

[16] Clements, D. H. & Burns, B. A. (2000). "Students' development of strategies for turn and angle measure". *Educational Studies in Mathematics*, 41(*1*), 31-45.

[17] Rollick, M. B. (2009). Towards a Definition of Reflection. *Mathematics Teaching in The Middle School , 14.*

[18] Arikunto. (2002). *Prosedur Penelitian Suatu Pendekatan Praktek.* Jakarta: Rineka Cipta.

[19] Moleong. (2013). *Metodologi Penelitian Kualitatif*. Bandung: Remaja Rosdakarya.

[20] Prayitno, S. (2019). *Evaluasi Pembelajaran Matematika*. Mataram: Duta Pustaka Ilmu.

[21] Fauziah, N., Hakim, A., & Andayani, Y. (2019). Meningkatkan literasi sains peserta didik melalui pembelajaran berbasis masalah berorientasi green chemistry pada materi laju reaksi. *Jurnal Pijar MIPA*, *14*(2), 31-35.

[22] Rahmatina, S., Sumarmo, U., & Johar, R. (2014). Tingkat Berpikir Kreatif Siswa dalam Menyelesaikan Masalah Matematika Berdasarkan Gaya Kognitif Reflektif dan Impulsif. *Jurnal Didaktik Matematika* , 62-70