e-ISSN: 2549-5070
p-ISSN: 2549-8231

Journal of Medives : Journal of Mathematics Education IKIP Veteran Semarang
Volume 7, No. 2, 2023, pp. 219 - 231
https://doi.org/10.31331/medivesveteran.v7i2.2580

Exploration of Student Algebraic Thinking in Terms of Impulsive Reflective Cognitive Style

*Lughina A'yun Zahrotu Najma[1], Masduki[2]
*Muhammadiyah University of Surakarta
*a410190212@student.ums.ac.id

***Received**: May 2023. **Accepted**: June 2023. **Published**: July 2023.*

ABSTRACT

Algebra is the part of mathematics that helps represent problems. Learning algebra is crucial since it has numerous applications outside of mathematics and in daily life. The subject of algebra is one that students need to master. The purpose of this study was to reveal the ability of algebra students' thinking profiles in solving math problems in terms of cognitive style reflective and impulsive. The subjects of this study were 32 students at a university in Surakarta. The method used in this study is a qualitative method with a case study approach. The instruments in this study were the MFFT test (Matching Familiar Figure Test), algebraic tests, and interviews. The results showed that 1) Students who have a reflective cognitive style and students who have an impulsive cognitive style can fulfill two indicators of algebraic thinking, namely functional thinking, generalization, and justification. 2) Students who have a reflective cognitive style are more systematic in working on problems. Meanwhile, students who have an impulsive cognitive style are more likely to write only the final result.
***Keywords**: algebra thinking, cognitive, reflective-impulsive*

How to Cite: Najma, L., & Masduki, M. (2023). Exploration of Student Algebraic Thinking In Terms Of Implusive Reflective Cognitive Style. *Journal Of Medives : Journal Of Mathematics Education IKIP Veteran Semarang*, *7*(2), 219 - 231.

INTRODUCTION

Algebraic thinking is a thought process that involves the development of thinking that uses algebraic symbols as aids, but is not separate from algebra, and thinking that uses algebraic symbols such as problem-solving, modeling, inference, and prediction (Kieran, 2004). Booker and Windsor (2010) state algebraic thinking is the process of reasoning by generalizing, developing concepts, and formulating. Algebraic thinking is the mathematical analysis of terms relating to words, tables, graphs, charts, and equations using mathematical tools, the determination of relationships between functions, and the calculation of unknown values (Ntsohi, 2013). Algebraic thinking is an ability formed from the process of thinking activities which include generalization, abstraction, dynamic thinking, analytical thinking, modeling, and organization (Lew, 2004). Algebraic thinking is a mathematical generalizing activity, using a literal representation of symbols, and representing functional relationships no longer applied to the middle class and beyond, but is also an increasingly common thread in the interweaving of ideas that shape mathematical thinking in elementary grades (Blanton & Kaput, 2011).

Kieran (2004) states three components in algebraic thinking, namely generalization ability, transformation ability, and global metalevel ability. Generalization skills are algebraic skills that involve building formulas and equations. Transformation skills are algebraic skills related to the rule-based modification. Global meta-level skills are skills that use algebra as a tool to solve algebraic and non-algebraic problems. Algebraic reasoning has two main components: developing mathematical reasoning tools and learning the basic ideas of algebra. The idea of algebra is the content of the mathematical thinking tools that are built. There are three general categories of mathematical thinking tools namely problem-solving skills, reasoning skills, expression skills (Kriegler, 2011). Algebraic thinking has three components, namely the use of symbols and algebraic relationships, the use of patterns and generalizations, and the use of various forms of representation (Dindyal, 2011). (Ralston, 2013) states that there are three components of algebraic thinking, namely numerical manipulation, modeling and patterns. First, the subcomponent of numerical manipulation includes generalizations of arithmetic efficiency in general. The two subcomponents of modeling include equivalence, open sentences, the meaning of equal signs, and the use of variables.

Algebra is very important to learn because there are many benefits in everyday life, not only in mathematics. Algebra is a material that students must master (Booker &; Windsor, 2010). The ability to think algebraically is one of the means for students to be able to generalize and abstract a problem logically (Foster, 2007). Algebraic thinking can help students to construct linguistics and representations to symbolize patterns, analyze, draw, and relationships (Blanton & Kaput, 2011). Algebraic thinking is inseparable from students' ability to solve a problem. Problems in mathematics can be interpreted as verbal problems, word problems and story problems (Phonapichat et al, 2014).

In algebraic thinking, it is common to find inherent differences in the way each student receives and processes information. This happens because of differences in students' cognitive abilities (Maharani et al., 2018). Cognitive styles are defined as individual differences in memory and thinking, or the way information is distinguished, understood, stored, realized, and used (Kogan, 1973). Cognitive styles based on students' contextual learning speed can be divided into two types: reflexive cognitive styles and impulsive cognitive styles (Riding &; Cheema, 1991). Cognitive style is the difference in the way a person manages information (Oh &; Lim, 2005). Firestone and Douglas (1977) state that reflective-type students consider more options before answering so that the answers given tend to be more correct. Impulsive students react quickly to situations but tend to be mistaken in their responses. The impulse-reflex cognitive style is defined as a cognitive system that combines time and effort with high-uncertainty problems. Students who are responsive to problems with less thorough problem-solving, such as tend to be wrong in solving problems, are said to have an impulsive cognitive style. Students who are slow learners, i.e. students who take longer to solve problems and usually get the results right, are called reflexive cognitive styles. (Rozencwajg, 2015).

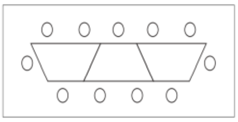
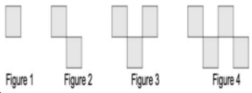
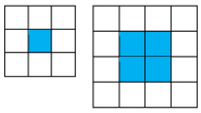
Many research studies on algebraic thinking have been carried out, but most of them are carried out on junior high school students, including (Harti &; Agoestanto, 2019) related to the ability to think algebraically in terms of the ability to think critically in mathematics of junior high school students in problem-based learning, (Kusumaningsih &; Herman, 2018) on the ability to think algebraically of junior high school students through multiple representation strategies with a realistic approach, (Kusumaningsih et al, 2018) on the ability to think algebra in terms of the ability to think algebra in Solving math problems in terms of gender differences. Research on algebraic thinking in college students is very limited. Therefore, this study focuses on revealing students' algebraic thinking skills in terms of impulsive reflective cognitive style. The importance of research that examines algebraic thinking skills is associated with reflective-impulsive cognitive styles to develop students' algebraic thinking skills according to reflective-impulsive cognitive learning styles.

METHOD

This research method uses qualitative methods with a case study approach model. The subjects of this study were 32 students at one of the universities in Surakarta. Researchers use the algebraic thinking component of the research instrument used including algebraic thinking test questions, MFFT (Matching Familiar Figure Test) cognitive style instruments, and interview guidelines. Researchers compiled an algebraic thinking test question instrument by adapting questions from PISSA 2012 (OECD, 2012). Researchers compiled 13 questions consisting of 4 generalization category questions, 5 functional thinking category questions, and 4 generalization and jstification category questions. Components of algebraic thinking according to (Kaput &; Blanton, 2005). Before use, the problem is first validated by 2 mathematicians. Based on the validation results, researchers set seven questions by eliminating 2 questions in the functional thinking component and 1 in the generalization and justification component. Furthermore, researchers conducted question trials on 15 students in addition to the subjects to be researched. Then, to classify the students' cognitive styles, researchers used MFFT instruments from (Warli, 2010). Furthermore, to uncover students' algebraic thought processes in depth on each cognitive style, researchers used interview guidelines. Before use, interview guidelines are first validated by expert validators.

In the paper, of the 7 questions studied that were used to examine algebraic thinking skills, three questions will be analyzed consisting of 2 functional thinking questions and 1 generalization and justification as presented in Table 1.

Table 1. Examples of Algebraic Thinking Test Questions

No	Question Type	Question
1	Functional thinking	In a meeting room, there are several trapezoid-shaped tables. The sitting position of the person if three tables are arranged is presented in Figure.  a. Determine the number of people who can be seated if there are 20 tables arranged as pictured! Explain the solution you used! b. If there are 40 people present, determine the number of tables needed! Explain the solution you used! c. Determine a formula that expresses the relationship between many tables and many people who can sit!
2	Functional thinking	Given the geometric pattern as follows.  In Figure 1 there are 4 corner points, Figure 2 there are 7 corner points. a. If there are 30 squares arranged following the pattern as shown in Figures 1 to 4, determine the many corner points formed! Explain the solution you used! b. Define a formula that expresses the relationship between many corner points and many squares according to the pattern in Figure 1 through 4!
3	Generalizations and justifications	 Specify: a. Many blue tiles are needed to arrange the tile pattern as shown in Figure if 52 white tiles are available! b. Many white tiles are needed to compose the tile pattern as shown in Figure if 64 blue tiles are available! c. Determine the formula that expresses the relationship between many blue tiles and many white tiles!

Furthermore, based on the results of the algebraic thinking test and MFFT questionnaire to 32 students, recapitulation data were obtained as presented in Table 2.

Table 2. Recapitulation of Cognitive Styles

Cognitive Styles	Number of Students
Reflective	14
Implusive	15
Quick-accurate	3

Based on the data in Table 2, researchers selected 6 subjects consisting of 3 subjects in the reflective cognitive style category and 3 subjects in the impulsive cognitive style category. Subject selection is based on the speed at which the questionnaire is completed and the frequency of errors made by the subject. To facilitate data analysis, reflective subjects were assigned S1, S2, and S3 codes, while impulsive subjects were assigned S4, S5, and S6 codes.

Data analysis is carried out by first conducting document analysis, namely analysis of students' answers in solving algebraic thinking test questions. The focus of the analysis is on the steps of solving the problem and the strategy used to solve the problem. In document analysis, researchers use assessment rubrics as presented in Table 3.

Table 3. Rubik's Assessment

Judging Criteria	Score
Completion steps and correct answers	3
Right resolution steps and wrong answers	2
Partial correct resolution steps and incorrect answers	1
Incorrect resolution steps or unable to answer the question	0

Furthermore, researchers conducted interviews to dig deeper into students' steps and solving strategies in solving algebraic thinking problems. The interview is also meant to validate the student's answers in the document i.e. the student's answer sheet.

RESULTS AND DISCUSSION

In this section, the results of document analysis and interviews are presented 6 subjects of reflective and impulsive cognitive styles in solving functional thinking problems, generalizations and justifications.

Question number 1

Question number 1 is used to explore students' ability to do functional thinking, which is a process to find functional relationships. Based on the test results, in point a subjects SI, S2, S3, S4, S5, S6 can solve the problem using the right solving steps and get the right answer as well. Then, in point b, subjects S3, S5 can solve the problem using the right solving steps and get the right answer as well, subject S6 uses the right solving steps but gets the wrong answer and subjects S1, S2, S4 use partial correct solving steps with wrong answers. In point c, subjects S2, S3, S4, S5 can solve the problem using the right solving steps and get the right answer as well and subjects S1, S6 are unable to solve the problem using the right solving steps but the answers obtained are not correct. The answer of the S3 subject in solving question number 1 is presented in Figure 1.

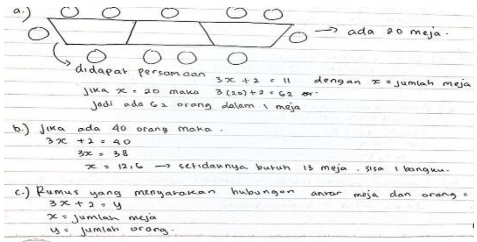


Figure 1 . Reflective Answer 3

Based on Figure 3, S3 first redraws the chair pattern based on the problem. S3 writes the equation 3(x) + 2 = number of sitting, where x is the number of tables. Based on the calculation results, R3 can conclude that if there are 20 tables available then there are 62 people who can sit. In point b, S3 writes the equation 3x + 2 = 40. S3 can conclude if there are 40 people present, then many tables are needed i.e. 13 tables remaining 1. S3 uses the equation 3x + 2 = y to express the relationship of table children and people, where x is the number of tables and y is the number of people. Furthermore, the researcher conducted an interview with S3 to further explore S3's understanding in solving question number 1. Excerpts of the interview with S3 are presented as follows.

P : How did you solve question number 1?

S : I saw from the picture in question, there were 3 tables, then the number of seats was 11 then there were 2 chairs on the right side and left side. I got the equation 3x+2 = 11 where x is the number of tables, so I immediately put 20 into x so the result is 3(20) + 2 = 62. For point b I use the equation that if there are 40 people then 3x + 2 = 40 can be concluded to require 13 tables remaining 1 bench. For the formula I use, the equation in the answers to questions a and b with x number of tables.

Based on the results of interviews and analysis of the answers to question number 1, it can be concluded that S3 is able to use functional relationships to solve problems related to functional thinking. Then the S5 solving step in solving question number 1 is presented in Figure 2.

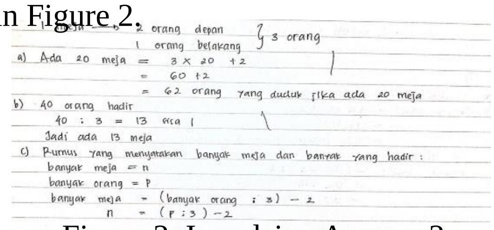


Figure 2, Impulsive Answer 2

Based on figure 2. In point a, S5 writes 1 table there are 3 people. Next, S5 multiplies the number of seats at each middle table by the number of known tables which is 3 x 20 = 60. There is 1 seat on the right side and there is 1 seat on the left side. So that the number of seats 60 + 2 = 62. Based on the calculation results, I2 can conclude if 20 tables are 62 people who can sit. In point b, S5 divides the people present by many seats at each middle table which is 40 : 3 = 13. Based on the calculation results, S5 can conclude that if there are 40 people present, there are 13 tables needed. In point c, S5 uses the formula to express the relationship between many tables with many people with n = (p : 3) - 2 where n many tables, p many people. S5's understanding of functional thinking is supported by the results of the researcher's interview with S5. Furthermore, the researcher conducted an interview with I2 to further explore S5's understanding in solving question number 1. Excerpts of the interview with S5 are presented as follows.

P : How did you solve question number 1?

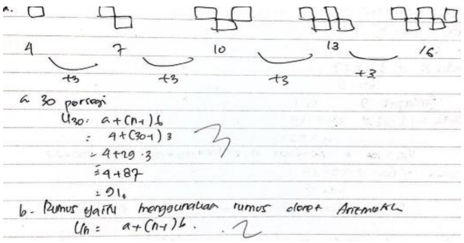
S : There are 20 tables means automatically each table is filled with 3 people means x20 tables, while the right and left sides are filled 1 and 1 means 3 x 20 + 2 so 60 + 2 = 62 people. Then the b if if 40 people are present while 1 table is in the middle there are 3 people without the right and left sides means 40: 3 there are 13 the rest there is 1. Then for the formula it is a lot of tables suppose n then many people are suppose p then n = (p : 3) -2

Based on the results of interviews and analysis of answers to question number 1, it can be concluded that S5 is able to use functional relationships to solve problems related to functional thinking.

Thus, there are two strategies carried out by the subject to solve question number 1. The first strategy is to first draw a trapezoid-shaped table. Next use the equation to determine many tables with many people who can sit. Then the second strategy is to directly multiply many chairs by many tables. In addition, reflective subjects are more systematic and detailed in the steps of solving problems. While immupulsive subjects tend to answer directly, while in documents written the results only.

Question number 2

Question number 2 is used to explore students' ability to do functional thinking, which is a process to find geometric patterns. Based on the test results, subjects S1, S2, S3, S4, S6 can solve the questions using the right solving steps and get the right answers as well. Then the S5 subject was unable to solve the problem using the right solving steps so that the answers obtained were not correct. The answer of the S1 subject in solving question number 1 is presented in Figure 3.



Gambar 3. Jawaban Reflektif 1

Based on Figure 3, in point a, S1 first draws a geometric pattern and finds the angle points as the information in the problem. Next, S1 looks for the difference in the angle points in each of these geometric patterns. Then, S1 writes the formula Un = a + (n - 1) b to determine many angular points with a = 4, n = 30 , b = 3. Next, S1 operates the formula to U_{30} = 4 + (30 – 1) 3 with the result 91. Based on the calculation results, S1 can infer many corner points if there are 30 squares, which is 91. In point b, S1 uses the arithmetic sequence formula with the formula Un = a + (n-1) b to express the relationship between many corner points and many squares. Furthermore, the researcher conducted an interview with S1 to further explore S1's understanding in solving question number 2. Excerpts of the interview with S1 are presented as follows.

P : How is your solution number 2?

S : That a one is looking for U_{30} = a + (n - 1) b. a = 4, n = 30, b = 3. So 4 + (30-1) 3. Then 4 + (29) 3 final result 91. Point b uses arithmetic formulas

Based on the results of interviews and analysis of answers to question number 2, it can be concluded that S1 is able to use patterns to solve problems related to functional thinking. Then the S4 solving step in solving question number 2 is presented in Figure 4.

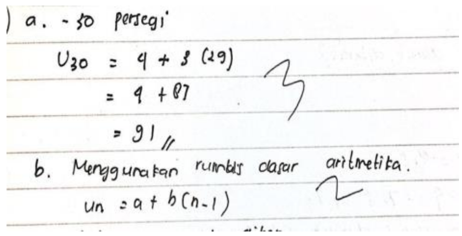


Figure 4. Implusive Answer 1

Based on Figure 4, in point a, S4 writes U_{30} = 4 + 3 (29) to determine many angular points. Based on the calculation results, S4 can infer many corner points if there are 30 squares, which is 91. In point b, S4 uses the arithmetic sequence formula with the formula Un = a + (n-1) b to express the relationship between many corner points and many squares. Furthermore, the researcher conducted an interview with S4 to further explore S4's understanding in solving question number 2. Excerpts of the interview with S4 are presented as follows.

P : How did you solve question number 2?

S : Because what is asked is 30 squares, I use the arithmetic series formula so U_{30} = 4 + 3 (29), where 4 is the first term then 3 of the difference in the corner points in each figure then 29 of (30 - 1). So later the result will be 91. For the b I use the formula Un = a + b (n-1)

Based on the results of interviews and analysis of answers to question number 2, it can be concluded that S4 is able to use geometric patterns to solve problems related to functional thinking.

Thus, there are two strategies carried out by the subject to solve question number 2. The first strategy is to first redraw the geometric pattern based on the problem and find the difference in the angle points in the geometric pattern image 1,2,3,4.Then the second strategy is by directly finding many angular points formed by the arithmetic sequence formula. In addition, reflective subjects are more systematic and detailed in the steps of solving problems. While immupulsive subjects tend to answer directly.

Question Number 3

Question number 3 is used to explore students' ability to generalize and justify, which is a process to find a pattern or a shape. Based on the test results, in point a subjects SI, S2, S3, S4, S5, S6 can solve the problem using the right solving steps and get the right answer as well. In point b, subjects S1, S2, S5 can solve the problem using the right solving steps and get the right answer as well. Then subject S3 uses the correct completion step but gets the wrong answer and subject S4,S6 uses the partial correct completion step with the wrong answer. In point c sbjek S1, S2, S3, S4, S5, S6 can solve the problem using the right solving steps and get the right answer as well. Figure 5 shows the answer to S1 in solving question number 3.

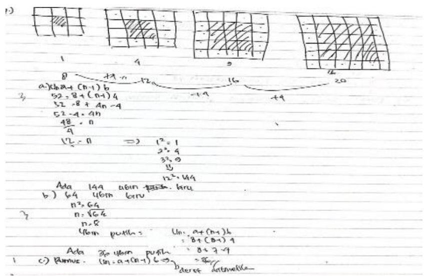


Figure 5. Reflective Answer 1

Based on Figure 5, In point a S1 work first draw a tile pattern. Then, S1 writes Un = a(n - 1)b to search for lots of blue tiles. Based on the calculation results, S1 can infer the number of blue tiles required which is 144. In point b, S1 does this by rooting 64. Next, S1 writes Un = a + (n – 1) b to count the white tiles. Based on the calculation results, S1 can infer the number of white tiles required which is 36. In point c, S1 uses the formula Un = a + (n – 1)b to express the relationship between many blue tiles and many white tiles. Furthermore, the researcher conducted an interview with S1 to further explore S1's understanding in solving question number 3. Excerpts of the interview with S1 are presented as follows.

P : How did you solve question number 3?

S : If it is known Un = 52, so a is 8 because it is asked white, U52 = 8+(n-1)b. So 52= 8 + (4n-4) ,.,so 48 = 4n. Then the n is 12. So because the result of the blue tiles of the first quadrant is 1 squared is 1, the second is 4, then the quadrant result of the 12 quadrants = 144 so there are 144 tiles. To find white tiles, the root result of 64 is 8 white tiles. Then Un = a+(n-1)b a = 8, b = 4, n = 8 so the result is 36. If the c is the correct one using the ordinary arithmetic sequence formula.

Based on the results of interviews and analysis of answers to question number 3, it can be concluded that S1 is able to use patterns to solve problems related to generalization and justification. Then the S5 solving step in solving question number 3 is presented in Figure 6.

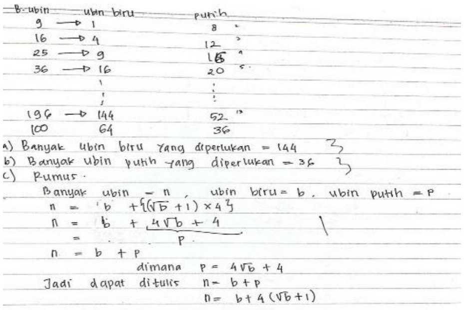


Figure 6. Implusive Answer 2

Based on Figure 6, S5 writes that if there are 9 tiles, then there is 1 blue tile. If there are 16 tiles, then there are 4 blue tiles and so on. Next, S5 calculates many white tiles by subtracting many tiles with many tiles with blue tiles, for example, in figure 1, many tiles, 9 with blue tiles, which is 1, then you get 9-1 = 8 white tiles. On point a, S5 writes down as many blue tiles as required 144. In point b, S5 writes down the required number of white tiles = 36. In point c, S5 writes the formulan = b + {(($\sqrt{b}$ + 1) x 4 }. Next S simplifies to n = b + p., n = b + 4 ($\sqrt{b}$ + 1) where n = many tiles, b = blue tiles, p = white tiles. Furthermore, the researcher conducted an interview with S5 to further explore S5's understanding in solving question number 3. Excerpts of the interview with S5 are presented as follows.

P : How do I solve question number 3?

S : The one that a there are 9 tiles then the blue tiles there is 1 means there are 8 white tiles, then for the 2nd there are 16 white tiles then there are 4 blue tiles so there are 12 blue tiles then (silent) there was a pattern yesterday but forgot the pattern how did finally get the answer that there are many blue tiles needed there are 144 if there are 52 tiles that are white. Yesterday I didn't think it was a geometric series or a geometric or arithmetic sequence thinking about number patterns, it was in the form of what was important in the pattern so I didn't think it was only focused on geometry or arithmetic I didn't think about it

Based on the results of interviews and analysis of answers to question number 3, it can be concluded that S5 is able to use patterns to solve problems related to generalization and justification.

Thus, there are two strategies carried out by the subject to solve question number 2. The first strategy is to count each white tile and blue tile on the pattern, and determine the difference between each tile pattern 1,2, and so on. Then the second strategy is by reducing many tiles with many white tiles. In addition, reflective subjects are more systematic and detailed in the steps of solving problems. While immupulsive subjects tend to answer directly.

In the problem of functional thinking indicators and generalization and justification, based on the results of the analysis, there are students with reflective cognitive styles and students with implusive cognitive styles have different strategies in solving problems. In functional relation problems, reflective subjects in solving the problem first redraw the image based on the problem. Then the reflective subject creates an equation to determine many tables with many people who can sit. Meanwhile, the implusive-style subject solved the problem by directly multiplying many chairs by many tables. In the geometry pattern problem, the reflective subject in solving the problem first redraws the geometric pattern based on the problem and finds the difference in the angle points in the geometric pattern image 1,2,3,4. Meanwhile, the implusive subject solves the problem by directly finding many angular points formed by the arithmetic sequence formula. In the generalization indicator and justification problem, the subject is reflective in solving the problem first, redrawing the geometric pattern based on the problem and finding the difference from the corner point to another corner point. Meanwhile, the subject is implusive in solving problems by directly using the arithmetic series series formula.

Both subjects in solving problems categorize functional thinking and generalization and justification using different representations to express ideas and solve problems. Reflective subjects use the presence of images, numbers and symbols. Whereas, the implusive subject uses representations of numbers and symbols.

The results of the analysis of the algebraic thinking test, in general, reflective subjects and impulsive subjects are able to solve algebraic thinking problems and meet the indicators of functional thinking and generalization and justification. Reflective subjects in solving functional thinking problems and generalizations and justifications are more systematic in answering questions. This is in line with opinion (Prayitno et al. 2022) that reflective subjects answer questions systematically, and are meticulous in solving given questions. Meanwhile, the implusive subjects solve functional thinking problems and generalizations and justifications answer directly, and when the interview responds quickly to the questions given. This is according to opinion (Aprilia et al, 2015) which states that impulsive subjects tend to be quick in responding to questions given during interviews and writing down all the ideas that are in their minds during the test process.

When doing algebra problems, reflective subjects take a long time, and reflective subjects read the problems repeatedly to understand the problem. While the implusive subject solves algebra problems faster. Correspondingly, according to (Rahayu & Winarso, 2018) Reflective students take longer to answer questions, while implusive subjects respond or answer quickly. Some reflective subject results express his ideas with images. Meanwhile, implusive subjects do not use images in conveying their ideas. This is in line with research (Azmi S. et al, 2022) The reflective subject is more precise in expressing its mathematical ideas, relating problems with drawings or diagrams and mathematical expressions. Impulsive cognitive skills are still not precise in expressing mathematical ideas, relating problems to pictures or diagrams, and mathematical expressions.

Reflective subjects were better at solving algebra tests than implusive subjects despite some incorrect results. This is in accordance with the opinion (Kobandaha et al, 2019) that the number sense ability of reflective subjects is better than that of implusive subjects. In line with research (Satriawan et al 2018) Reflective subjects are so careful that they quickly realize and correct mistakes. However, impulsive subjects tend to be quick and not careful to solve problems that arise, so do not pay attention when something goes wrong.

In this study, based on 6 research subjects from 3 reflective subjects and 3 impulsive subjects, it can be concluded that reflective subjects are better than impulsive subjects. This is in accordance with previous research by (Ningsih & Cintamulya, 2018) that the thinking ability of reflective subjects is better than that of impulsive subjects.

CONCLUSION

Based on the results of research on students' algebraic thinking skills on reflective and impulsive cognitive styles, researchers concluded that in solving algebraic thinking problems reflective subjects and impulsive subjects were able to meet the components of functional thinking and generalization and justification. In the components of functional thinking and generalization and justification, reflective subjects solve by using relationships and patterns to solve problems with systematic and more rigorous steps in writing answers. While impulsive subjects solve by using relationships and patterns to solve problems, but in the solving step is not systematic and tends to directly write down the final result. This is in line with the cognitive style that reflective subjects have answers that are systematic, thorough, careful and answers tend to be accurate, while impulsive subjects write down all the ideas in their minds when answering questions, so that the solving step tends to be unsystematic.

REFERENCES

Aprilia, Nahda Cindy, Sunardi, & Trapsilasiwi, Dinawati. 2015. “Proses Berpikir Siswa Gaya Kognitif Reflektif dan Impulsif dalam Memecahkan Masalah Matematika di Kelas VII SMPN 1 Jember”, dalam Jurnal Edukasi 2, no. 3 (2015): 31 – 37.

Azmi S, Baidowi, Hikmah N, Tyaningsih R Y, Kurniawan E. (2022).” *analysis of students' mathematics communication ability based on cognitive styles and mathematical knowledge* 17(2): 231–38.

Kobandaha, Putri Ekawaty, Yusuf Fuad, and Masriyah Masriyah. (2019). “Algebraic Reasoning of Students with Logical-Mathematical Intelligence and Visual-Spatial Intelligence in Solving Algebraic Problems.” *International Journal of Trends in Mathematics Education Research* 2(4): 207–11.

Kusumaningsih, Widya, and Tatang Herman. (2018). “Improvement algebraic thinking ability using multiple representation strategy on realistic.” 9(2): 281–90.

Maudy, S Y et al. (2018). “Gender Differences in Algebraic Thinking Ability to Solve Mathematics Problems Gender Differences in Algebraic Thinking Ability to Solve Mathematics Problems.”

Ningsih, Dian Agustin, and Imas Cintamulya. (2018). “Analisis Berpikir Kritis Siswa Berbasis Gaya Kognitif Melalui Model Pembelajaran Problem Based Learning (PBL) Dengan Menggunakan Media Roda Keberuntungan Di SMP Muhamammadiyah 15 Sedayulawas Analysis of Critical Thinking Student Based on Cognitive Style.” 15: 90–96.

Rahayu, Yuli Aulia, and Widodo Winarso. (2018). “Critical Thinking of Students in Solving Mathematics Judging from the Differences in Types of Reflective and Impulsive Cognitive Styles.” *Jurnal Imiah Pendidikan dan Pembelajaran* 2(1): 1–11.

Satriawan, M. A., M. T. Budiarto, and T. Y.E. Siswono. 2018. “Students' Relational Thinking of Impulsive and Reflective in Solving Mathematical Problem.” *Journal of Physics: Conference Series* 947(1).

Blanton, Maria L., and James J. Kaput. 2011. “Functional Thinking as a Route Into Algebra in the Elementary Grades.” : 5–23.

Booker, George, and Will Windsor. 2010a. “Developing Algebraic Thinking: Using Problem-Solving to Build from Number and Geometry in the Primary School to the Ideas That Underpin Algebra in High School and Beyond.” In *Procedia - Social and Behavioral Sciences*, Elsevier Ltd, 411–19.

Dindyal, Jaguthsing. (2011). “Algebraic Thinking in Geometry at High School Level: Students’ Use of Variables and Unknowns.” *National Institute of Education* 27(21): 183–90.

Firestone, Philip, and Virginia Douglas. (1977). “The Effects of Verbal and Material Rewards and Punishers on the Performance of Impulsive and Reflective Children.” *Child Study Journal*.

Foster, David. (2007). “Chapter 12 Making Meaning in Algebra Examining Students ’ Understandings and.” *Assessing Mathematical Proficiency, MSRI Publications* 53: 163–76.

Harti, Laela Sih, and Arief Agoestanto. (2019). “Analysis of Algebraic Thinking Ability Viewed from the Mathematical Critical Thinking Ablity of Junior High School Students on Problem Based Learning.” 8(2): 119–27.

Kaput, James J, and María Blanton. (2005). “Characterizing a Classroom Practice That Promotes Algebraic Reasoning.” *Journal for research in mathematics education* 36(5): 412.

Kieran, Carolyn. (2004). 8 The Mathematics Educator *Algebraic Thinking in the Early Grades: What Is It? 1*.

Kogan, Nathan. (1973). Life-Span Developmental Psychology *Creativity and* Cognitive *Style: A Life-Span Perspective*. ACADEMIC PRESS, INC.

Kriegler, By Shelley. (2011). “just what is algebraic thinking ?” : 1–11.

Kusumaningsih, Widya, and Tatang Herman. (2018). “improvement algebraic thinking ability using multiple representation strategy on realistic.” 9(2): 281–90.

Kusumaningsih, Widya, Pran Yudi Setiawan, and Rizky Esti Utami. (2018). “Profil Berpikir Aljabar Siswa Smp Dalam Pemecahan Masalah Matematis Ditinjau Dari Gaya Kognitif Dan Gender.” *JIPMat* 5(1).

Lew, Hee-Chan. (2004). “Developing Algebraic Thinking in Early Grades: Case Study of Korean Elementary School Mathematics 1.” *The Mathematics Educator* 8(1): 88–106.

Maharani, p., trapsilasiwi, d., yudianto, e., & sugiarti, t. (2018). *Profil berpikir aljabar siswa smp dalam menyelesaikan masalah matematika ditinjau dari gaya kognitif (reflektif dan impulsif)*. Http://jurnal.unej.ac.id/index.php/stf

Nahda cindy aprilia, sunardi, & dinawati trapsilasiwi. (2015). *Thinking process of reflective and impulsive cognitive style’s student tosolving the mathematics problem in vii grade of smpn 11 jember*.

Ntsohi, *Mamosa* M. E. (2013). “Investigating Teaching and

Learning of Grade 9 Algebra Through Excel Spreadsheets: A Mixed-Methods Case Study for Lesotho.” (December): 279.

OECD. 2012. “PISA (2012) Released Mathematics Items.” *PISSA*: 1–92.

Oh, Eunjoo, and Doohun Lim. (2005). “Cross Relationships between Cognitive Styles and Learner Variables in Online Learning Environment.” *Journal of Interactive Online Learning* 4(1): 53–66.

Phonapichat, Prathana, Suwimon Wongwanich, and Siridej Sujiva. (2014). “An Analysis of Elementary School Students ’ Difficulties in Mathematical Problem Solving.” *Procedia - Social and Behavioral Sciences* 116(2012): 3169–74.

Prayitno, Anggar et al. (2022). “The Analysis of Student’s Algebraic Reasoning Abilities in Reflective and Impulsive Cognitive Styles.” (2018).

Ralston, N C. (2013). “The Development and Validation Og a Diagnostic of Algebraic Thingking Skills.”

Riding, Richard, and Indra Cheema. (1991). “Educational Psychology : An International Journal of Experimental Cognitive Styles — an Overview and Integration.” *Educational Psychology: An International Journal of Experimental Educational Psychology* 11(3–4): 37–41.

Rozencwajg, Paulette. (2015). “Cognitive Processes in the Reflective- Impulsive Cognitive Style Cognitive Processes in the Reflective – Impulsive Cognitive Style.” *The Journal of Genetic Psychology* 166(4): 451–63.

Warli. (2010). “Kreativitas Siswa SMP Yang Bergaya Kognitif Reflektif Atau Impulsif Dalam Memecahkan Masalah Geometri.” *Jurnal Pendidikan dan Pembelajaran* 20(2): 190–210.