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The Reflective and Impulsive Graduate Student's Creativity Problem Solving of Three Variables of Linear Equations System

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Abstract

The challenge for prospective mathematics teachers in the future is to have a good mastery of the material, be able to solve math problems and think creatively. So that later they will be able to guide their students to develop creativity in 21st-century life. Cognitive style and learning influence the establishment of the creativity of mathematical problem-solving. The purpose of the study was to describe the creativity of students with reflective and impulsive cognitive styles in solving problems of a three-variable linear equation system. The research was carried out using descriptive-qualitative research methods. The research subjects were the Mathematics Education Study Program students at the University of Palangka Raya. The research instrument uses the Matching Familiar Figure Test, a problem-solving ability test, and an analytic rubric. Data were analyzed by scatterplot, pie diagram, reduction, triangulation, and inference. Research findings on students with reflective cognitive style in stages (1) understand problems and develop mathematical models with fluency, flexibility, originality, and elaboration; (2) complete the plan with fluency, flexibility, and elaboration; (3) check the results with fluency and elaboration. Students with impulsive cognitive styles are only in the stage of understanding the problem with fluency, novelty, and elaboration indicators.

Keywords: *creativity, impulsive, linear equation system, problem-solving, reflective*

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Abstrak

Tantangan bagi calon guru matematika di masa depan harus menguasai materi, mampu memecahkan masalah matematika dan kreativitas berpikir yang baik. Agar nantinya mereka mampu membimbing para siswanya mengembangkan kreativitas dalam kehidupan abad 21. Gaya kognitif dan pembelajaran berpengaruh terhadap pembentukan kreativitas memecahkan masalah matematika. Tujuan penelitian mendeskripsikan kreativitas mahasiswa dengan gaya kognitif reflektif dan impulsif memecahkan masalah sistem persamaan linier tiga variabel, Penelitian dilaksanakan dengan metode penelitian deskriptif-kualitatif. Subjek penelitian adalah mahasiswa Program Studi Pendidikan Matematika Universitas Palangka Raya. Instrumen penelitian menggunakan Matching Familiar Figure Test, tes kemampuan pemecahan masalah dan rubrik analitik. Data dianalisis dengan scatterplot dan pie diagram, reduksi, triangulasi dan penyimpulan. Temuan penelitian pada mahasiswa dengan gaya kognitif reflektif pada tahap-tahap (1) memahami masalah dan menyusun model matematika dengan kefasihan, keluwesan, kebaharuan, dan elaborasi; (2) menyelesaikan rencana dengan fasihan, keluwesan, dan elaborasi; (3) memeriksa hasil dengan kefasihan dan elaborasi. Mahasiswa dengan gaya kognitif impulsif hanya tahap memahami masalah dengan indikator kefasihan, kebaharuan, dan elaborasi.

INTRODUCTION

Background

The challenges of learning 21st-century for prospective mathematics teachers are required to be able to carry out Technological, Pedagogical, and Content Knowledge (TPACK). Mathematic learning should develop mastery of critical thinking, creativity, collaboration, and communication skills. Mastery of content knowledge and creativity in solving mathematical problems is very important for students to master. These competencies are the provision for students to become future teachers of mathematics. According to Wijers & de Haan (2020) and Guinungco & Roman (2020), the skill of solving math problems is one of the important thinking skills to be mastered by students. Meanwhile, according to Marliani (2015) and Wilda et al. (2017), creativity has a positive effect on mathematics mastery and problem-solving.

Creative thinking is related to efforts to find solutions to everyday life problems. The three-variable linear equation system (TVLES) can be used as a tool to explore ideas for solutions to everyday problems. TVLES is material studied in Algebra lectures. One of the goals of studying TVLES is to solve everyday life problems. During the learning process, the process of understanding the concept and solving TVLES problems is also formed. In this case, the TVLES problem-solving process requires creative thinking. Creativity contributes to the thinking process of understanding mathematics both from the aspect of mastering the material and solving mathematical problems.

Creative thinking skills have been formed during students are working on learning assignments. The results of previous research show that creativity can be formed through the process of learning mathematics. Creative thinking is influenced by the level of students' mathematical abilities. Research by Suripah & Sthephani (2017) shows that in solving cube roots of complex equations, students with a high level of mathematical ability are able to master all indicators of creativity. The results of this study indicate that the factor of mathematical ability levels influences student creativity in solving complex equation roots problems. Likewise, the results of research by Malekian & Fathi (2012) and Kwon et al. (2006) planning, implementing, and using mathematics learning strategies affect creativity in learning mathematics. Wulandari et al. (2016) found that the cognitive style and creativity of Bandung Institute of Technology students were significantly correlated with the achievement index.

Creativity in solving math problems in students is influenced by the characteristics of thinking. One of the characteristics of thinking is cognitive style, which influences students' creativity in understanding and solving mathematical problems. According to Marliani, (2015), cognitive style is one of the individual characteristics. Cognitive style is a tendency in terms of feeling, remembering, organize, process, and solve problems, to distinguish, understand, store, and inform. Cognitive styles according to experts, such as Kagan et al. (1964), Kagan (2016), and Rozencwajg & Corroyer (2005) classified two types of cognitive styles, namely reflective and impulsive.

Reflective individuals tend to take time to think before planning an action. Meanwhile, individuals who are impulsive tend to respond more directly. Warli (2010) states that there are significant differences in the mathematical abilities of students whose cognitive style is reflective higher than impulsive.

Cognitive style as a tendency to process information influences individual creativity in solving mathematical problems. Types of thinking styles affect the level of student creativity in solving math problems (Purnomo et al., 2017) . It's related to the research of Warli (2010) state that there are significant differences in the mathematical abilities of students with a higher reflective cognitive style than impulsive ones. So the style of thinking affects the creativity of thinking in solving mathematical problems.

This opinion implies that the creative thinking of students in solving TVLES problems will also be influenced by the characteristics of reflective and impulsive thinking styles. Thinking processes that tend to be reflective and impulsive will provide ample space for students to read, understand, and explore mathematical models to solve TVLES problems. The TVLES problem requires a careful understanding of its meaning. The problem is whether the learning process through lecturing can support the creativity of Mathematics education students to solve mathematics problems.

This study focused on finding profiles of students' mathematical thinking creativity in solving problems related to TVLES in terms of the characteristics of reflective and impulsive cognitive styles. In line with the research focus, the research objectives were to describe (1) students' creative thinking abilities with a reflective cognitive style and (2) students' creative thinking abilities with an impulsive cognitive style in solving TVLES problems. In the following, a theoretical construction of creativity in solving TVLES problems and cognitive style is built.

Theoretical Framework

Creative Thinking

Creativity according to Pehkonen (1997) is an individual's ability to produce something new and unpredictably. Minchekar (2017) defines creativity as a process of obtaining valuable original and renewable ideas. Wulandari et al. (2016) state that creativity is a person's ability to deal with a situation that is difficult to overcome with new ideas that are adaptive to difficulties. These definitions to stated that creativity is an individual's ability to find new ideas that are valuable in getting a solution to a problem. Creative thinking in learning mathematics is a process of thinking by bringing up new ideas or combining ideas that were previously done.

Indriyani et al. (2020) define the ability to think creatively as an individual's mental process of generating ideas smoothly, flexibly, and in detail. According to Siswono (2005), the process of creative thinking is related to the process of compiling ideas, building ideas, and planning

and implementing these ideas to get a new product. Based on this definition, mathematical creative thinking is an individual mental process of creating new ideas in solving problems related to mathematics. These new ideas can be accepted as mathematically correct and created smoothly, flexibly, and flexibly.

Relevant to this explanation Nurhayati & Rahardi (2021) state the ability to think creatively mathematically is the ability to find solutions to mathematical problems in a simple and flexible manner. In addition, creative thinking is an original cognitive ability in the process of solving mathematical problems. According to Kwon et al. (2006), Marliani (2015), Minchekar (2017), Purnomo et al. (2017), and Yulianto et al. (2021) the ability to think creatively mathematically can be interpreted as the ability to solve mathematical problems with more than one completion of thinking fluency, flexibility, elaboration, and originality in the answers. From the opinion above, it can be concluded that there are four key elements of mathematical creative thinking, namely fluency, flexibility, originality, and elaboration. These four key elements of creativity need to be formed in students' thinking when participating in learning for mathematics courses.

Problem-Solving Skills

The problem-solving process produces a way to organize problem situations that produce good problem-solving structures and contain the achievement of problem-solving goals. Mathematical problem solving is a thinking process by integrating concepts, theorems, principles, and Mathematical axioms in a problem situation to be solved, and producing a form of mathematical problem solving that has true value based on mathematical logic.

Schoenfeld (2016) describes the math problem-solving strategy put forward by Polya as follows. First, the process of understanding the problem through the activity of compiling questions from the problem situation. Second, making a problem-solving plan is carried out by determining the components or data, or information one by one. Third, solving the problem is carried out by transforming the problem statement into a mathematical model and completing mathematical calculations. Fourth, reviewing the problem by examining the results of solving the questions that have been formulated previously. Based on the stages of solving these problems, the indicators of mathematical problem-solving ability are understanding the problem, developing a solving plan, completing the plan, and checking again.

Reflective-Impulsive Cognitive Styles

Cognitive style is a person's unique way of learning, both related to how to receive and process information, attitudes toward information, and habits related to the learning environment (Zakiah, 2020). Individual differences that persist in how to compile and process the information on these experiences are known as cognitive styles (Fadiana, 2016).

Kagan et al. (1964), Kagan (2016), and Rozencwajg & Corroyer (2005) classify cognitive styles into two categories, namely reflective and impulsive. The reflective individual has the characteristic of thinking about solving problems for a long time, but carefully so that the answers given tend to be correct. The Impulsive individual thinks solving problems in a short time, is less thorough, so the answers tend to be wrong. So, there are two important aspects of the reflective and impulsive cognitive styles, namely the time and correctness of the answers used by students to solve problems. Lahinda & Jailani (2015)

stated that cognitive style acts as cognitive control.

METHOD

This research was carried out using a qualitative-quantitative mixed method (Creswell, 2020), which focused on describing students' reflective and impulsive thinking creativity in solving TVLES problems. The qualitative descriptive method was carried out by describing the reflective and impulsive subject's creativity in solving TVLES problems. While the quantitative descriptive method is used to classify subjects according to cognitive style. The research phase follows the flow of activities according to Elo et al. (2014) to ensure the trustworthiness of research findings, as presented in Figure 1.

Figure 1. The Research Phases

The preparation phase includes the activities of choosing data collection methods, how to choose subjects, and units of analysis. Methods of data collection using tests and interviews, to ensure the credibility of data collection as stated Elo et al. (2014) can be done by a combination of the two methods. Cognitive style tests using the Matching Familiar Figure Test (MFFT) by Kagan et al. (1964) which was updated to MFFT-2021 and has good validity and reliability according to (Viator et al., 2022). Creativity in solving TVLES problems is explored by testing TVLES's problem-solving abilities. The answers of the research subjects were analyzed using the rubric of mathematical problem-solving skills and the rubric of thinking creatively. The interview instrument was in the form of a list of questions about mathematical problem-solving abilities and creativity. The stages of data collection are method and theoretical triangulation techniques (Elo et al., 2014).

The research subjects were determined using a purposive sampling technique (Elo et al., 2014), where the research subjects were selected according to the research objectives. The research subjects were selected by purposive sampling from students of the Mathematics Education Study Program, Teacher Training and Education Faculty of University Palangka Raya, who had taken Algebra courses and were currently taking School Mathematics III course of 34 students. The selection of subjects has fulfill transferability (Stahl & King, 2020), where the same subject, context, and experience can also be found in the context of lectures at other campuses that educate prospective Mathematics teachers.

The organizational phase includes categorization and abstraction, interpretation, and representativeness analysis. The organizational phase was carried out on the cognitive style data by giving the MFFT test to 34 subjects individually. The results of categorization, abstraction, and interpretation services as a reference for selecting each subject with the highest reflective cognitive style and the lowest impulsiveness. In this way, the representation of research subjects is fulfilled.

According to Denzin and Lincoln (2005), data interpretation should use adequate criteria. The abstraction and interpretation of the MFFT test results use the criteria for classifying cognitive style according to the quadrants with the median time (t) and f (right choice frequency) axes presented in Figure 2 and the cognitive style criteria in Table 1.

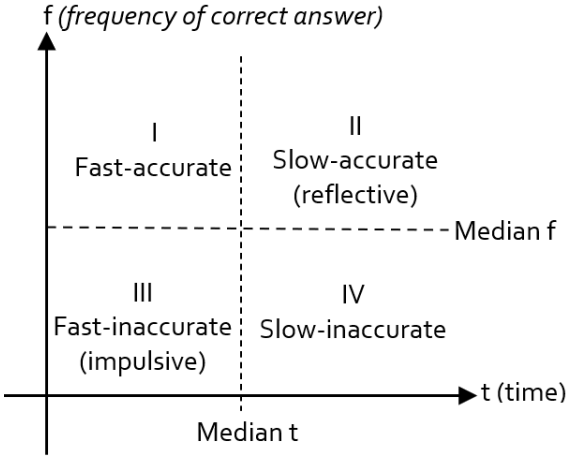


Figure 2. Reflective-Impulsive Quadrants

Table 1. The Cognitive Styles Categorization

Quadrant	Cognitive styles	Criteria
I	*Fast-accurate*	t ≤ median t f ≥ median f
II	*Slow-accurate (reflective)*	t ≥ median t f ≥ median f
III	*Fast-inaccurate (impulsive)*	t < median t f < median f
IV	*Slow-inaccurate*	t > median t f < median f

Subjects were grouped into four categories and their percentages were calculated according to the fast-accurate, slow-accurate (reflective), fast-inaccurate (impulsive), and slow-inaccurate categories. The next step is the reflective and impulsive subjects who are selected, doing the TVLES problem-solving ability test. Solutions to TVLES problems written on the answer sheet, reviewed, interpreted, and abstracted refer to the analytic rubric of creativity in solving TVLES problems. The identification results were deepened through the triangulation of sources by interviewing reflective and impulsive subjects, followed by interpretations and conclusions. The results of data analysis are presented with tabulations, scatterplots, pie diagrams, and problem-solving analyses of answers.

In the next stage, reflective and impulsive subjects were in-depth interviewed to fulfill the dependability and confirmability (Stahl & King, 2020). Analysis of TVLES problem-solving answers using an analytical rubric with the following stages. First, the ability of the two subjects to solve TVLES problems was analyzed according to Polya's stages of problem-solving (Schoenfeld, 2016). Second, the results of the analysis of TVLES's problem-solving abilities were analyzed again from the aspect of the emergence of problem-solving creativity indicators according to the stages of problem-solving.

RESULTS AND DISCUSSION

Results

The following presentation presents the results of an analysis of the ability to solve TVLES problems and the creativity of solving TVLES problems for reflective and impulsive students. TVLES problems are related to bank loans and bank interest issues, as well as years of historical events in Indonesia.

Cognitive Styles

There are 34 students who underwent the MFFT test, and 28 students only can answer all the test items. The results of the calculation analysis obtained a median answer time of 9.00 and a median correct answer score of 11.00. Then the distribution of MFFT score presented using a scatter plot. Which the median time at abscissa line and the median of MFFT score at ordinate line. Then result scatter plot identified students' cognitive styles and using a pie diagram presented the percentage of students grouping according to cognitive style can be presented in Figure 3 and 4.
There are 28 students identified who had a reflective cognitive style, 11 people (47%), 2 people (9%) were slow-inaccurate, 9 people (39%) were impulsive, and 6 people (5%) were fast-accurate. Students with a reflective cognitive style are characterized

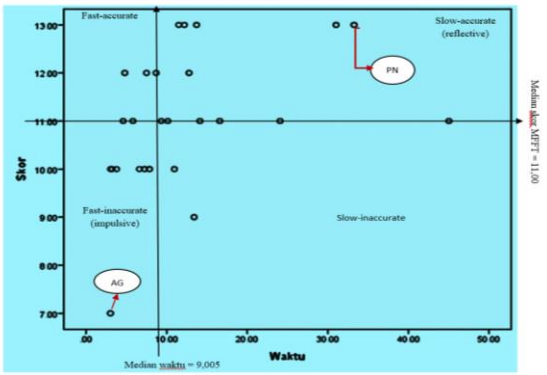


Figure 3. Scatter Plot of Cognitive Styles of 28 Students

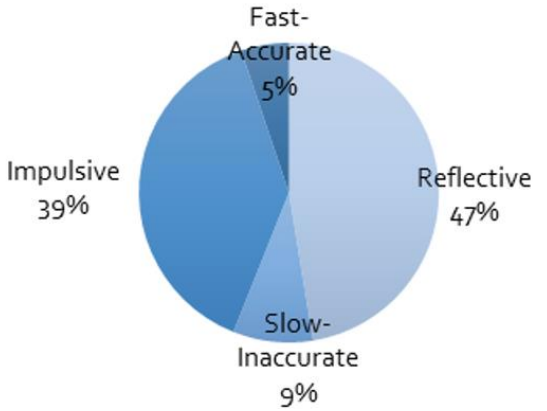


Figure 4. Percentase of Students Base on the Cognitive Styles

by being able to answer well using a long time. Students with a slow-inaccurate cognitive style are characterized by tending to answer incorrectly for a long time. Impulsive students tend to answer incorrectly quickly. And fast-accurate students can answer well in a short time. The results of this study are relevant to Rozencwajg & Corroyer (2005) and (Faradillah et al., 2018) found four students' cognitive styles, namely reflective (slow-accurate), impulsive (fast-inaccurate), fast-accurate, and slow-inaccurate. According to Rozencwajg & Corroyer (2005) and (Seçer et al., 2009) the process of cognition in reflective individuals is able to think analytically with mature cognition. Meanwhile, the impulsive subject in his thinking process is holistic with immature cognition.

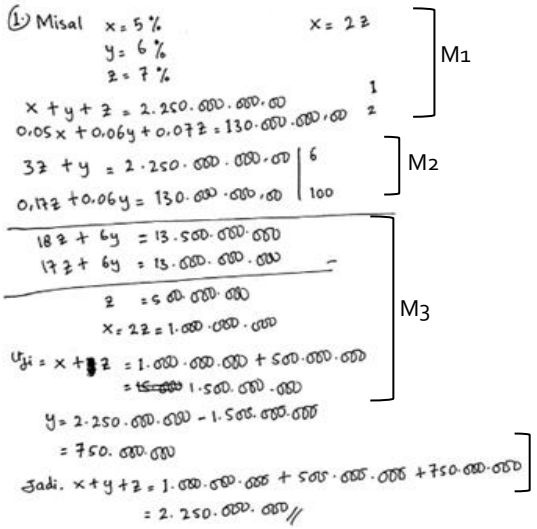
The 11 students with a reflective cognitive style, PN students were selected who had the longest time to take the test and all the answers were correct. Among the 9 students with an impulsive cognitive style, AG students were selected who had the shortest time to do the test with the most answer errors. There are two aspects analyzed in the reflective subject's answers, namely the ability to carry out the stages of problem-solving and problem-solving creativity. The following presentation describes TVLES's problem-solving creativity for subjects with reflective and impulsive cognitive styles.

The Ability of Reflective Subject to Solve TVLES Problems

The following presentation presents the results of the analysis of the ability of subjects who have a reflective cognitive style to solve TVLES problems with the four stages of Polya for problem 1 bank loans and interest rates and problem 2 years of Indonesian historical events.

Problem 1: Bank Loan and Interest Rate

Figure 5 presents the PN subject's answers to problem 1. PN subjects, in lines 1 to 4,



Note: M1 = understanding the problem | M2 = make the plan | M3 = complete the plan | M4 = check the results

Figure 5. The Answer of Subject PN to Problem 1

seem able to write down what is known by assuming the interest rate is x = 5%, y = 6%, z = 7%, and x = 2z, indicating that the PN subject has understood the problem. The results of the analysis of the ability to understand problem 1 in the answers are referred to as the results of interviews with PN subjects.

An excerpt from the interview with the PN subject in Box 1, states that after reading the questions and in his mind Problem 1 can be solved with TVLES. The information obtained is in the form of bank interest on one company's loan. The PN subject succeeded in understanding problem 1, both the facts in the problem and the variable symbolization for these facts.

Box 1: Interview of Understand the Problems 1

After reading the questions, try to explain what you think of problem 1?
"I think the contents of the story problems will be resolved with TVLES."
What is asked in problem 1?
"What was asked in question number 1 was about interest on a loan from a company..."

The PN subject thought when he read the problem that problem 1 could be solved with TVLES and the information was in the form of bank interest on one company's loan. The PN subject succeeded in understanding problem 1, both the facts in the problem and the variable symbolization for these facts.

The answer to the next PN subject is to write down the three-variable equation system model for the mathematical model of the solution. Equation (1) is x + y + z = 2,250,000,000 as the mathematical model for the loan amount. Equation (2) 0.05 x + 0.06 y + 0.07 z = 130,000,000,000 as a mathematical model for loan interest. This answer shows that the PN subject has been able to develop a solution plan by constructing a mathematical model using TVLES. According to the PN subject, the solution is to make equations as presented in the interview excerpts in Box 2.

Box 2. Interview of Make the Plan Problem 1

To work on the problem, what did you do to make your solution easier?
"Determine equation 1, equation 2, and equation 3. As well as other equations if any".

At the completion stage of the mathematical model of the two TVLES problems, the PN subject used two methods, namely substitution, and elimination for the calculations. Equations (1) and (2) are solved by the PN subject at the initial stage by substitution, where the value x = 2z is entered into the system of equations (1) and (2) which results in an equation in the form of a two-variable system of equations to become x + y + z becomes 3z + y, and 0.05x + 0.06y + 0.07z becomes 0.17z + 0.06y. The PN subject succeeded in creating a new, simpler system of equations for equation (1), namely 3z + y = 2,250,000,000, and equation (2) becomes 0.17z + y = 130,000,000.

Furthermore, the PN subject solves it by eliminating the coefficients of similar tribe variables on the y variable, to get the values of the z, x, and y variables. The PN subject successfully completed the TVLES calculations for the solution to problem 1 correctly. The PN subject's mathematical reasoning goes well where students can relate the two TVLES solving methods correctly. The results of this study are in line with Setiawan (2016) where reflective subjects can relate mathematical ideas (relate) in solving mathematical problems correctly.

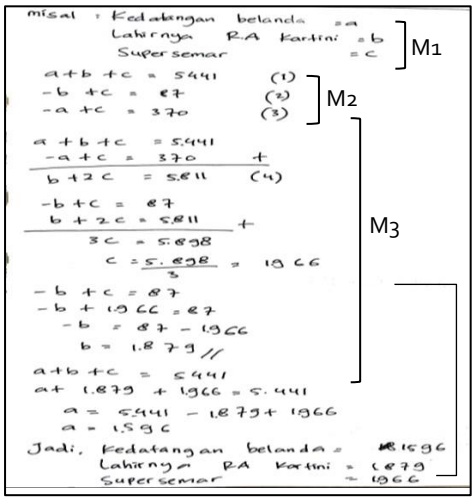
In the final part of solving TVLES, after the x, y, and z values are found, the PN subject checks the solution again, by inserting the x, y, and z values into equation (1), namely x + y + z = 1,000,000,000 + 500,000,000 + 750,000,000 =

2,250,000,000. The results of this calculation indicate that the x, y, and z values from the previous calculations are correct. The results of the analysis of the PN subject's answers are referred to by the results of the interview in Box 3. At this stage, the PN subject was able to check the correctness of the results of solving the problem of bank loans and interest rates. The following is an excerpt of an interview with a PN subject related to checking the results.

Box 3. Interview of Check the Solution Problem 1

Are you sure about the answers you get?
"Yes. Because I have proven it by means of the final result, I add it up to prove whether it is correct, whether it is in accordance with the known results."

Problems 2: Indonesian Historical Events



Note: M1 = understanding the problem | M2 = make the plan | M3 = complete the plan | M4 = check the results

Figure 6. PN Subject's Answer to Problem 2

The PN subject's answer to problem 2 is presented in Figure 6. The PN subject was able to understand the problem by writing, for example, the arrival of the Dutch = a, the birth of R.A. Kartini = b, and Supersemar = c. In the results of the interviews in Box 4 below, the PN subjects have understood what is being asked in problem 2.

Box 4. The Interview to Understand the Problem 2.

Furthermore, what do you know about the information contained in the problem?
"What I know about the information contained in the problem is that I can know in what year the Indonesian historical events occurred."

The PN subject was able to compile a mathematical model into TVLES, where there are three equations that form a true TVLES, namely equation (1) a + b + c = 5441, equation (2) -b + c = 87, and equation (3) -a + c = 370. Then the PN subject checks the results by plugging the values a, b, c into equation (1) in problem 2, namely a + b + c = 5441 ⇨1596 + 1879 + 1966 = 5441. In the results interview in Box 5, the PN subject was able to explain how to check the correctness of his answers, by adding up the values of the variables a, b, c to the equation a + b + c = 5.441.

Box 5. Interview of Check the Results Problem 2

After your results, did you check the results again? Explain!
"Yes. I checked it by the way I added it to the example. For example, in the matter of historical events in Indonesia, I assume that a = the arrival of the Dutch, b = the birth of R.A. Kartini, c = Supersemar" namely a + b + c = 5,441.
"I prove it by adding the result of a plus the result of b and then adding the result of c as I get a = 1596, b = 1879, c = 1966. Then add up whether it is true that the result is 5441: a + b + c = 5441 ⇨1596 + 1879 + 1966 = 5441 (so it is proven)".

Reflective Subject Creativity to Solves the TVLES Problem

Reflective student creativity in solving TVLES problems for problems 1 and 2 at each stage of problem-solving is summarized and presented in Table 7.

Indicators of creativity include fluency, flexibility, originality, and elaboration (Kwon et al., 2006; Marliani, 2015; 2015; Minchekar, 2017; Purnomo et al.,

Table 7. The Analysis of Creativity of Reflective Subject solved the TVLES Problems

Problem-solving skills	Indicators of creativity			
	Fluency	*Flexibility*	*Originality*	*Elaboration*
M1: understand the problem	M1-*Fluency*: The idea of symbolizing an example in a variable is true	M1-*Flexibility*: The choice of variable symbol letters in problem 1 and problem 2 is different.	M1-*Originality*: The idea of symbolizing variables according to their own ideas	M1-*Elaboration*: The analogy is determined by the stages of reading, understanding, detailing the facts, writing the example, and elaborating it into the symbolization of the variables x, y, z, and a, b, c
M2: make the plan	M2-Fluency: The mathematical model is written in TVLES form for problem 1 equation 1: x+ y + z = 2,250,000,000.00 and equation 2: 0.05x + 0.06y + 0.07z = 130,000,000,000.00 is true.	M2-Flexibility: Developing a mathematical model adjusting the meaning of the first statement sentence to the second statement sentence in the problem, to form a system of equations to solve the problem.	M2-Originality: The mathematical idea of representing these statement sentences into a mathematical model in the form of a system of equations refers to the meaning of the statement itself and is true.	M2-*Elaboration*: Using the steps to understand the meaning of the question statement sentence and determine the equation that is relevant to the meaning of the sentence.
M3: complete the plan	M3-*Fluency*: The idea with the elimination and substitution method is the correct way of solving TVLES	M3-*Flexibility*: Explaining the solution using the elimination and substitution methods, proceed to check the correctness of the calculation results by entering variable values	M3-*Originality*: Do not appear.	M3-*Elaboration*: Stages of completion of TVLES settlement with detailed steps to find the result of the value of the variable being sought.
M4: check the results	M4-*Fluency*: The way to check the correctness of the answers by entering the variable values obtained from the calculation results into the previous equation is an idea.	M4-*Flexibility*: Do not appear	M4-*Originality*: Do not appear	M4-*Elaboration*: Completion with a detailed elaboration, starting from writing equation (1), substituting the values of the variables x, y, z into equation 1, and completing the calculation so that the sum of the left side of the equatior is equal to the right side of the equation.

2017; Yulianto et al., 2021). The results of the analysis presented indicate that PN subjects with a cognitive-reflective style have the following creativity profile.

Creativity understands the problem. At the stage of understanding the problem of creativity indicators that appear in the PN subject's answers are as follows. *First*, the PN subject uses variable symbolization for the facts in the problem. The idea of symbolizing this variable is an idea that has a true value, which means that the fluency indicator appears. *Second*, PN subjects are also able to make analogies and symbolize variables from one analogy to another. From the example for problem number 1 using the symbols for the variables x, y, and z, to the example for problem 2 using the symbols for the variables a, b, and c. This indicates that the flexibility indicator appears.

Third, the PN subject makes an example by specifying a variable name which is written in detail with the idea of symbolizing the variable from their own idea. In this case, the originality indicator appears. The different symbolization ideas in the two problems indicate that the PN subject has new ideas in variable symbolization. *Fourth*, an example is defined by the stages of reading, understanding, detailing the facts in the problem, then writing it in the form of an example and symbolizing the variables x, y, z, and a, b, c. The stages in this symbolization reflect the presence of an elaboration indicator. Reflective student creativity in solving TVLES problems for problems 1 and 2 at each stage of problem-solving is summarized and presented in Table 7.

The Creativity Make the Plan. PN subjects have ideas regarding solving steps using the elimination method. The mathematical model compiled contains correct ideas regarding fluency, where the mathematical model is written in TVLES form for problem 1 equation 1: x+ y + z = 2,250,000,000.00 and equation 2: 0.05x + 0, 06y + 0.07z = 130,000,000,000.00 is true. Likewise, the mathematical model for solving problem 2 by writing equation 1: a + b + c = 5441, equation 2: -b + c = 87, and equation 3: -a + c = 370 is true.

The idea of compiling a mathematical model is drawn from the meaning of the statement sentences in problems 1 and 2 which are understood to determine the coefficients and variable names in problem 1 for equation 1. Based on this meaning, write the operation sign (+) for the variables x, y, and z that make up equation 1. Then move again to the second statement in problem 1, where the coefficients of the variables x, y, and z are determined based on the bank's interest rate and use the addition operation sign (+) to represent equation 2.

The PN subject also does the same in solving problem 2. In this case, the PN has the flexibility of thinking in making a mathematical model of the solution to problem 1 and problem 2. The mathematical model is formulated based on the meaning understood by the PN subject to the statement sentences in problems 1 and 2. Where the mathematical idea to represent the statement sentences in a mathematical model is true. The mathematical model contains indicators of novelty (originality) and uses steps from understanding the meaning of the question statement sentences and determining their equations (elaboration).

The Creativity Completes the Plan. The description of calculations to find the values of x, y, z, or a, b, c made earlier contains the correct ideas (fluency). PN subjects are fluent in solving equation models by elimination and substitution. The completion stage of TVLES with substitution followed by elimination indicates that the translation is prepared to move from one correct way to another (flexibility). Another characteristic seen in the stages of completing the TVLES model for solving problems 1 and 2 is the detailed steps to find the result of the value of the variable being sought. In other words, the TVLES completion stage for solutions to problems 1 and 2 has elaboration characteristics.

The Creativity to Checks Back the Solution. PN subject was able to re-check the solution to problems 1 and 2. Re-examine the solution to ensure that the method was correct and fluent. Stages of completion with a detailed elaboration, starting from writing equation (1), substituting the values of the variables x, y, and z into equation (1), and completing the calculations. So that the sum of the left side of the equation is the same as the right side of the equation. Thus, it can be stated that the PN subject's ability to examine the results has creativity with elaboration indicators.

The Ability of Impulsive Subject to Solve TVLES Problems

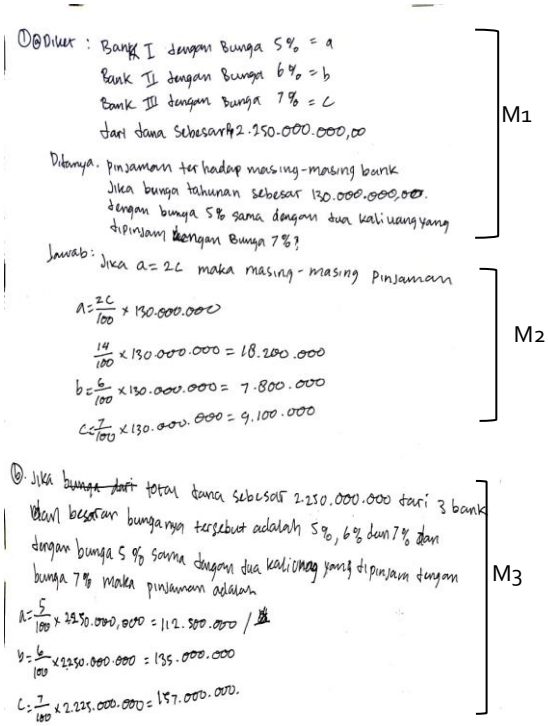
Subject AG has an impulsive cognitive style that answers in the shortest time with the least number of correct answers. The following presents the results of the analysis of the AG subject's ability to solve problems 1 and 2.

Problems 1: Bank Loans and Interest Rates

AG subjects were able to understand loan problems and bank interest rates, by writing down what was known and what was asked. AG writes down what is known by making an example in the form of variables a, b, and c for each of the bank interest rates and loan funds from problem 1. What is asked by rewriting the question sentence from problem 1? Figure 5 presents subject AG's answer to problem 1.

Subject AG developed a solution plan using the concept of comparison to determine a mathematical model. The mathematical model that was created did not match the mathematical concepts in problem 1, where subject AG used comparisons while the mathematical concepts in problem 1 used TVLES. Subject AG was unable to construct a correct mathematical model for problem 1 solutions.

Subject AG developed a solution plan using the concept of comparison to determine a mathematical model. The mathematical model does not match the mathematical concept in problem 1, where subject AG uses the concept of comparison, which is correct using the concept of TVLES. Subject AG was unable to construct the correct mathematical model for problem 1 solutions. Because the completion of the mathematical model was not in accordance with the stages of solving



Note: M1 = understanding the problem | M2 = make the plan | M3 = complete the plan | M4 = check the results

Figure 7. Subject AG's Answer to Problem 1

TVLES, as a result, an error occurred at the stages of completion and obtaining the result.

Box 6. The Interview to Understand the Problem 1

After reading the questions, try to explain what you think about the concept of the problem.
"By way of example, changing into a linear equation then using the elimination method after that the substitution method to get the value or loan from each bank"
What do you know about the information contained in the question?
"The company borrowed IDR 2,250,000,000.00 from three banks with the interest of 5%, 6%, and 7% respectively for a total interest of IDR 130,000,000,000.00."
What is being asked in this question?
"Company loans to each bank?"

The results of interviews with AG subjects are presented in Box 6. After being interviewed, subject AG gave an answer that was different from the written answer. At the stage of understanding the problem,

subject AG stated that by changing the example to obtain a linear equation then using the elimination and substitution methods.

At the stage of making a mathematical model, the subject AG makes a mathematical model with only one linear equation, which should be formulated by three linear equations. But when interviewed, the subject AG gave an inconsistent answer with a written answer in Box 7. The following presents an interview trailer with the subject AG.

Box 7. The Interview to Make a Mathematical Model

What are the concepts used for solving the problem from the information obtained in the problem?
"After being formed, the equation will be obtained:
a + b + c = 2,250,000,000.00
2C + B + C = 2,250,000,000.00
3C + B = 2,250,000,000.00 ... (1). And
5% A + 6% B + 7% C = 130,000,000.00
17% C + 6% B = 130,000,000.00

At the stage of completing the plan, in the answer sheet due to the stage of making the model being wrong, the continuation at this stage the subject AG also makes a mistake in making calculations. The interview trailer of Box 8 showed the inconsistency of AG in providing answers.

The results of the interview with the subject AG showed that he was able to complete the mathematics model solution of problem 1 using the elimination and substitution methods correctly. The subject AG realized that the answer was written in the wrong answer sheet. And after interviewing the subject AG was able to improve the answer. AG subjects can describe their calculations with the method of elimination and substitution correctly.

Box 8. The Interview of Complete the Plans

How do you make a mathematical model and its solution to the problem?
"Build the equation of
3c + b = 2.250.000.000 ... (1)
17c + b = 13.000.000.000..(2)".
What is the solution you provide to solving the problem?
"Elimination method:
3c + b = 2.250.000.000.000 |×6| 18c + 6b = 13.500.000.000
17c + b = 13.000.000.000 |×1| 17c + 6b = 13.000.000.000
_____ -
c = 500.000.000"
"substitution method:
c = 500.000.000
3c + b = 2.250.000.000
3(500.000.000) + b = 2.250.000.000
1.500.000.000 + b = 2.250.000.000
b = 750.000.000
a = 2c
a = 2(500.000.000)
a = 1.000.000.000".

The interview treasure of check solution with the subject AG is presented in Box 9. In the final stage, checking the results conducted an interview with the subject of AG regarding the answer written in the answer sheet. The AG subject does not link the answer examination on the answer sheet that has been done but checks the results based on the answers submitted in the interview.

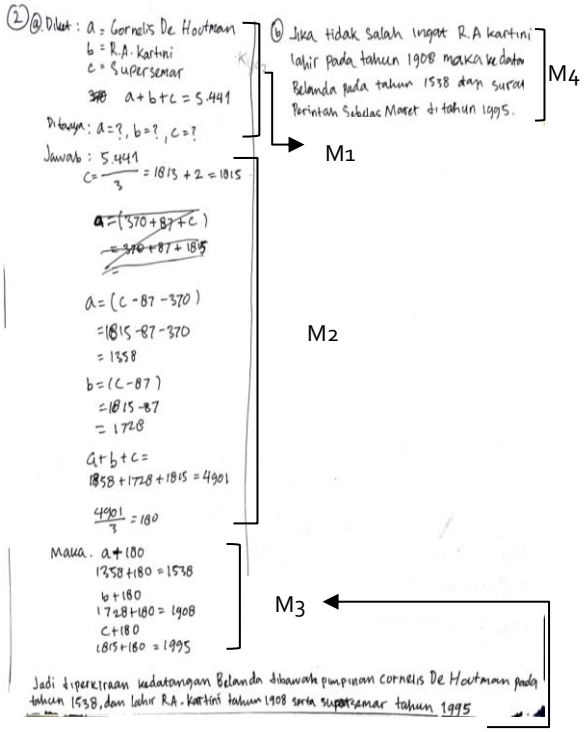
Box 9. The Interview to Check the Solution

What are you checking? Try to explain!
"Yes, throughout substitute the values of variables to the equations:
a = 500.000.000
b = 750.000.000
c = 1.000.000.000
a + b + c = 2.250.000.000
(500.000.000) + (750.000.000) + (1.000.000.000) = 2.250.000.000
⇨ 2.250.000.000 = 2.250.000.000."

Problems 2: Indonesian Historical Events

The AG subject is also able to understand problem 2 by giving a visitation for the year for three historical events in Indonesia, and by giving a symbol of variables A, B, and c. The subject AG is also able to make a

mathematical model A + B + C = 5,441, but incomplete, where there is only one algebraic equation written. There should still be two more equations written, namely -b + c = 87 and -a + c = 370. The subject of subject for problem 2 is presented in Figure 8.



Note: M1 = understanding the problem | M2 = make the plan | M3 = complete the plan | M4 = check the results

Figure 8. The Answers of Subject AG to Problem 2

The answers given by the AG subject in the answer sheet referred to the results of interviews related to problem-solving stage 2, showing inconsistency in solving problem 2. The interview trailer in Box 10 shows that answers were written with different interview results.

Box 10. The Interview Treasure to Make Mathematical Models

What was the first to do to make a mathematical model and its solution to the problem?
"Build the equations:
y = z – 87 .... (1)
x = z -370 .... (2)."
What is the elaboration of the solution?
"Substitute:
x+ y + z = 5441
(z – 370) + (z – 87) + z = 5441
3z – 457 = 5441
3z = 5441 – 457
3z = 3898
z = 1966
for z = 1966 | *x = z - 370*
y = z – 87 | *x = 1966 -370*
y = 1966 – 87 | *x = 1596*
y = 1879".
Is there another solution? Explain!
"There is, when studying the year of the events, or one of them, for example, the year of Supersemar's birth in 1966, put in the equation:
y = z – 87 *x = z - 370*
y = 1966 – 87 *x = 1966 - 370*
y = 1879 *x = 1596".*

The results of the settlement made by the subject AG are in the answer sheet by guessing. In contrast to the AG subject's answer in the interview in Box 11, able to check the results correctly.

Box 11. The Interview to Check the Solution

What are you checking? Try to explain!
"Yes, by entering the variable value into the equation:
x = 1596
y = 1879
z = 1966
x + y + z = 5441
1596 + 1879 + 1966 = 5441
5441 = 5441."

The Creativity of Impulsive Subject solving the TVLES Problems

AG subjects quickly answered, a short time in writing answers during the test with a quick time for both problems, but the answers are wrong. But when interviewed by

the subject AG confirmed the correct answer and realized his mistake after the answers were collected. The subject AG is not careful in reading and understanding the sentences in problems 1 and 2, so he only writes down the equation a + b + c = 5441.

The results of the analysis of the ability to understand problems 1 and 2 in the answers given by the subject AG refer to the answers written on the answer sheet. Because the answer pattern written on the answer sheet is the first answer, given. In understanding problems 1 and 2, the subject AG writes what is known and what is asked correctly, with the visitation of variables according to their own ideas. The subject of AG has a true idea related to the visitation of the variable, the element of fluency appears and contains a new idea in its own way (originality) appears in the AG subject's answer.

But at the stages of the next problem solving, namely preparing plans, carrying out solutions, and checking out results, in the answers of the subject AG does not appear all four characteristics of creativity. Because the mathematical model is arranged, and the solution is wrong.

The prominent feature of the impulsive subject in solving the TVLES problem is the inconsistency of the answers written with the answers given when interviewed. The answers written use different methods in the way mentioned in the interview. When answering the questions in the answer sheet, the impulsive subject thinks about the answer by reading sentences in problems 1 and 2 and immediately writes the answer, without looking back at the contents of the problem. The mistake of answering was only realized by the reflective subject after a few days and was delivered in the interview.

Figure 8 presents the results of the analysis of the creativity of the subject of AG solving problems 1 and 2. The prominent feature of the impulsive subject in solving the TVLES problem is the inconsistency of the answers written with the answers given when interviewed. The answers written use different methods in the way mentioned in the interview. When answering the questions in the answer sheet, the impulsive subject thinks about the answer by reading sentences in problems 1 and 2 and immediately writes the answer, without looking back at the contents of the problem. Resulting in errors in the answer. The mistake of answering was only realized by the reflective subject after a few days and was delivered in the interview.

Discussion

The study aims to describe the ability of students' creative thinking in solving TVLES problems in terms of reflective and impulsive cognitive styles. TVLES issues related to the theme of bank loans and bank interest and years of historical events in Indonesia. The results of the data analysis show that reflective student was able to solve the problem of bank loans and the years of historical events in Indonesia correctly. Meanwhile, the impulsive student makes some mistake solution of that problems.

The advantages of this study lie in the form of non-routine TVLES problems, requiring a high level of thinking ability in their resolution. Analysis of creativity in solving problems is focused on students. The results of previous research on the type of problem and creativity-solving problems discuss more solutions to mathematical problems in schools. While the problem in this study is focused on mathematical material for prospective mathematics teachers. Based on the cognitive style, the results of previous research use the creator of learning styles of field-dependent and independent fields. This study specifically analyzes student creativity in solving problems according to the

cognitive style of reflection and impulsiveness.

The stages of understanding the problem, compiling a mathematical model, completing the mathematical model, and checking out the results correctly. Students can determine the number of loans in three banks with different interest rates and are able to determine the year of historical events in Indonesia using Mathematics models related to TVLES. Reflective students also have consistency in solving problems but require a long time to answer.

Research findings from the results of the analysis of the ability to solve TVLES problems reflective and impulsive students are as follows. *First*, reflective students can solve TVLES problems using Polya's problem-solving stage correctly. *Second*, reflective students have consistent problem-solving answers, made for a long time, but the answer is correct.

Third, the cognitive control of reflective students looks better, where students can re-check the truth of the final answer carefully. Unlike the findings of Lahinda & Jailani (2015), who found that in junior high school students, reflective subjects tend to have low cognitive control compared to impulsive subjects. Mubarika et al. (2022) state that creativity also affects self-regulation in learning mathematics.

Fourth, students with impulsive cognitive styles can understand TVLES problems. But not able to compile and complete the mathematical model correctly, as well as at the stage of checking out the results. Mathematical model and the settlement stage is incorrect logically. *Fifth*, impulsive students quickly write answers but are not careful in understanding the meaning of sentences in the problem mentioned above. So impulsive students are not able to solve problems at the next stage. Impulsive students only realized their mistakes after some time and were able to correct their answers correctly, which was seen in the interview results.

Students with impulsive cognitive styles can solve the problem of bank loans and bank interest and years of historical events in Indonesia, at the stage of understanding problems. But not able to compile and complete the mathematical model correctly, as well as at the stage of checking out the results. The answers given by impulsive students are wrong, whereas the mathematical model and the completion stage are wrong.

Impulsive students are fast in writing answers but are not careful in understanding the meaning of the sentence in the problem mentioned above. This finding was strengthened by Fadiana (2016), who found that impulsive students tend to solve mathematical story problems faster than reflective students. It can be concluded that reflective students have a better TVLES problem-solving ability than impulsive students. According to Silma et al., (2019), impulsive subjects answered questions quickly and were not examined again, tend to dislike analogy problems, often answer wrong, had poor problem-solving strategies, and gave inaccurate opinions. The mathematical model that is arranged also cannot be justified in mathematical logic.

Students with impulsive cognitive styles are only aware of their mistakes after some time and can correct the answers correctly. Characteristics of impulsive subjects answer questions quickly, tend to dislike analogy problems, often answer wrong, have poor problem-solving strategies, and providing inaccurate opinions. The findings of this research are supported by Chen (2021) that the reflective subject has the ability to speak English better than impulsive subjects. From the results of the analyses, it can be stated that students with reflective cognitive styles have better

thinking control, compile answers carefully and thoroughly, capable.

Implications

The characteristics of the reflective and impulsive cognitive style affect creativity in solving TVLES problems. The characteristics of this cognitive style need to be considered in learning. It would be very effective for learning to be carried out by giving different treatments to reflective and impulsive subjects. The implication for lecturers in designing and implementing learning refers to an approach in differentiation learning throughout profiling to find the cognitive style of their students.

If learning is carried out using individual methods, reflective students are given TVLES learning assignments by providing sufficient time allocation, occasionally giving metacognitive questions, and giving them the opportunity to think about finding solutions longer.

Whereas for students with an impulsive cognitive style, individually, giving TVLES learning assignments can start from the easy ones and gradually move up to the difficult ones. Impulsive students need to practice reading and understanding the material more thoroughly. Lecturers guide students by giving metacognition questions repeatedly. Even, if necessary, impulsive students are given individual remedial/consulting programs for completing TVLES assignments. The aim is to provide an opportunity for impulsive students to re-examine the mistakes made in completing the TVLES problem-solving task.

If learning is carried out using a method that demands group collaboration, the lecturer needs to consider the diversity of cognitive style characteristics in forming assignment groups. Reflective and impulsive students can be combined in one group. Where reflective students with a high level of accuracy can become peer tutors for impulsive students. So that there is a process of dividing the tasks and obligations of everyone in group cooperation.

CONCLUSION

Reflective students can solve TVLES problems correctly, thoroughly, and consistently with their answers. Meanwhile, impulsive students make many mistakes in the four stages of problem-solving and tend to make solutions inconsistent.

Students with a reflective cognitive style have creativity in solving TVLES problems at the stage of understanding the problem and constructing a mathematical model with the characteristics of fluency, flexibility, novelty, and elaboration. At the stage of completing the TVLES model, creativity emerges with the characteristics of fluency, flexibility, and elaboration. At the stage of examining the results, creativity appears with the characteristics of fluency and elaboration.

Students who have an impulsive cognitive style at the stage of understanding the problem have creativity with fluency, novelty, and elaboration characteristics. In the stages of problem-solving, creating a mathematical model, completing a mathematical model, and checking the results, because the fluency aspect does not appear, the four characteristics of creativity at this stage do not appear.

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