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Mathematics Anxiety and Students' Creative Thinking Process in Solving Number Patterns Problems

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Abstract

This research aims to describe students' creative thinking process with high and low mathematics anxiety in solving number patterns problems. The research used a descriptive qualitative method. The subject of this research data was 27 students of Junior High School class VIII. The research subjects is one student with the highest levels of creative thinking ability at each level of mathematics anxiety. Data collection techniques used in this research were questionnaires, tests, and interviews. The result data of mathematics anxiety questionnaire were analyzed by summing the scores of each student. Scoring is based on a five-point Like Scale. Data analysis of the results of problem-solving tests refers to the indicators of creative thinking abilties namely fluency, novelty, and flexibility. Interview data were analyzed based on of the creative thinking, namely synthesizing ideas, generating ideas, planning the application of ideas, and applying ideas. The results showed that student with high mathematics anxiety can't understand the purpose of the tests, can only generate one solution idea. Student with low mathematics anxiety productively in generating ideas to solve the problem.

Keywords: Creative Thinking Process, Mathematics Anxiety, Number Patterns.

Abstrak

Tujuan penelitian ini untuk mendeskripsikan proses berpikir kreatif siswa dengan kecemasan matematika tinggi dan rendah dalam menyelesaikan masalah pola bilangan. Penelitian ini menggunakan metode penelitian kualitatif deskripsi. Sumber data penelitian yaitu 27 siswa SMP kelas 8. Subjek penelitian adalah satu siswa dengan tingkat kemampuan berpikir kreatif tertinggi pada masing-masing tingkat kecemasan matematika. Teknik pengumpulan data menggunakan angket, tes, dan wawancara. Data hasil angket kecemasan matematika dianalisis dengan menjumlahkan skor angket masing-masing siswa. Pemberian skor berdasarkan lima poin skala Likert. Analisis data hasil tes penyelesaian soal pola bilangan mengacu pada indikator kemampuan berpikir kreatif yaitu kefasihan, fleksibilitas, dan kebaruan. Data hasil wawancara dianalisis berdasarkan empat tahap proses berpikir kreatif, yaitu mensintesis ide, membangun ide, merencanakan dan menerapkan ide. Hasil penelitian ini menunjukkan bahwa siswa dengan kecemasan matematika tinggi tidak mampu memahami tujuan dari soal, hanya memberikan satu ide penyelesaian. Siswa dengan kecemasan matematika rendah produktif dalam menghasilkan ide untuk menyelesaikan soal.

Kata kunci: Proses Berpikir Kreatif, Kecemasan Matematika, Pola Bilangan.

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Introduction

Thinking activities occur when someone is confronted with questions that must be answered or problems that require a solution. Siswono (2018) stated that thinking is a mental activity that occurs when someone is faced with a problem situation that must be solved. Through human education is expected to develop the ability to think, one of which is of creative thinking. The development of creative thinking ability gets great support in education. Permendikbud Number 20 of 2016 on the Dimension of skill stated that every student must have action and creative thinking skill. The statement shows that the ability of creative thinking becomes an important element that must be considered in the learning process, especially in mathematics learning.

However, many of findings regarding mathematics learning have not emphasized the development of students' reasoning and creative thinking. The teacher prefers to teach mathematics by

memorization and regard the students' creative thinking as unimportant. Mathematics has an important role in life. Mathematics not only teaches the ability count, but in mathematics learning also trains students to think logically, analytically, systematically, critically, and creatively. Davis (1984) explains that the ability of creative thinking must be emphasized in mathematics learning because mathematics is needed in life, problems in life are not the routine problem so need creative thinking ability in solving them. Siswono (2018) defined creative thinking as an activity mental that someone uses to generating new ideas. Creative thinking allows someone to be able to produce several solutions to solve the problems.

Siswono (2008) divided levels of creative thinking ability (TKBK) into five levels, namely level 0 (not creative), level 1 (almost not creative), level 2 (quite creative), level 3 (creative), and level 4 (very creative). Indicators at each level are fluency, flexibility, and novelty. Level 0 if the student cannot show the three indicators of creative thinking in solve the problems. At level 1 student can only show fluency, while level 2 if students can show flexibility or novelty, and at level 3 students can show fluency and novelty; or fluency and flexibility. At the highest level (very creative) students can show all three indicators of creative thinking. According to Siswono (2016), fluency is the ability of students to give several diverse and correct answers to solve the problems. Flexibility is the ability of students to give different methods of solving the problems. Novelty is the ability of students to give several different and correct answers. The levels of creative thinking ability in this research was used to select subjects.

The student's creative thinking process in solving mathematics problems is also an important element for the teacher to know. Ginsburg (1996) stated, "the essence of mathematics is not producing correct answer, but thinking creatively". The teacher must be able to understand students' creative thinking process to solve the problems and then direct students to change their thinking patterns if that is indeed needed. Siswono (2016) explained the creative thinking process is the stage of creative thinking that consists of synthesizing ideas, generating ideas, planning the application of ideas, and applying ideas. Synthesizing ideas occurs when students collect ideas or information they get and then associate them with mathematical concepts related to the problem (Puspitasari et al, 2018). Generating ideas means bringing up and combining ideas related to the problem given to plan the solutions. Planning the application of ideas is to choose a certain idea that is used to solve the problem. Applying an idea is to use an idea that has been in advance planned to solve the problem.

Although basic math skills are important for daily life, but in reality, many students feel anxious when confronted with mathematics assignments. Feelings of anxiety and tension will certainly affect students when dealing with mathematics problems in real life. Feelings of anxiety and tension, when faced with mathematics are called mathematics anxiety. Klados et al (2017) explained that students experience mathematics anxiety can be characterized by a condition of anxiety in situations related to mathematics. Reali et al (2016) also stated that mathematics anxiety is an uncomfortable condition experienced by students when dealing with mathematics problems. Mathematics anxiety will affect students' moods and emotions so that it can disrupt students' thinking processes in solving mathematics problems. This is the agreement with the statement of Machromah et al (2015) which confirms that mathematics anxiety will interfere with the thinking process, especially the students' creative thinking process in solving mathematics problems.

The results of observations made by the researcher, obtained information that students are afraid of mathematics teachers, most students experience uncertainly about the answer given, and students' mindset on mathematics is difficult. It shows that most students experience mathematics anxiety. The levels of mathematics anxiety experienced by students vary, Mahmood & Khatoon (2011) divided the levels of mathematics anxiety into two, namely high and low-level mathematics anxiety. In the practice of learning, differences in mathematics anxiety experienced by students need to get the attention of the teacher. Vulpe & Dafinoiu (2011) concluded that students with low mathematics anxiety get better results on three indicators of creativity, consisted of fluency, novelty, and flexibility than students with

high mathematics anxiety. Creativity is a product of creative thinking, meaning that the possibility of differences in the creative thinking process between students with high and low mathematics anxiety in solving problems (Daker et al, 2020; Fetterly, 2020; Nugroho, 2020).

Number pattern is a sequence of numbers with certain rules to able to calculate each of the next numbers from the order of the previous numbers (Bishop, 2000). The topic of number pattern is the topic that uses the pattern for the purpose of solving the problem. Number pattern learning can explore students' creative thinking abilities because they can use a variety of different ways and perspectives in solving number patterns problems. Research that is relevant to this research, namely the results of Apriliani, Suyitno, & Rochmad (2016) research showed students with low mathematics anxiety have the level of creative thinking ability in the point of 4 (very creative) and level 2 (quite creative), while students with high mathematics anxiety have the level of creative thinking ability in the point of 2 (quite creative), level 3 (creative) and, level 4 (very creative). Based on the description above, the purpose of this research is to describe the creative thinking process of students with high and low mathematics anxiety in solving number patterns problems.

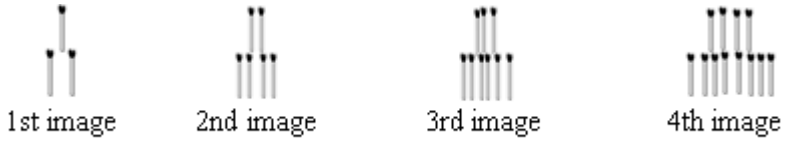
Method

This research used a descriptive qualitative method. Siswono (2019) explained that qualitative research aims to explore phenomena comprehensively. The research will describe the creative thinking process of students with high and low mathematics anxiety in solving number patterns problems. The subject of this research data was 27 students of Junior High School class VIII. Data collection techniques used were questionnaires, tests, and interviews. The Questionnaire is used to classify students based on mathematics anxiety levels. In this research, the questionnaire used was adapted from the Mathematics Anxiety Scale (MAS) developed by Mahmood & Khatoon (2011) which had tested its validity and reliability. The test is used to determine the levels of student's creative thinking ability in solving number patterns problems. The interview aims to describe the student's creative thinking process in solving number patterns problems.

This research used purposive sampling techniques because researchers want to get information so they have to choose the subject that can be learned the most (Siswono, 2019). The research subjects chosen were two students. The desired criteria is to choose one student with the highest levels of creative thinking ability at each level of mathematics anxiety and have high communication skills. The main instrument in this research was the researcher himself, while the supporting instruments were mathematics anxiety questionnaire, problem-solving tests, and interview guidelines that had been validated by two mathematics education lectures. Data on mathematics anxiety questionnaire results were analyzed by summing the scores of each student. Scoring is based on a five-point Likert scale. Data analysis of the results of problem-solving tests refers to the indicators of creative thinking abilities namely fluency, novelty, and flexibility. Then do the categorized based on the levels of creative thinking ability given Siswono (2008). Interview data were analyzed based on the stages of the creative thinking process, namely synthesizing ideas (collect ideas or information they get and then associate them with mathematical concepts related to the problem), generating ideas (bringing up and combining ideas related to the problem given to plan the solutions), planning the application of ideas (choose a certain idea that is used to solve the problem), and applying ideas (use an idea that has been in advance planned to solve the problem). Furthermore, all data are analyzed with the following steps: data reduction, data presentation, and drawing conclusions (Sugiyono, 2015).

The following is a problem-solving tests used in this research:

1. Roger has matchsticks. The matchsticks are arranged in a variety of patterns.



a) How many matchsticks are in the 5th image?
b) How many matchsticks are in the nth-image? Give your explanation!
c) Arrange the matchsticks that Roger has into several different patterns! (minimum of two different patterns and arrange until 5th image)
d) Determine the many matchsticks in the n-th image for the patterns you have made (in problem c) using two different methods!

Result and Discussion

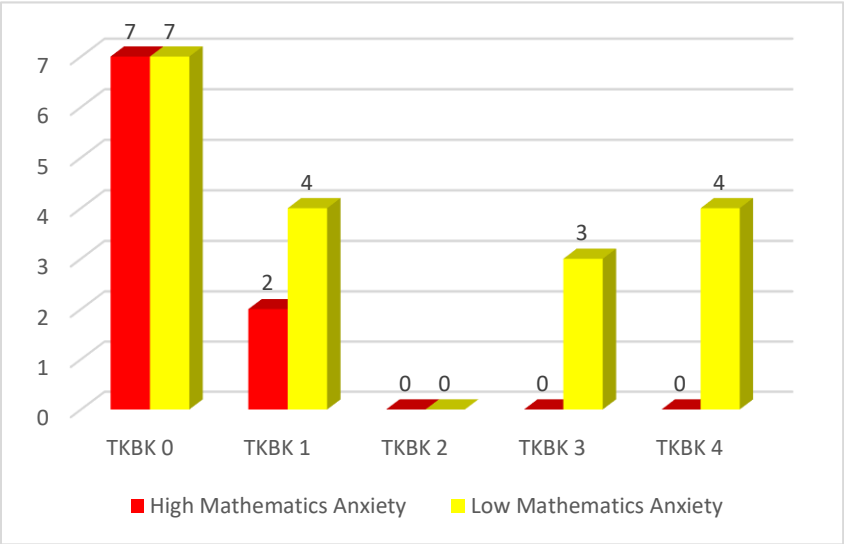


Figure 1. Results of Mathematics Anxiety Questionnaires and Problem Solving Tests

The results of the analysis data of the mathematics anxiety questionnaire and problem-solving tests can be seen in the diagram above. Based on figure 1, the research subjects in this research were one student with TKBK 1 for the category of high mathematics anxiety and one student with TKBK 4 for the category of low mathematics anxiety. Analysis of the thinking process in this research consists of the stages of synthesizing ideas, generating ideas, planning the application of ideas, and applying ideas.

Students' creative thinking process with high and low mathematics anxiety showed the difference from each stage. In synthesizing ideas, ideas obtained by students with low mathematics anxiety is based on observations on the images in the test and arithmetic sequence formulas, while in students with high mathematics anxiety only based on observations on the images in the test. This can be shown through interview excerpts from subject high mathematics anxiety (JAK) and subject low mathematics anxiety (PRA).

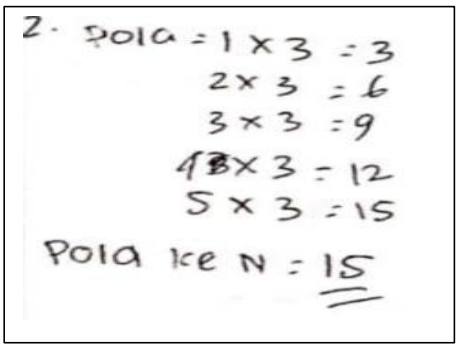
Researchers : *What information can you get from the test?*
JAK : *Pattern.*
Researchers : *Do you understand the purpose of the test?*
JAK : *I'm not understand.*
Researchers : *Does the test have anything to do with the topic learned?*
JAK : *Nothing.*
...

Researchers	:	*What information can you get from the test?*
PRA	:	*Number patterns and formulas.*
Researchers	:	*Explain the purpose of the test is?*
PRA	:	*Problem 1a, looking for many matchsticks on the fifth image. Problem 1b, many matchsticks in the nth-image. Problem 1c, make at least two different patterns. Problem 1d, determine the n-th image of two patterns that have been made before.*
Researchers	:	*Does the test have anything to do with the topic learned?*
PRA	:	*There are, the topic of number patterns.*

Fragment 1. Dialogue Between Researcher and Students With High and Low Mathematics Anxiety on Synthesizing Ideas

JAK can't understand the purpose of the test, so that can't explain the information in the test. JAK also cannot relate the information to the topic that has been learned. Different from JAK, PRA can explain the purpose of the test with detail and clarity. PRA can relate images of matchsticks arranged with the topic of number patterns.

Researchers	:	*Do you have difficulty in generating ideas?*
JAK	:	*Yes, I' having a hard time.*
Researchers	:	*What the ideas did you get to solve the problem?*
JAK	:	*To answer problem 1b, the first image multiplied by 3 is equal to 3 (many matchsticks), the second image multiplied by 3 is equal to 6, and so on. So, the n-th image is 15 matchsticks. To answer question 1c, the idea that I got from the image in the test.*

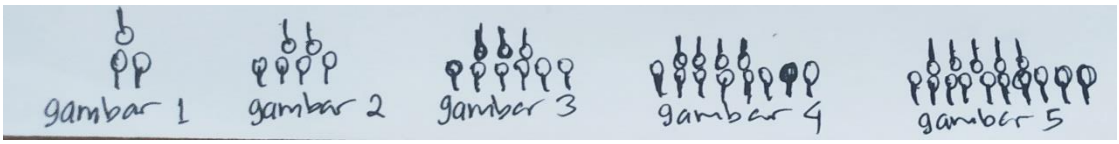


Translate
Pattern 1 = 1 × 3 = 3
Pattern 2 = 2 × 3 = 6
Pattern 3 = 3 × 3 = 9
Pattern 4 = 4 × 3 = 12
Pattern 5 = 5 × 3 = 15

Pattern n = 15

Figure 2. JAK's Work Result of 1b

Researchers	:	*Why did you change your patterns like that? (Figure 3)*
JAK	:	*(The subject is silent and can't explain the reason)*



Translate
1st image 2nd image 3rd image 4th image 5th image

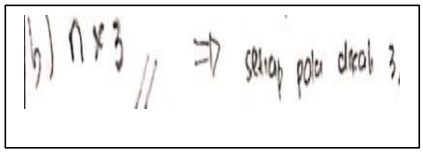
Translate				
1st image	2nd image	3rd image	4th image	5th image

Figure 3. JAK's Work Result of 1c

...

Researchers : *What the ideas do you use to solve the problem 1b?*

PRA : *The first image multiplied 3 because in the first image there are three matchsticks, the second image multiplied 3 is the result 6 (matchsticks), so each image multiplied 3.*



Translate
each pattern times 3

Figure 4. PRA's Work Result of 1b

Researchers : *What the ideas did you get to make this pattern? (Figure 5a)*

PRA : *I see the pattern in the test, I deleted the top of matchsticks (in the test).*

Researchers : *Where from you get the ideas to make this pattern? (Figure 5b)*

PRA : *I have seen a pattern like that in the book*

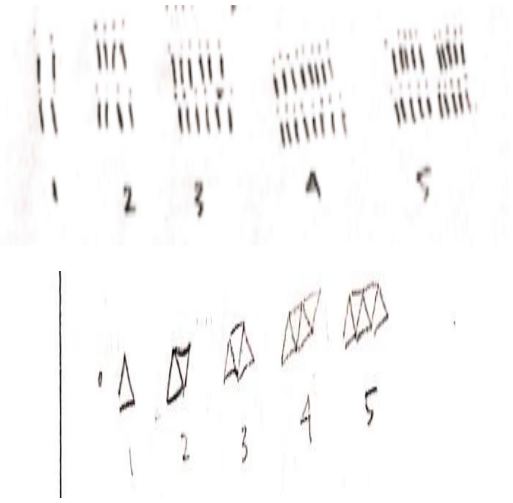


Figure 5. PRA's Work Result of 1c

Researchers : *What the ideas did you get to solve the problem 1d?*

PRA : *First, by looking at the differences of many matchsticks from image one to the next image. The second, using the arithmetic sequence formula.*

Fragment 2. Dialogue Between Researcher and Students With High and Low Mathematics Anxiety on Generating and Planning The Application of Ideas

In the generating ideas stages, students with low mathematics anxiety are more productive in generating ideas to solve the problems than students with high mathematics anxiety. PRA, not the difficulty in generating ideas, this is indicated by the two ideas it gets. The ideas that appear to solve the problems using arithmetic sequence formula and determine patterns that are formed by looking for the difference many matchsticks in each image. Students with high mathematics anxiety have difficulty in generating ideas so that can only give one idea to solve the problems. The idea that appears from observations in the image then see the patterns formed.

In planning the application of ideas, students with high mathematics anxiety are not productive and not fluent to generate ideas, this is indicated by only comply indicators of fluency to solve the problems. JAK can't explain the plan to solve the problems with clarity. Students with low mathematics anxiety are fluent and productive to generate ideas, this is indicated by the ability of subject in complying with all indicators of fluency, novelty, and flexibility to solve the problems. From two ideas that appeared, the ideas chosen to solve the problem are looking for the difference many matchsticks in each image, the consideration is because the subject doesn't understand if using the arithmetic sequence formula.

Researchers : *Explain your method to determine many matchsticks in nth-image! (Figure 3a)*
JAK : *The first image there are 4 matchsticks, the second image there are 8 matchsticks, the third image there are 12, so each image is multiplied 4. Then the n-th image there are 4n matchsticks.*

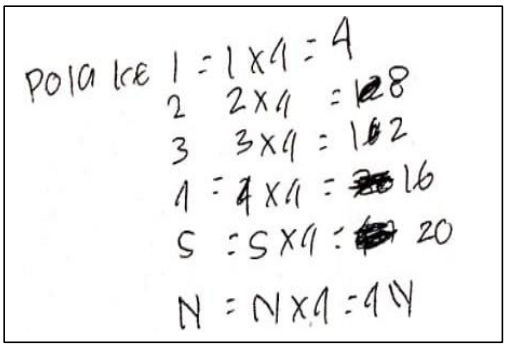
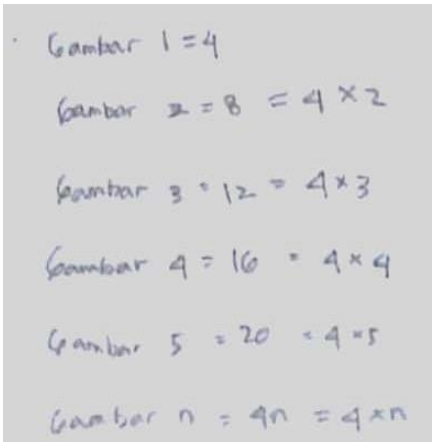


Figure 6. JAK's Work Result of 1d

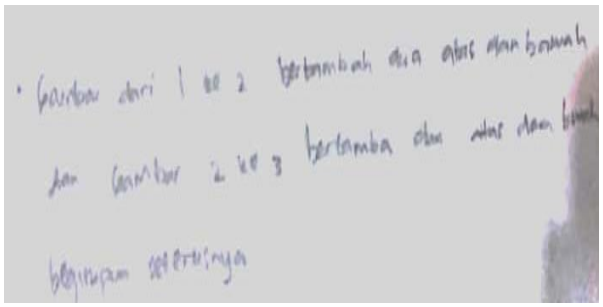
Researchers : *Do you apply the ideas that you have planned before?*
JAK : *No.*
...
Researchers : *Why you don't use the two ideas you got before?*
PRA : *No, because I am more understand by looking for the difference many matchsticks in each image than using the arithmetic sequence formula.*
Researchers : *How you can determine the many matchsticks in the nth-image? (Figure 5a)*
PRA : *1st image there are 4 matchsticks, 2nd image there are 8 matchsticks, 3rd image there are 12 matchsticks. So, many matchsticks in the n-th image are 4n.*
Researchers : *Do you have another idea?*
PRA : *From 1st and 2nd images, two matchsticks increase at the top and bottom, and so on. Then many matchsticks in the n-th image are 2n+2n.*



(a)

Translate
Picture 1 = 4
Picture 2 = 8 = 4 × 2
Picture 3 = 12 = 4 × 3
Picture 4 = 16 = 4 × 4
Picture 5 = 20 = 4 × 5

Picture n = 4n = 4 × n



(b)

Translate
The picture from 1 to 2 increases two top and down
The picture from 2 to 3 increases two top amd down, etc

Figure 7. PRA's Work Result of 1d

Researchers : Do you apply the method you have chosen to solve the problem?
PRA : Yes, I applied one of the two ideas I got.

Fragment 3. Dialogue Between Researcher and Students With High and Low Mathematics Anxiety on Applying Ideas

In applying ideas, both subjects don't use arithmetic sequence formula and prefer looking for the many matchsticks in the n-th image by determining the difference many matchsticks of each image. Students with high mathematics anxiety did not realize if applied the idea that has been chosen before, so it can be said that JAK solves the problems intuitively (based on feelings). JAK can't clearly explain the steps of solve, has a made mistake and is not realize it. That is because JAK experiences high mathematics anxiety, it can be seen during the interview process that JAK is anxious, nervous, scared, be sweaty, and not confident of the answer. Students with low mathematics anxiety applied the idea that has been chosen before and write steps to solve in detail. Although it has a made mistake in the calculation but the PRA quickly realized and corrected it. PRA is not nervous while facing a problem - solving tests and confident of the answer. Machromah et al (2015), Reali et al (2016), and Klados et al (2017) explained students experience mathematics anxiety can be characterized by a condition of anxiety in situations related to mathematics, especially the students' creative thinking process in solving mathematics problems. Students with high mathematics anxiety can only dominate of flexibility and the students with low mathematics anxiety is able to meet all indicators of creative thinking skills (Pratiwi & Dwijanto, 2019)

Conclusion

The result of this research showed that the level of mathematics anxiety experienced by students influences the students' creative thinking process in solving number patterns problems. The results of this research indicate that there are differences in the creative thinking process of students with high and

low mathematics anxiety in solving number patterns problems that follow the stages of creative thinking consisting of synthesizing ideas, generating ideas, planning the application of ideas, and applying ideas. Students with high mathematics anxiety can't understand the purpose of the tests, can't explain the information in detail, difficulty in generating ideas, only generating one idea to solve the problem. The ideas that arise based on observations in the image are not fluent in explaining the plan of ideas chosen to solve the problem, never made a calculation error, and was not confident in the answer. Students with low mathematics anxiety can understand the purpose of the tests, explain the information in detail, fluently, and productively in generating ideas. The idea that to solve the problem is to use a formula and see the difference between many matchsticks in each image, never made a calculation error but quickly corrected it and was confident with the answer.

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