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Student's Creativity in Solving Problems on Number Operations Lesson

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Abstract

This study aims to assess students' creativity in solving problems related to number operations presented in the form of open-ended problems. Additionally, it seeks to identify any variations in creativity between male and female students. Employing a mixed research method with an exploratory sequential design, the research was conducted in Class VII at Junior High School, MTs Zainul Hasan Balung, Jember Regency, and Indonesia. The study involved a total of 57 respondents, comprising 23 male students and 34 female students. Data collection was performed through written tests featuring open-ended problems and subsequent interviews. Qualitative data analysis employed the interactive models of Miles, Huberman, and Saldana, encompassing data condensation, presentation, and verification/conclusion. Quantitative data analysis utilized the chi-square test. The study's findings revealed that the creativity levels of the research subjects varied between level 3 and level 2. Furthermore, differences in creativity were identified between male and female students. The assessment of student creativity considered four indicators: fluency, flexibility, novelty, and plausibility. Importantly, this study established a significant relationship between student creativity and gender.

Keywords: *Creativity, Problem, Open-Ended Problem, Gender, Number Operations*

1. INTRODUCTION

A person living in the 21st century is required to master appropriate skills to adapt and contribute meaningfully to life. One of the essential skills of the 21st century is creativity (Ayele, 2016; Choeriyah et al., 2021; Suyitno, 2020). Creativity is crucial for individuals in the 21st century and can be enhanced through a conducive parenting environment (Bezerra et al., 2021), leading to numerous positive outcomes. Conversely, an unsupportive environment can hinder creativity.

Moreover, a supportive social environment significantly influences students' creativity. Students receiving support from schools to foster creativity exhibit higher creative self-efficacy and become more creative individuals (Chang et al., 2016; Choeriyah et al., 2021). The availability of spaces for students to nurture their creativity, such as personal spaces, areas for group discussions, spaces for experimentation, and social interaction spaces like cafes and parks, positively impacts student creativity (Castillo-Vergara et al., 2018). Gulliksen (2017) also established a close relationship between gaming and the environment for creativity.

The creativity inherent in an individual can predict academic achievement. Although high creativity often correlates with high IQ, a high IQ does not guarantee high creativity (Gralewski & Karwowski, 2016). Additionally, emotional intelligence (EI) does not influence student performance or achievement (Hansenne & Legrand, 2012). Furthermore, a negative

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relationship exists between creativity and academic achievement in school (Gajda, 2016). Nakano et al. (2021) support this, highlighting reported differences in creativity between men and women, a sentiment echoed by Tsai (2013), who conducted creativity research on children and young adults using the Consensual Assessment Technique (CAT).

In the digital age, creativity manifests through three factors: achievements or activities related to creative pursuits, creative activities commonly undertaken at school, and self-actualization of digital creativity (Delis et al., 2007; Hoffmann et al., 2016). Schools can employ various strategies to enhance creativity, including the methods and learning approaches used, professional development, promotion of creativity, identification, and encouragement of students through extracurricular programs, and the design of problems with non-specific or general answers (Maksić & Pavlović, 2011).

Creativity is perceived as an individual's ability or cognitive activity that generates innovative approaches in viewing and solving problems or situations (Miranda & Mamede, 2022; Subanji et al., 2021). A problem is defined as a realized situation or condition (often presented as a question) requiring resolution, prompting efforts to find a way to overcome the situation (Niss & Blum, 2020).

Mathematical problems that can be used in studying creativity are open problems (Kholil, 2020; Titikusumawati et al., 2019). Shimada and Becker (Shimada & Becker, 1997, hal. 1) mention that problems formulated to have many correct answers are incomplete problems or open-ended problems.

The most important characteristic of open problems is the availability of possibilities and flexibility for students to use some methods that they consider most appropriate for solving the problem (Fianti et al., 2017; Subanji & Nusantara, 2022). In a sense, questions in an open form are directed to lead to a growing understanding of the problem posed and allow students to develop their creativity.

This presentation shows that student creativity needs to be developed through student habituation in solving open-ended problems. Therefore, this article aims to represent the creativity of students in solving the problem of the number operation material given in the form of an open-ended problem and to know the difference in creativity between male and female students.

2. LITERATURE REVIEW

2.1 Creativity

In studying creativity there are many understandings and approaches proposed by experts. They define creativity comprehensively from various points of view. Creativity was originally defined as innate intelligence that later developed into the result of the fusion of one's innate abilities and the process of adaptation to the environment (Jahnke et al., 2015). The notion of creativity then expands, where creativity is seen as the highest level of expressing a new idea and the ability to combine unrelated topics in different ways to avoid already common patterns (Krumm et al., 2016). This means that creativity is associated with the process of exploiting possibilities that may be contrary to conventional means (Taylor & Callahan, 2005), the willingness to accept something new, and the willingness to accept risks and not be afraid of challenges (Jahnke et al., 2015).

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Lucas (Lucas, 2016) groups five models of creativity, namely imaginative (playing with possibilities, making connections, using intuition), inquisitive (delusion and asking, exploring, and investigating, challenges), persistent (unique, enduring difficulties, and tolerance), collaborative (giving and receiving input, appropriate cooperation, sharing results), and disciplined (reflection on criticism, developing techniques, self-development). Meanwhile, Jauk et al. (Jauk et al., 2014) grouping creativity into three, namely originality (getting things done in a way that has never been done before), novelty (creating something new), and difference or seeing things from a different point of view.

Several other aspects are also added in creativity, such as fluency (number of ideas), flexibility (diversity of ideas), new authenticity and usefulness of an idea (Warren et al., 2018), imagination, positive motivation, and independence (Maksić & Pavlović, 2011). In addition, Agnoli et al (Agnoli et al., 2018) also add intrinsic motivation to students and environmental influences (inside and outside the school) that can predict creative student achievement/ achievement. Collard & Looney (Collard & Looney, 2014) say that in life, the development of creativity in a person will be a fundamental thing that will affect their happiness. Creativity that is well developed in a person will make it easier for them to use their imagination, think and be opinionated, and express the ideas that are in their minds.

The characteristics of a creative individual are able to imagine, use his knowledge to explore something he does not yet know, and has great curiosity and dares to express new ideas that they have in mind. Creative individuals have effort and determination, have great confidence in their abilities (Collard & Looney, 2014; Zhou et al., 2013). Creative individuals are those who are interested in new and complex ideas, think abstractly, generalize ideas, foresee possibilities, analyze a big/thorough picture, have unusual imaginations and dreamers, love intellective games, curiosity, find pleasure when playing with ideas, the ability to offer many solutions with different points of view, dare to take risks, be consistent try to continue to be something new, hyperactive or extreme energy and have a more positive self-concept (Taylor & Callahan, 2005). Meanwhile, according to Runco, Millar, Pickles, & Cramond (Runco et al., 2010), the creative individual is when a person who faces a problem that has never been studied before yet knows how to solve it.

In addition, another characteristic of creative individuals is high intrinsic motivation to be more creative for them in their respective fields. High level of discipline, dedication, and responsibility to his work. High confidence in their fields of expertise. Creative individuals are able to think divergently and provide high standards and are committed to the work they do. They also have flexible thinking, which is always looking for new situations and thinking about many possibilities (Taylor & Callahan, 2005). In more detail, Boytos et al. (Boytos et al., 2017) group creative individuals into two groups, namely underdogs and top dogs. An underdog is a person who fights hard to get something they don't have, while a top dog is a person who maintains what they already have.

Kaufman & Beghetto (Kaufman & Beghetto, 2009, 2013) discusses creativity based on its level. They classify the level of creativity into 4 levels, namely: big-C, pro-C, little-C, and mini-C. Big-C is an extraordinary creativity, which is possessed by great scientists, pro-C is an expert-level creativity, that is, professional-level creativity inherent in creators who are not yet included at an extraordinary level. Little-C is a daily creativity that is seen in a person in his daily life and experiences. Mini-C is creativity that shows a person is able to provide new and meaningful ideas in the learning process. Meanwhile, D. Pitta-Pantazi, et al (Pitta-Pantazi et al., 2021) classify creativity as mini-creativity (mini-C) with three categories, namely (a)

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constructing ideas and insights into abstract mathematical concepts; (b) able to create, manipulate, and represent mathematical concepts; and (c) demonstrate flexibility in thinking.

Creativity in an individual is influenced by several factors, namely social and economic status, extrinsic factors, and the environment. A family with a good social and economic status can affect the development of one's creativity. A family with a good social and economic position is able to produce a more creative child (Castillo-Vergara et al., 2018). Extrinsic activities, which can be in the form of intellectual activities available at home such as the availability of books, have a positive influence on a person's level of creativity. In addition, a conducive environment also has a very large influence on the development of creativity. An environment at home and at school that supports the creative process can develop individual creativity for the better. However, these factors affect only in the early stages of the individual, namely in childhood. These factors no longer have an effect by the time an individual grows up. Meanwhile, the intrinsic motivation of parents (e.g. helping children identify their mistakes rather than giving gifts) was found to have no effect whatsoever on a child's creative development (Gralewski & Karwowski, 2016).

An effective, innovative, and creative learning atmosphere can be created by a creative teacher. Creative teachers can create classroom learning in a good academic atmosphere, improve independent attitudes, trust, and good personal growth in children. The characteristics of a creative teacher can be seen the following aspects, namely: first, the learning aspect. In this aspect, the teacher presents interesting subject matter, pays attention to the student learning process, integrates science with daily activities, and presents stories according to student conditions as learning. Second, the class management aspect. In this aspect, the teacher always pays attention to the comfort of students in the classroom. This can be done by designing classes attractively and sometimes holding learning outside the classroom. Third, the task aspect. Creative teachers always try to design tasks that can improve students' creativity. Fourth, the aspect of interaction with students. In this aspect, teachers try to strengthen students to dare to express their arguments, use the basic abilities of students, and provide positive feedback. Fifth, the character aspects of teachers who are active and enthusiastic, interested and attentive, broad-thinking and actively listening (Abedini & Broujeni, 2016). This is due to the creativity of children in the presence of their teachers seen from learning that uses self-reflective, an independent learning process, showing great motivation and curiosity, creating, or producing something, showing many or more than one perspective, achieving the originality of new ideas and doing to the maximum (Jahnke et al., 2015).

Therefore, a conducive environment is needed that can help individuals learn and can develop their creativity according to what is needed to think openly and productively. Individual creative conditions can be observed from the many ideas, activities in learning, and the many ways used to solve problems in their world. This can be seen when they are given a problem and the way they use in solving the problem in various ways and correct solutions. Creative individuals can be seen from the thought processes that are carried out. With the right guidance and a supportive environment, students are invited to solve problems in an open way. Because this creativity is related to the highest function in thinking, a systematic process is needed to assess it (Castillo-Vergara et al., 2018).

To further focus on the definition of creativity in this study, here are some definitions of creativity based on the results of previous research. Creativity is an effective way of combining divergent and convergent thinking (Bicer et al., 2020; Elgrably & Leikin, 2021; Molad et al., 2020). Operationally, this view leads to the definition of creativity based on four related

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components, namely, fluency, flexibility, novelty (Silver, 1997; Utami et al., 2019), and elaboration (Runco et al., 2010). According to Goldin (Goldin, 2017) and Alves-Oliveira et al. (Alves-Oliveira et al., 2021), Creativity is a problem-solving performance through fluency, flexibility, and originality expressed in solving problems (Silva et al., 2023; Suratno et al., 2019). Meanwhile, Jesper Boesen (Boesen, 2006, hal. 19) assesses creativity based on four components, namely novelty, flexibility, plausibility, and mathematical foundation.

2.2 Open-ended problem

The open-ended problem is an incomplete problem designed in many ways and has many answers (Romli et al., 2018). One of the advantages of using open-ended problems is that it can develop student creativity (Hobri et al., 2019). Open-ended problems are classified into three characteristics, namely 1) an open process with many solutions that are of the correct value, 2) an open-ended result with many correct answers, and 3) after the problem is solved, the problem is still open to be developed into a new problem (Damayanti & Sumardi, 2018).

Shimada and Becker (Shimada & Becker, 1997, hal. 27) state that the characteristics of open-ended problems used in mathematics learning are presented with the aim of being able to develop students' thinking abilities and help them think from different points of view. Open-ended problems also include some examples of basic and high-level mathematical thinking. In addition, open-ended problems must have mathematical value and a wide scope. Open-ended problems according to Shimada and Becker (Shimada & Becker, 1997, hal. 27) are classified into three types: 1) Finding relations, students are asked to find some rules or mathematical relations; 2) classifying, students are asked to classify according to different characteristics, which allows students to discover some mathematical concepts; 3) Measuring, asking students to determine numerical measurements on multiple occasions. Molad et al. (Molad et al., 2020) said that high skills are needed for teachers in designing and developing open-ended questions for students who have diverse abilities. Students are expected to be able to use their knowledge and mathematical abilities that they have learned before in solving problems. Therefore, in this study, the problem used is the open-ended problem of number operation material which is designed to have many ways and many correct answers.

3. METHOD

This study used a mixed research method with an exploratory sequential design. This design begins with collecting and analyzing qualitative data and then continues with quantitative data analysis (Creswell & Creswell, 2018, hal. 52). Qualitative methods are used to describe students' mathematical creativity in solving material problems of number operations. Qualitative data analysis using the interactive model of Miles, Huberman, and Saldana (Miles et al., 2014, hal. 31) consists of data condensation, data presentation, and verification or conclusion. Meanwhile, quantitative methods are used to test whether or not there are differences in student creativity between male and female subjects with chi-square tests (Wagner, 2015, hal. 83). This quantitative data analysis was performed using SPSS 24. This research was conducted in class VIIA and VIIB Junior High School, MTs Zainul Hasan Balung, Jember Regency (Indonesia) with a total number of respondents was 57 students consisting of 23 men and 34 women. For qualitative data purposes, purposive sampling techniques are used by selecting one high-ability student, namely NRA, one medium-ability student, namely LIO, and one low-ability student, namely IM, which is seen based on mathematics scores in the midterm assessment.

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The instruments in this study are written tests and interview guidelines. The instrument is equipped with an assessment rubric and validated by two mathematicians. Class VII students are given test questions in the form of number operation problems. Next, researchers examined and grouped answers based on students' level of creativity. This data is used to determine the level of creativity of grade VII junior high school students, MTs Zainul Hasan Balung. The level of creativity of students can be determined from the following table 1.

Table 1: Creativity Level (Kholil, 2020; Siswono, 2011)

Level	Criteria for creativity
4	Fluency, flexibility, novelty, plausibility.
3	Fluency, flexibility, novelty; or fluency, flexibility, plausibility.
2	Fluency, and flexibility.
1	Flexibility; or fluency.
0	Does not meet all criteria for creativity

Then researchers conduct interviews as triangulation and explored deeper information. Researchers used handphones to record voices when interviews were conducted so that no information was overlooked by students. The test questions given to students are as follows.

Note the numbers 2 and 3. From the number can produce 8, 9, etc. even all integers as follows,
3 – 2 = 1; 3 + 2 = 5; 23 = 8; 32 = 9, etc.
From 2 and 3 we can produce many numbers depending on our creativity. If we suppose that number x and y where x is an odd number and y is an even number, or vice versa, x an even number or y an odd number, write down the various possible operations of the two numbers to produce an odd number? Give your reasons!

Figure 1: Test questions

4. RESULTS

In this article, data is collected through the provision of test questions and interviews. The data collected consists of qualitative data and quantitative data. Qualitative data are obtained from the results of student work on the open-ended problems given, then analyzed and described the creativity that students have based on their level. Qualitative data are selected and further observed on the basis of considerations in the determination of the subject of study. The subjects in this study are NRA, LIO, and IM. Meanwhile, quantitative data in the form of student creativity scores were used to analyze whether or not there were differences in creativity between male and female students using an independent sample t-test.

First, the student's work with the initials NRA shows that he is trying to understand the problem by re-presenting the information illustrated on the question and writing down the problem as shown in the following picture.

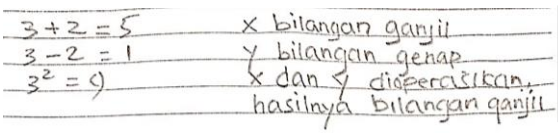

Figure 2: NRA presents back information on the issue

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In figure 2 it can be seen that the NRA returns 3 + 2 = 5, and 3 – 2 = 1. This presentation is used to explore the even number *x* and the odd number *y* as shown in the following figure.

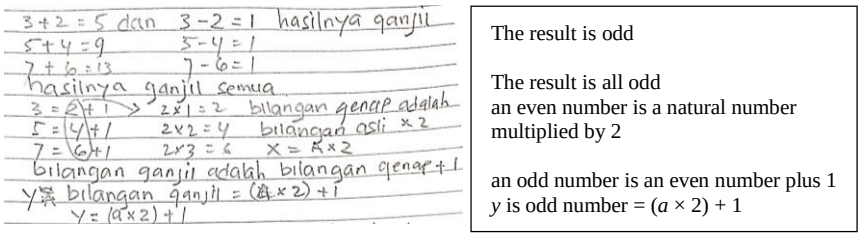

Figure 3: Exploration of odd and even numbers

In figure 3, the NRA states that the even number x is $A \times 2$ and the odd number y is $(a \times 2) + 1$. Furthermore, the NRA operates x and y by summing and subtracting them. Using these definitions, the NRA can logically give a rationale for the addition and subtraction of x and y that produce odd numbers. This can be seen in figure 4 below.

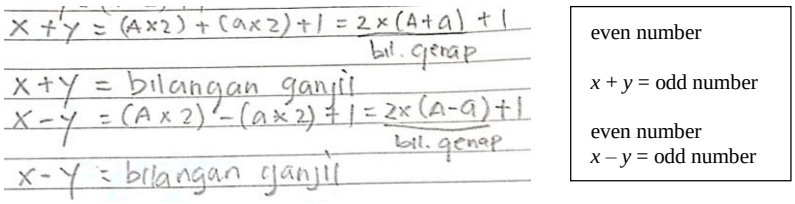

Figure 4: NRA answers

In figure 4, it can be seen that the NRA sums the numbers x and the number y, then he uses the distributive property by removing 2 from each $(A \times 2)$ and $(a \times 2)$ so that an odd number is obtained.

From these answers, the researcher interviewed the NRA to find out more about the reasons for the NRA in answering the problem, as follows.

Researcher : How do you find the definition of odd numbers and even numbers?

NRA Students : I answer by using odd numbers or even numbers certainly, the numbers do not yet represent all odd numbers and even numbers. So I'm looking for numbers that apply to all odd numbers and even numbers.

Researcher : How do you find even numbers $x = A \times 2$ and odd numbers $y = (a \times 2) + 1$?

NRA Students : I used the illustration in question *3 + 2 = 5*. From there I add up numbers to find the pattern of numbers so that I can find even numbers *x* and odd numbers *y*.

Researcher : Fine. The answers you give are only two, namely $x + y$ and $x – y$. Is there no Other answer besides the two operations?

NRA Students : Hmm, there's more.

Researcher : Why do you only give two operations?

NRA Students : yes sir, time is up. I am long in finding even numbers *x* and numbers odd *y*.

Researcher : So how come you have the idea of answering the addition and subtraction operations?

NRA Students : I see an illustration in the question of sir.

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From the exposure of these data, it can be concluded that the NRA can provide answers or ideas smoothly and correctly accompanied by explanations. This is an indicator of fluency. If further observed the NRA answer, can generate two answers by using addition and subtraction operations that produce odd numbers. This is an indicator of flexibility by generating varied answers with different approaches. Furthermore, the NRA can provide a logical reason by using the definitions of even numbers and odd numbers to denote the addition and subtraction of even numbers x and odd numbers y that produce odd numbers. This is an indicator of plausibility by which the NRA can provide logically based arguments that are mathematically based to reinforce the answers presented. Thus, the NRA meets three indicators of creativity, namely fluency, flexibility, and plausibility. This means that the creativity of the NRA reaches level 3.

Different from NRA, LIO meets three indicators, namely fluency, flexibility, and novelty. Indicators of fluency are fulfilled through correct answers accompanied by their explanations. LIO's answer to the given problem is $x + y$, $x - y$, y^2, and $x.y$ + *odd numbers*, where the operation produces odd numbers. LIO tried to give a logical reason for the answer but was not quite right in providing definitions of odd and even numbers. Here is LIO's answer to defining odd and even numbers.

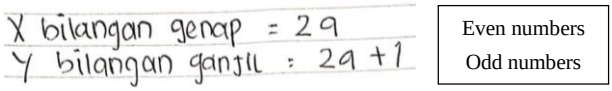

Figure 5: Odd and even numbers

In figure 5, it can be seen that LIO uses the same change in odd numbers and even numbers, namely *a*. So that results in the rationalization of the reason for the answer he gave is not quite right. This is what causes LIO not to meet the plausibility indicator.

After further investigation through interviews, he realized his mistake in making the definition of odd numbers. Here's an excerpt from the researcher's interview with LIO.

Researcher : How to create the definition of even numbers and odd numbers as in the answer to your question?

LIO Students : I write down even numbers from *2, 4, 6, 8,* and so on. From there I see that an even number is divisible by *2*.

Researcher : then how can you write down that even number *2a* and the number odd *2a+1*?

LIO Students : At first I was confused about how to write it. But after thinking for a long time even numbers begin with *2* and the next number is multiplied by *2*, so I write it with *2*, *2.2*, *2.3*, *2.4*, and so on.

Researcher : Then for the odd number?

LIO Students : It's the same method, I also wrote odd numbers first starting from *3, 5, 7,* and Beyond. Then I saw that the odd number was obtained by summing an even number with 1, that is, *3 = 2.1 + 1.5 = 2.2 + 1, 7 = 2.3 +1,* and so on. So I wrote that the even number is *2a* and the odd number is *2a + 1*.

Researcher : how come odd numbers start at *3*? Is 1 not an odd number?

LIO Students : yes right 1 odd number, but I start at *3* because looking at the problem. That is *2 + 3 = 5*. I think it starts there.

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From the interview passage, it can be seen that LIO has tried to think logically in finding the definition of odd and even numbers. But he hasn't been able to define it well. As a result, the reasons given for the next answer become less precise. Here's LIO's answer accompanied by why.

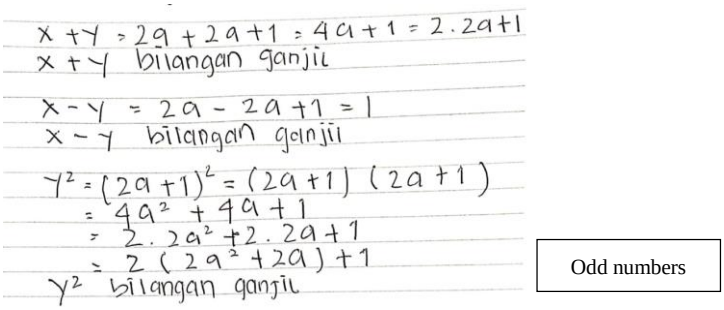

Figure 6: LIO's answer with his argument

Figure 6 shows that LIO provides argumentation logically based on mathematics, but because there is an error in the definition of the numbers *x* and *y*, the argumentation is incorrect. This shows that the plausibility indicator has not been fulfilled to the maximum. LIO can provide arguments logically but not quite right.

From figure 6 it can also be seen that LIO produces varied answers with different counting operations, namely $x + y$, $x - y$, y^2, and $x. y$ + odd numbers. Here's LIO's argument for $x.y$ + odd numbers.

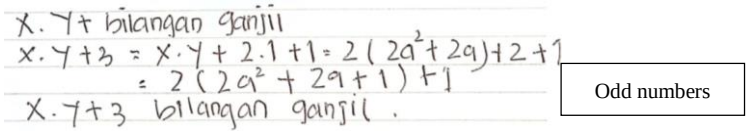

Figure 7: LIO's other answers

From LIO's answer, it can be seen that he can give varied answers with different approaches. This is an indicator of flexibility.

Of the four LIO answers, there is one answer that other students did not think of, namely $x.y$ + odd numbers as in figure 7. LIO combines addition and multiplication operations. To find out the reason for LIO in answering like this, the researcher interviewed LIO in the following interview passage.

Researcher : How do you think of giving an answer $x.y$ + odd number?

LIO students : At first I saw the example 32 = 9 that was in the question. It's a multiplication operation. Then I tried to multiply *2* and *3*, *2.3 = 6*, the result is even.

Researcher : then how come you can answer $x.y$ + odd numbers?

LIO students : from *2.3 = 6*, I summed it up with *3.6 + 3 = 9* the result is odd. Then I Try summing with another odd number. It turns out that the result is also odd. Finally, I wrote $x.y$ + odd numbers.

From the excerpt of the interview, it can be seen that LIO can provide an answer that combines the two operations. After being compared to the answers of his other friends, LIO was able to give different answers to his classmates. This is an indicator of novelty.

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From the exposure of these data, it can be concluded that LIO can provide answers or ideas smoothly accompanied by explanations. This is an indicator of fluency. Furthermore, LIO can generate four different answers by using addition, subtraction, and multiplication operations that produce odd numbers. This is an indicator of flexibility by generating varied answers with different approaches. Furthermore, LIO can give an answer that combines two operations, namely the multiplication and summation operations which are different answers to the classmates. This is an indicator of novelty by which he can give different answers to his classmates. Thus, LIO meets three indicators of creativity, namely fluency, flexibility, and novelty. This means that LIO's creativity reaches level 3.

Next is the result of the work of students with the initials IM. After observation and analysis, IM meets two indicators of creativity, namely fluency and flexibility. Indicators of fluency are met with correct answers that are dissertation with reason. When doing the questions, it can be seen that the IM is smooth in doing the questions. Here's IM's answer.

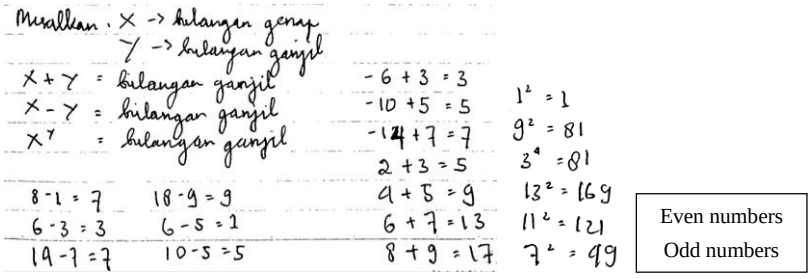

Figure 8: IM answers

From figure 8, it can be seen that the IM answered correctly which was accompanied by a reason. This is an indicator of fluency. To explore more deeply from IM answers, researchers interview IM as in the following interview passage.

Researcher : Try to tell me how you got the answer?

IM students : I just looked at the example given about sir. In question there are *3 + 2 = 5.3 – 2 = 1,* and *32 = 9.* From there I wrote *x + y* = odd numbers, *x – y* = numbers odd, and *xy* = odd numbers.

Researcher : Then what are the meaning of addition, subtraction, and rank of numbers in your answer?

IM students : On the matter of being asked to give a reason, that's my reason, sir.

Researcher : Is it unimaginable for other reasons?

IM students : No, sir.

Researcher : What do you think of what you guys are giving away?

IM students : It's hard, sir. At first, I thought it was easy, but after thinking about it further it turned out to be difficult.

Researcher : Where does the difficulty lie?

IM students : The answer is a lot, sir.

Researcher : have you never done a problem like this before?

IM students : never, sir.

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From the interview, information was obtained that in answering the IM question, it only imitates the example given by the question with additional arguments using certain other numbers to convince the answer. The arguments given by the IM are still inductive. This is not mathematically justified, so IM does not meet the plausibility indicator. From figure 8 it can also be seen that IM answers with three different operations, namely addition, subtraction, and rank. This suggests that IM gives varying answers with different operations. This is an indicator of flexibility. In the answer, it does not look like a unique and different way so IM does not meet the novelty indicator.

From the exposure of these data, it can be concluded that IM can provide correct answers or ideas smoothly accompanied by explanations. This is an indicator of fluency. Furthermore, IM can generate three different answers by using addition, subtraction, and power operations that produce odd numbers. This is an indicator of flexibility by generating varied answers with different approaches. IM does not meet the indicators of novelty and plausibility. This is because IM is unable to give different answers from others, and the arguments given to the answers are still inductive, so they are not mathematically justified. In other words, the argument is not yet logical. Thus, IM meets two indicators of creativity, namely fluency, and flexibility. This means that IM creativity reaches level 2.

Furthermore, as many as 57 students' answers to the problems given were analyzed based on their level of creativity. 26 students (45.61%) were at level 3 where their answers met the indicators of fluency, flexibility, and novelty or some met the indicators of fluency, flexibility, and plausibility. Of these 26 students, there are 10 students with high mathematical abilities, and 16 people with moderate mathematical abilities. The remaining 31 students (54.39%) are at level 2 where they can meet the indicators of fluency and flexibility. These 31 students at level 2 consist of 23 students with moderate skills and 8 students with low mathematical abilities. Of a total of 57 subjects, none of them achieved level 0, level 1, and level 4 creativity. This means showing that the creativity of students in class VII began to develop. Furthermore, if analyzed by gender, the level of creativity can be seen in the following table 2.

Table 2: Levels of creativity by gender

Gender	Creativity levels					Total
	0	1	2	3	4	
Male	0 (0%)	0 (0%)	13 (22, 81%)	10 (17, 54%)	0 (0%)	23 (40, 35%)
Female	0 (0%)	0 (0%)	18 (31, 58%)	16 (28, 07%)	0 (0%)	34 (59, 65%)

Furthermore, to find out whether there is a difference in the creativity of male and female students in solving problems, the chi-square test is used. The data used in this chi-square test was obtained from the scoring of student creativity of class VII MTs Zainul Hasan Balung. Before the chi-square test is carried out, the normality and homogeneity of the data are first tested. The following is the output of the normality test results (table 3) and the homogeneity test (table 4) with SPPS 24.

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Table 3: SPSS output normality test

Tests of Normality							
	Gender	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Creativity Score	Male	,252	23	,001	,877	23	,009
	Female	,234	34	,000	,873	34	,001
a. Lilliefors Significance Correction							

In table 3, it can be seen that the result of the signification (Sig.) is 0.001 for male students and 0.000 for female students on the Kolmogorov-Smirnov test. Based on the Kolmogorov-Smirnov test obtained Sig. each group of students < 0.05, so the data of the two groups of students were not normally distributed. Meanwhile, for the Shapiro-Wilk test, Sig. 0.009 (< 0.05) was obtained for male students and 0.001 (< 0.05) for female students, so the data of the two groups of students on the Shapiro-Wilk test were also not normally distributed.

Table 4: SPSS output homogeneity test

Test of Homogeneity of Variance					
		Levene Statistic	df1	df2	Sig.
Creativity Score	Based on Mean	,671	1	55	,416
	Based on Median	,431	1	55	,514
	Based on Median and with adjusted df	,431	1	54,645	,514
	Based on trimmed mean	,687	1	55	,411

Next is the homogeneity test. In table 4, it can be seen that the Levene value is shown in the line the Based on Mean creativity score, which is 0.671 with Sig. of 0.416 (> 0.05) which means that there is a similarity in variance between groups of students or the data is homogeneous.

Because the data is not normally distributed, the hypothesis test used in this study is a non-parametric statistical test with a chi-square test. Here are the results of the SPSS output of the chi-square test.

Table 5: SPSS output of chi-square test

Test Statistics	
	Creativity Score
Chi-Square	9,596[a]
df	3
Asymp. Sig.	,022
a. 0 cells (0, 0%) have expected frequencies less than 5. The minimum expected cell frequency is 14, 3.	

Based on the SPSS output (table 5), the chi-square test obtained a chi-square value of 9.596 with df = 3 and Asymp. Sig. 0.022. Interpret the results of the chi-square test, it can be done in 2 ways, namely looking at the significant value and comparing the calculated chi-square value with the chi-square table. The significance value obtained was 0.022 < 0.05 and the table chi-square value was 7.815 with df = 3, so it was 7.815 < 9.596. This means that there is a difference in creativity between male and female subjects. Therefore, it can be concluded that there is a relationship between creativity and the gender of students.

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5. DISCUSSION

Creativity is one of the most important abilities in this century. Creativity can be explored through the habituation of students in solving open-ended mathematical problems. In this study, students were given open-ended problems on number operations material. This research was conducted using a mixed method with a sequential exploratory design. The research begins with collecting qualitative data and then continues with collecting quantitative data. Qualitative data is used to explore and describe students' mathematical creativity in solving mathematical problems on number operations. While quantitative data is used to determine differences in creativity between male and female students.

Based on the presentation of data in the results of this study, there were 26 students or 45.61% of the 57 students at creativity level 3. Students at this level consist of 10 high-ability students and 16 moderately capable students. 10 highly capable students and 3 moderately capable students can provide answers that meet the indicators of fluency, flexibility, and plausibility.

The other 13 students of moderate ability were able to meet the indicators of fluency, flexibility, and novelty. Another 31 students or 54.39% of the 57 students were at creativity level 2. Students at level 2 consist of 23 students of medium ability and 8 students of low ability. At this level, students can meet the indicators of fluency and flexibility. This is in accordance with the research of Sa'dijah et al. (Sa'Dijah et al., 2019) which states that students with high mathematical abilities will be able to solve problems and meet three indicators of creativity. This is also confirmed by Elgrably and Leikin (Elgrably & Leikin, 2021) who say that members of the international mathematical Olympiad who have high abilities can fulfill the component of creativity.

The results showed that students in class VII MTs Zainul Hasan Balung were able to reach a level of creativity at level 3. This was an important note for teachers at the school that student creativity could still be developed and improved to reach a higher level. This can be obtained by improving the learning design in the classroom. Learning is designed by choosing learning models that can develop and improve students' thinking skills, such as fluency, flexibility, and originality (Alves-Oliveira et al., 2021; Goldin, 2017), and elaboration (Runco et al., 2010). In fact, with a quality learning design, plausibility, novelty, and mathematical foundation skills can be developed (Boesen, 2006).

In this study, it was also found that there is a relationship between student creativity and gender. This can be seen in Table 2 and Table 5. That is, there is a difference between the creativity of male students and the creativity of female students. Thus, it can be concluded that the creativity of students is related to gender.

This is in accordance with research conducted by Baran, et al. (Baran et al., 2011) which states that students' creativity differs significantly by gender. This is also confirmed by Nakano et al. (Nakano et al., 2021) who state that there is a difference between gender and student creativity where the creativity of female students is superior to that of male students. However, some studies prove that male students are superior to female students in creativity (Tsai, 2013). Unlike the research conducted by Baer & Kaufman (Baer & Kaufman, 2008) which found that there was no significant difference between gender and student creativity.

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6. CONCLUSIONS

Students' creativity in this study consisted of four indicators, namely fluency, flexibility, novelty, and plausibility. Student creativity is observed based on the level of creativity. The level of creativity in question consists of level 4 with creativity indicators that are met, including fluency, flexibility, novelty, and plausibility; level 3 with creativity indicators fulfilled including fluency, flexibility, novelty or fluency, flexibility, and plausibility; level 2 with creativity indicators fulfilled including fluency, and flexibility or flexibility, and novelty; level 1 with indicators of creativity fulfilled including novelty or flexibility or fluency; and level 0 if it does not meet all aspects of creativity.

A total of 57 students' answers to the problems given were analyzed based on their level of creativity. 26 students (45, 61%) were at level 3 where their answers met the indicators of fluency, flexibility, and novelty or some met the indicators of fluency, flexibility, and plausibility. Of these 26 students, there are 10 students with high mathematical abilities, and 16 people with moderate mathematical abilities. The remaining 31 students (54, 39%) are at level 2 where they can meet the indicators of fluency and flexibility. These 31 students at level 2 consist of 23 students with moderate skills and 8 students with low mathematical abilities.

The statistical test in this study was carried out using the chi-square test with data that were not normally distributed. The calculated chi-square value was obtained by 9,596 and then compared to the table chi-square of 7,815 with df = 3, so 9,596 > 7,815 or the chi-square count greater than the chi-square table. This means that there is a difference in creativity between male and female subjects. Therefore, it can be concluded that there is a relationship between creativity and the sex of students. This research is limited to the creativity of individual students. It is necessary to discuss further social creativity which is designed through groups so that students' social activities can be seen in communicating and collaborating.

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