Analyzing Divergent Thinking Ability of Students on The Topic of Linear Equations in Grade VIII of State Junior High School

I Ketut Suastika[1*], Feny Rita Fiantika[2], Buhaerah[3]
[1]Universitas PGRI Kanjuruhan Malang, Indonesia, suastika@unikama.ac.id
[2]Universitas PGRI Adi Buana Surabaya, Indonesia, fenyfiantika@unipasby.ac.id [3]Institut Agama Islam Negeri Parepare, Indonesia, buhaerah@iainpare.ac.id

Abstract: *Divergent thinking is a type of creative thinking that can provide various possible answers based on the information provided. A person with a divergent thinking type generally likes to experiment or try new things. The purpose of this study was to analyze the divergent thinking skills of class VIII students of SMP Negeri 1 Dampit on the material of linear equations. This study is a qualitative study with a descriptive research design. The instruments used were divergent thinking ability tests and interviews. The indicators of divergent thinking ability are fluency, flexibility, originality, and elaboration. The results of this study are: (1) for the fluency indicator, students gave wrong answers but the mathematical procedure was appropriate, because students were in a hurry when working; (2) for the flexibility indicator, students were not able to find more than one way to solve the problem; (3) for the originality indicator, students solved the problem differently and according to the concept; and (4) for the elaboration indicator, students described the solution in detail and according to the concept but the answer was not correct.*
Keywords: *analysis, thinking, divergent thinking ability.*

1. INTRODUCTION

Divergent thinking skills among students are important in this era of global competition because the level of complexity of problems in aspects of modern life is increasing (Hasanah & Abdussakir, 2024). Divergent thinking is a type of creative thinking that can provide various possible answers based on the information provided, with an emphasis on diversity of quantity and suitability (Sandhiya & Bhuvaneswari, 2023). Creative thinking implies that an individual has diversity in solving a problem (Hundschell et al., 2022). Divergent thinking is the ability to find many ideas to solve the problems faced (Utami, 2016). Divergent thinking directs individuals to produce many ways that are relevant to the problems faced. The various solutions produced are not always in the form of novelty, but in the form of developing existing solutions so that they are based on the knowledge they have (Singgih et al., 2024).

Divergent thinking is an activity associated with sensitivity to issues, considering new information and unusual ideas with an open mind, and being able to make connections in solving problems (Webb et al., 2021; Agustina, 2020). When faced with a problem, individuals with divergent thinking will attempt to find broad answers from different perspectives, but these answers can be linked with rational reasons so that they can be accepted by others who understand (Palmiero et al., 2020). According to Abdulla Alabbasi et al. (2021), indicators of divergent thinking can be formulated as follows.

1. Fluency is characterized by being able to provide many ideas, numerous problem-solving solutions, numerous questions fluently, and being able to offer many ways or suggestions to do various things.
2. Flexibility is characterized by generating varied ideas, answers, or questions, being able to view a problem from different perspectives, and being capable of providing more than one solution approach.

3. Originality is characterized by being able to provide new and unique expressions, as well as being able to think of unconventional ways to express oneself.
4. Elaboration is characterized by being able to add or elaborate on details or sequentially outline an object, idea, or situation to make it more engaging.

Divergent thinking is a thinking pattern characterized by the dominance of the right hemisphere of the brain, lateral thinking, involving thoughts around or diverging from the central issue (Huang et al., 2024). So it is natural that individuals with divergent thinking patterns are able to provide alternative answers even if those solutions may not be relevant to the existing problem. It is often found that learners fail to explore other methods when solving problems.

Divergent thinking skills play an important role in mathematics education because they can encourage students to produce various creative and original solutions to the problems they face (Andri Nugroho, 2023). Divergent thinking allows students to explore various approaches to solving mathematical problems, especially those that are open-ended (Gunawan et al., 2023; Palmiero et al., 2020). This encourages the development of creativity and flexible thinking skills (Zhu et al., 2019). Divergent thinking encourages students to consider various possibilities and perspectives in solving problems (Gunawan et al., 2023; Runco, 2022). This not only increases creativity but also strengthens critical and analytical thinking skills, which are essential in understanding mathematical concepts in depth (Winarso & Haqq, 2020).

A study by Gunawan et al. (2023) showed that students with good divergent thinking skills were able to produce more diverse and innovative solutions in solving open-ended mathematics problems. Research by De Vink et al. (2021) found that divergent thinking contributed positively to students' mathematics performance in multiple-solution tasks.

Based on the observation results conducted by the researcher, it was found that 66.87% of students were able to solve problems according to the formulas or procedures taught by the teacher, while 33.13% of students were able to develop their own results in their own way. Mathematics teachers also explain that students more frequently use formulas or mathematical procedures taught by the teacher rather than using their methods. This indicated that the divergent thinking ability of learners is less optimal.

SPLDV material is very essential. This material has been taught since junior high school. According to (Sulistiyowati & Wahyuni, 2024), SPLDV is often used to model and solve real problems, such as determining the price of goods, calculating sales profits, or managing budgets. By understanding SPLDV, students can develop logical and analytical thinking skills in dealing with everyday situations. (Lively & Machromah, 2024) added, SPLDV material trains students in compiling mathematical models of contextual problems, choosing the right solution method (such as substitution, elimination, or mixed methods), and interpreting the results. These skills are very important in developing critical thinking and problem-solving skills. Given the above, this study aimed to analyze the divergent thinking ability of students on the topic of linear equations in Class VII of State Junior High School 1 Dampit.

2. METHOD

This study employed qualitative research with a descriptive research design. The study was conducted at State Junior High School 1 Dampit, Malang Regency. The subjects of the study were students of class VIII A, consisting of 5 students categorized as follows: one student in the excellent category, one student in the good category, one student in the fair category, one student in the poor category, and one student in the mediocre category.

The instruments used were divergent thinking ability tests and interviews. The data collection procedure in this study involved tests, interviews, and documentation. Meanwhile, data analysis used the Miles and Hiberman model. (Farib et al., 2019), namely data reduction, data display, and conclusion drawing. The validity of the data was examined through the triangulation method, which involved comparing data from the results of divergent thinking ability tests, interviews, and documentation. The study was done in several

stages, such as the preparation stage, the implementation stage, and the reporting stage. The percentage calculation technique for divergent thinking ability levels uses the following formula:

$$P = \frac{n}{N} \times 100\%$$

Note: P= Percentage
n= The score acquired by a student
N= Maximum score

The scoring categories used to determine the level of divergent thinking ability of students are as follows:

Table 1. Categories of Divergent Thinking Score Percentage Results

The Percentage of Achievement in Divergent Thinking Aspect (P)	The Category of Divergent Thinking Level
85%<P≤100%	Excellent
70%<P≤85%	Good
55%<P≤70%	Fair
40%<P≤55%	Poor
0%≤P≤40%	Mediocre

(Prasetyo, 2020)

3. Findings and Discussions

In this study, to analyze students' divergent thinking skills in mathematics learning using a test instrument in the form of 3 open-ended problems. The test results are presented in Table 2. **Table 2. Grouping of Divergent Thinking Ability Test Results**

Name	Mean Score	Percentage	Category
GAB	44	91,7%	Excellent
NPC, RV, KNS, RAP, DHD, AOK, DAWS	35,7	74,4%	Good
AD, RDNC, AJ, OYBS, ASNS, MEA, ANAP, LAPM, AF, IRN	29,6	61,7%	Fair
AA, NEB, ZNF, APWP, SDS, DGA, AEPW	23	47,9%	Poor
ADS, ABA, AP, IHR, WNP, WDA, MI	13,9	29%	Mediocre

Based on the test results, interviews were conducted with students to obtain further information related to their answers. Interviews were conducted with 5 subjects, with levels of 1 subject in the very good category (GAB), 1 subject in the good category (NPC), 1 subject in the sufficient category (ANAP), 1 subject in the less category (APWP) and 1 subject in the very less category (AP). Interview subjects are presented in Table 3. **Table 3. Interview Subject**

No	Name	Total Score	Percentage	Category
1	GAB	44	91,7%	Excellent

2	NPC	38	79,2%	Good
3	ANAP	29	60,4%	Fair
4	APWP	24	50%	Poor
5	AP	14	29,2%	Mediocre

Based on the results of Table 3, a discussion was carried out regarding students' divergent thinking abilities in each category presented in the following data and descriptions:

Excellent divergent thinking ability

The answers of the student within the excellent category of divergent thinking ability are shown in Figure 1.

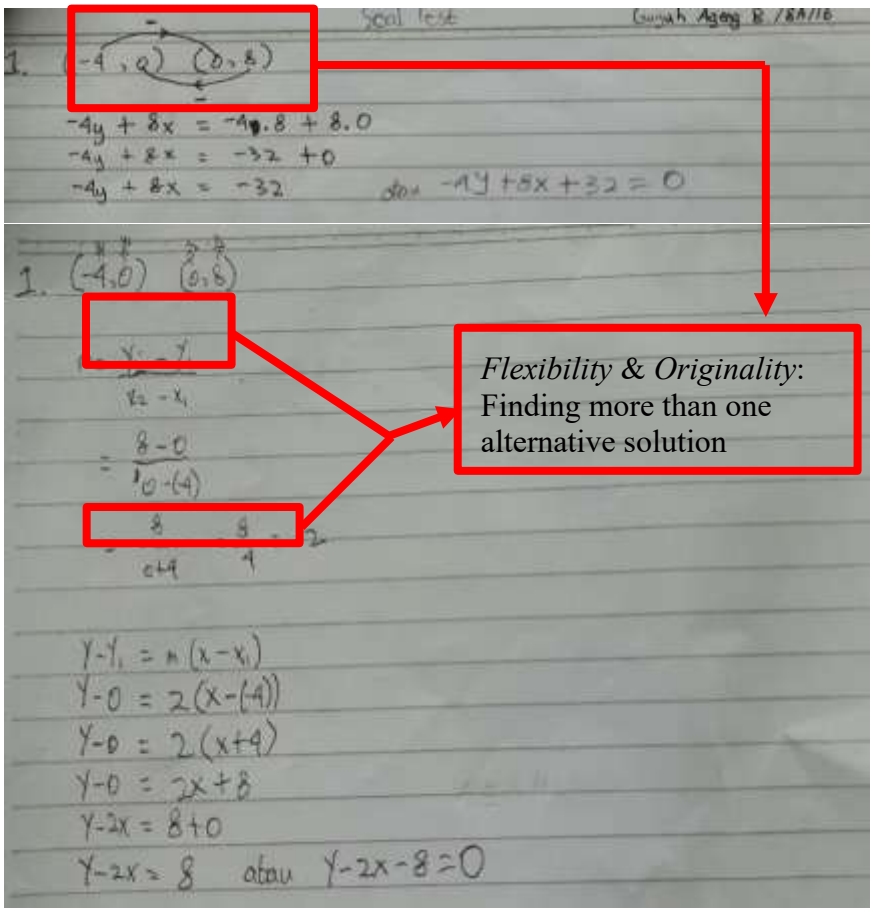

Figure 1. The Answer Results of the Student in the Excellent Category

Figure 1 shows that in the fluency indicator, the student with excellent divergent thinking ability can provide one correct answer using appropriate mathematical strategies and procedures. In the flexibility indicator, he can find more than one way to solve the problem using appropriate mathematical strategies and procedures. In the originality indicator, he can solve the given problem in a different way from others, which is also consistent with the concepts completely and accurately. Furthermore, in the elaboration indicator, he can elaborate on the solution of the given problem in detail and correctly.

The finding on the student in this category indicated that the student was able to provide correct answers using more than one method accurately and completely. The student in this category attempted to

find the correct and different answers. This is consistent with (Park et al., 2023), which stated that students who understand the problem can solve it using more than one method, as evidenced by their correct work. Additionally, it also corroborates with (Sopiah et al., 2020; Yayuk & As' ari, 2020) Students with moderate to high mathematical creative thinking ability tend to be able to solve problems using various methods.

Good divergent thinking ability

The answers of the student within the good category of divergent thinking ability are shown in Figure 2.

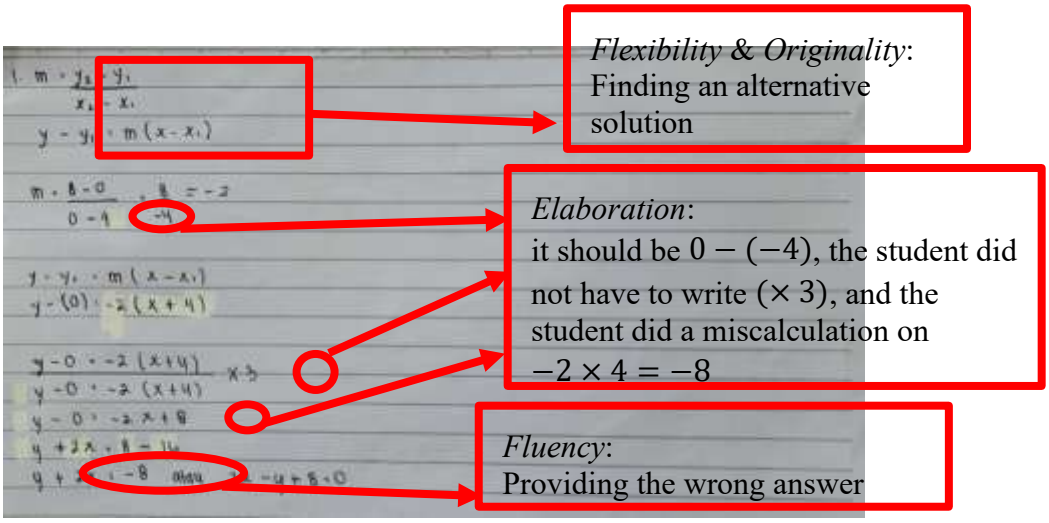

Figure 2. The Answer Results of the Student in the Good Category

Figure 2 shows that in the fluency indicator, the student with good divergent thinking ability gives one incorrect answer using appropriate mathematical strategies and procedures. In terms of flexibility, he is able to find one way to solve the problem using suitable mathematical strategies and procedures. In the originality indicator, he can solve the problem given in different ways and accordance with the concepts, but lacks precision. Finally, in the elaboration indicator, he is capable of elaborating on solutions to the given problem in detail but lacks accuracy.

The findings on the student in this category indicated that he was able to understand the given questions, thus enabling him to solve and elaborate on his answers, albeit with some inaccuracies due to a lack of precision. This condition is consistent with (Masfufah & Afriansyah, 2021), who suggested that students who can interpret questions quite well may still provide inaccurate answers due to a lack of precision. This matter also aligns with (Chiphambo & Mtsi, 2021) , who stated that mathematical calculations play a significant role in determining whether students' answers are correct or incorrect. The main cause of these errors is the students' lack of precision in calculating the final answers.

Fair divergent thinking ability

The answers of the student within the fair category of divergent thinking ability are shown in Figure 3.

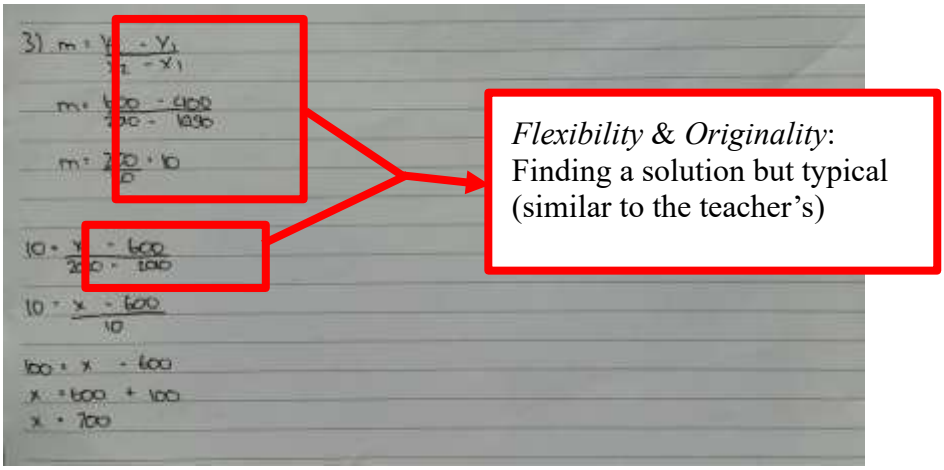

Figure 3. The Answer Results of the Student in the Fair Category

Figure 3 shows that in the fluency indicator, the student with good divergent thinking ability can provide one correct answer using appropriate mathematical strategies and procedures. In the flexibility indicator, he can find one way to solve the problem using appropriate mathematical strategies and procedures. In the originality indicator, he solves the given problem not in a different way, but by using the method provided by the teacher. Additionally, in the elaboration indicator, he is able to elaborate on the solution to the given problem in detail and correctly.

The findings on the student in this category indicated that he is less capable of understanding story problems; thus, he cannot solve problems using different methods and relies solely on the methods provided by the teacher. This condition is in line with (Tang et al., 2020) Who suggested that thinking skills are constantly evolving and can be learned? In terms of generating new ideas and concepts, students in this category often fail to meet the indicators because they rarely use different methods and prefer the methods provided by the teacher in solving story problems. Furthermore, this aligns with (Sánchez-Barbero et al., 2020) Who argued that students are unable to solve problems that differ from the examples provided by the teacher, as they are accustomed to receiving instruction from the teacher and only understand the forms of example problems presented on the board. **Poor divergent thinking ability**

The answers of the student within the poor category of divergent thinking ability are shown in Figure 4.

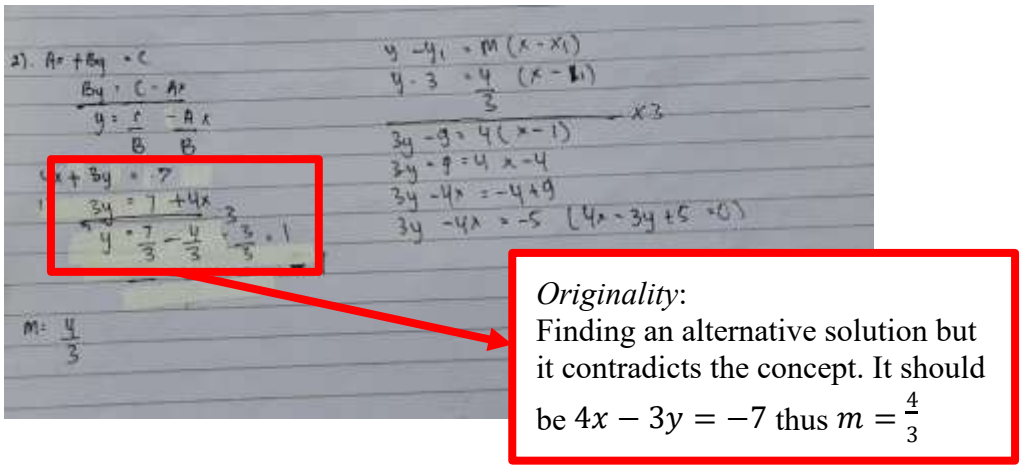

Figure 4. The Answer Results of the Student in the Poor Category

Figure 4 shows that in the fluency indicator, the student with poor divergent thinking ability provides a correct answer using inappropriate mathematical strategies and procedures. In the flexibility indicator, the student can find a way to solve problems using mathematical strategies and procedures that are not appropriate. In the originality indicator, solving the problem given in different ways but not in accordance with the concept. And in the elaboration indicator, the student can elaborate on the solution to the given problem in detail, but less accurately.

The findings on the student in this category indicated that he has difficulty understanding the problem, resulting in providing different ideas or methods to solve the problem using mathematical procedures that are not appropriate because the student has not yet understood the formulas used. This is in line with (Rismawati & Hutagaol, 2018) The opinion that obstacles faced in learning mathematics include low understanding of the concepts learned by students, students having difficulty communicating their mathematical ideas in solving problems, students being accustomed to memorizing formulas without understanding the concepts when learning mathematics, and students still making mistakes in using procedures to solve mathematical problems. Additionally, it is also in agreement with (Ma'rifah et al., 2020); (Barbieri & Booth, 2020) That mistakes can be caused by students not understanding the concepts. To understand the meaning of the problems, students must master the material and understand the concepts related to the problems.

Mediocre divergent thinking ability

The answers of the student within the mediocre category of divergent thinking ability are shown in Figure 5.

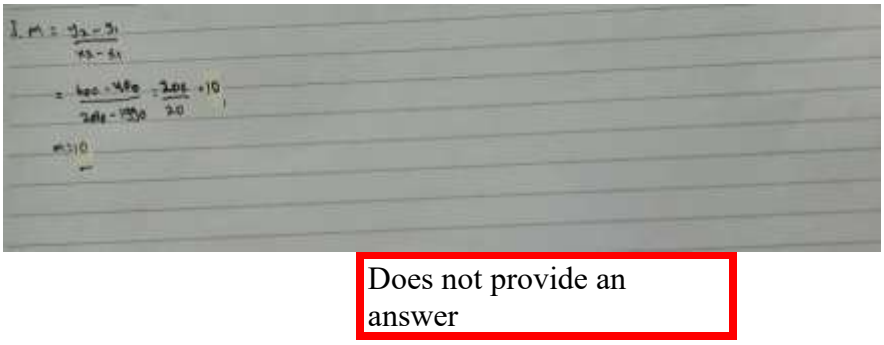

Figure 5. The Answer Results of the Student in the Mediocre Category

Figure 5 shows that in the fluency indicator, the student with mediocre divergent thinking ability does not provide any answer. In the flexibility indicator, the student finds one way to solve the problem using inappropriate mathematical strategies and procedures. In the originality indicator, the given problem is not solved in a different way. Furthermore, in the elaboration indicator, the solution to the given problem is not elaborated in detail. The findings on the student in this category indicated that the student is incapable of understanding the questions, resulting in incomplete solutions and no answers because he did not comprehend the material. This aligns with (Kirkland & McNeil, 2021) who stated that students who have not yet been able to analyze the questions in the problems will provide the oversimplified answers they provide. Additionally, (Mata, 2020) When working on problems, students who are unable to comprehend, analyze, and solve the problems will result in them answering with whatever comes to mind.

The data obtained from the study on the divergent thinking ability of students with indicators of fluency, flexibility, originality, and elaboration are as follows.

Fluency

The data were obtained from test questions given to students, and 5 students were selected whose analysis results on the fluency indicator have been presented. After being calculated, the percentage of achievement for the fluency indicator was found to be 67%. Based on the results of the conducted study on the fluency indicator, it showed that students gave incorrect answers but used appropriate mathematical procedures, which were caused by external factors such as the almost expired time, leading to a rush in completing the task. This finding is consistent with (Meiraini & Retnawati, 2020) Who stated that factors within students themselves are the causes of obstacles, including a lack of practice in solving problems, leading to low student comprehension, rushing in solving problems, and a lack of precision in mathematical calculations. Additionally, this condition is also consistent with (Hanipa & Sari, 2019), who mentioned that factors causing students to make mistakes in solving problems include a lack of practice in solving various problems, a lack of student understanding of prerequisite materials, limited time when solving problems, causing students to panic and rush in solving problems, thus resulting in a lack of precision.

Flexibility

The data were obtained from a test given to students, and 5 students were selected whose analysis results on the flexibility indicator have been presented. After being calculated, the percentage of achievement for the fluency indicator was found to be 45%. Based on the results of the conducted study on the flexibility indicator, it showed that students have not been able to find more than one way to solve problems because they lack effort, but they have already used appropriate formulas or methods.

This finding is consistent with (Safitri et al., 2020), who stated that students evaluate the method used to understand the problem by deciding that the answer chosen by the students is correct, but the students have not been able to decide that there is a different strategy in the problems that have been solved. This finding also corroborates with (Herlinda, 2019) The verification stage is when students recheck their answers and look for other ways to solve the problem. Sometimes students find several ways to solve problems and realize that there are still other ways, but students are too lazy to search because they want to finish quickly.

Originality

The data were obtained from a test given to students, and 5 students were selected whose analysis results on the originality indicator have been presented. After being calculated, the percentage of achievement for the originality indicator was found to be 62%. Based on the results of the conducted study on the originality indicator, it showed that students were capable of solving the given problem with different methods while still in accordance with the concepts. This finding is in line with (Sari & Untarti, 2021) The argument is that students with high mathematical resilience can provide various solutions systematically and in detail. Additionally, this finding also corroborates with (Halim & Ahyaningsih, 2019), who suggested creativity in mathematics, for instance, students can use new and different solution methods while still maintaining correctness within the context. **Elaboration**

The data were obtained from a test given to students, and 5 students were selected whose analysis results on the elaboration indicator have been presented. After being calculated, the percentage of achievement for the elaboration indicator was found to be 75%. Based on the results of the conducted study on the elaboration indicator, it showed that students were capable of elaborating the solutions of the given problem in detail and in accordance with the concepts, but giving incorrect answers.

This finding is consistent with (Artikasari & Saefudin, 2017) Which stated that the component of discovery helps stimulate students in the elaboration character, with the answers that students have found, they will be easier to detail clearly. Besides, this finding also corroborates with (Pratiwi et al., 2021) That students with high levels of learning independence can write answers by detailing the sequential steps with clear and complete explanations.

Based on the scoring data on the divergent thinking ability indicators, total scores were obtained and then converted into percentages to determine the divergent thinking ability indicator of the participants. This can be seen in Figure 6 as follows.

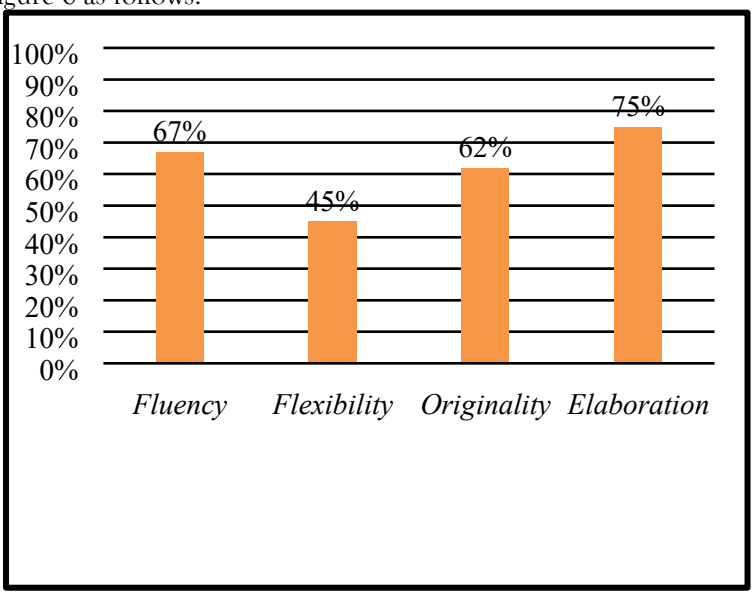

Figure 6. The Graph of Divergent Thinking Ability Indicators

1. CONCLUSION

The results Of the study on students' divergent thinking indicated that: (1) the student in the excellent category was able to provide correct answers using more than one method accurately and completely because he made an effort to find correct and different answers, (2) the student in the good category was able to understand the given problem so he can solve and elaborate his answers but less accurately due to lack of meticulousness, (3) the student in the fair category was less capable in understanding the story problem so he cannot solve the given problem using different methods, (4) the student in the poor category was less capable of understanding the given problem so he provided different ideas or methods in solving the problem using inappropriate mathematical procedures because he did not understand the formulas used, (5) the student in the mediocre category was less capable in understanding the given problem so he solved the problem imprecisely and did not provide answers because he did not understand the material.

In the fluency indicator, students provided incorrect answers, but the mathematical procedures were correct, likely due to rushing during the task, resulting in a fluency indicator achievement percentage of 67%. In the flexibility indicator, students were unable to find more than one way to solve problems, yielding a flexibility indicator achievement percentage of 45%. In the originality indicator, students solved problems differently and by the concepts, resulting in an originality indicator achievement percentage of 62%. In the elaboration indicator, students detailed their solutions accurately, but the answers were incorrect, leading to an elaboration indicator achievement percentage of 75%. Suggestions for future researchers include emphasizing concepts in the taught material and providing exercises ranging from simple to complex problems to improve students' divergent thinking abilities during the research. Additionally, if time permits, researchers are advised to administer multiple test questions to gain deeper insights into students' divergent thinking ability.

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