BIS EDUCATION
Volume 1 2025 | DOI: 10.31603/bised.174
6th Borobudur International Symposium on Humanities and Social Science (BIS-HSS) 2024
UNIMMA PRESS
Universitas Muhammadiyah Magelang

Student's creative thinking processes in solving integer and fraction operation problems

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Abstract

This study aimed to describe students' creative thinking processes when solving integer and fractional operations, specifically examining these processes in relation to field-dependent and field-independent cognitive styles. The findings of this research can serve as a valuable resource for teachers, enabling them to better understand and attend to their students' creative thinking processes during mathematics problem-solving. This understanding can also be utilized for evaluating student learning outcomes. A qualitative descriptive approach was employed for this study. Research subjects included two students each from the field-dependent and field-independent cognitive style categories, selected based on recommendations from a thesis supervisor. Data collection involved tests and interviews, utilizing the Group Embedded Figures Test (GEFT), creative thinking process test questions, and interview questions as instruments. Data validity was established through triangulation techniques. The results revealed distinct levels of creative thinking among the subjects. Both students categorized as field-independent demonstrated Level 3 creative thinking, indicating their ability to exhibit fluency and flexibility in problem-solving. Among the field-dependent subjects, one student also achieved Level 3, showcasing fluency and flexibility. Conversely, the second field-dependent subject was at Level 0, signifying an inability to demonstrate fluency, flexibility, or novelty in their problem-solving approach.

Keywords

Creative thinking process, Field dependent, Field independent

Published:
April 15, 2025

Selection and Peer-review under the responsibility of the 6th BIS-HSS 2024 Committee

Introduction

Education is one of the important things to improve the quality and welfare of a person. One of the important components that support the running of education today is the curriculum, the development of an independent curriculum that has the main objective of restoring the learning crisis (learning lost) experienced by Indonesian children. According to Devian et al. (2022), that one of the educational concepts put forward by Ki Hajar Dewantara is that learning must focus on student abilities, provide freedom of thought, and not provide coercion because it will kill the creativity of the student.

Therefore, teachers have greater flexibility and independence in conducting differentiated learning according to students' abilities and making adjustments to the context and local content (Nurhidayati, 2021).

The implementation of the curriculum is realized through the learning process, one of which is in mathematics. Mathematics subjects need to be given to all students starting from elementary school to equip students with the ability to think logically, analytically, systematically, critically, and creatively, as well as the ability to work together (Daryanto and Rahardjo, 2012). Given the importance of learning mathematics, there needs to be special attention to develop students' thinking skills, one of which is creative thinking. This is in line with what Wasahua (2021) said that creative thinking is a consistent way of thinking and is done repeatedly so as to produce creative and original products. This means that creativity is not only about products and results but also involves the process that is gone through to produce creative products.

The independent curriculum was developed as a curriculum framework that is more flexible and focuses on essential material and the development of the Pancasila learner profile and student competencies. According to Malikah et al. (2022) that the independent curriculum creates active and creative learning by prioritizing student learning outcomes based on the Pancasila learner profile. This is in line with the opinion of Manik et al. (2022), that the purpose of the independent curriculum is to learn so that students can find and understand themselves in learning mathematics which is expected to be creative and find their own way of expressing their learning opinions.

Creative thinking is closely related to mathematics, mathematics is a science related to numbers (Afidah, & Suhendar, 2020). Mathematics is one of the subjects taught at school that can be used to develop students' creativity. The development of creativity in mathematics is based on reasoning, logical, critical, objective and rational thinking that is needed in everyday life, as well as in the development of Science and Technology (IPTEK). Students perform a thinking process in learning math and solving math problems. In the minds of students, a thinking process occurs so that students can arrive at an answer, because the ability to think will help students make decisions and solve problems, the creative thinking process can be explored and known by looking at students' ability to solve problems (Nurwahyuni et al., 2020). Efforts to improve this creative thinking can be trained by making learning that bypasses students to solve their own problems (Nuha et al., 2018).

Therefore, a problem is needed that can bring out the creative thinking process that students have. According to Ariantika (2018) that one of the efforts to help students to be active and carry out the creative thinking process is to use contextual problems. This is because contextual problems link directly between problems and real situations experienced by students. The same thing was conveyed by Jazim et al. (2017) who stated that science in learning can be developed by providing problems can be done by providing stimuli in the form of problems related to student life so that students can find the solution process in a creative way.

Based on the researcher's interview with the mathematics teacher at MTs Darul Falah Sukorejo, the lesson hours for mathematics material are carried out for 2 lesson hours a week which results in the teacher's attention being more focused on learning outcomes, so that less attention is paid to the learning process of students. To pursue curriculum targets, teachers do not provide sufficient time for students to be actively involved in learning. As a result, teachers are active in learning, while students become listeners and recipients of information. In addition, math teachers rarely give math problems to students in the form of non-routine problems. Teachers are only fixated on routine problems that only train students mechanistically and are textbook in nature.

In learning mathematics, the problems given can be in the form of routine problems and non-routine problems. Routine problems are problems that can be solved by applying existing methods, while non-routine problems in solving them require their own strategies that must be owned by someone in solving them. One of the failures of most math teachers today is not being able to make students think critically and creatively and independently in learning (Nurhidayah, 2015). With the dense Pondok activities, students must have the ability to think creatively because during learning students must be able to understand the material and are asked to be able to solve math problems given by the teacher independently or in groups with a short time.

Nurhidayah (2016) states that success in learning is influenced by many factors, both influenced from within and from outside the person who learns. The creative thinking process of students can also be influenced by several factors including internal factors and external factors. Hardiyanto (2016) states that internal factors consist of learning abilities, learning motivation, interest and attention, attitudes and learning habits as well as physical and psychological while external factors are environmental. According to Wahyudi et al. (2022) all these factors must contribute to each other because they affect learning achievement and help achieve good learning achievement. These factors arise because each individual has differences. The dimensions of individual differences include intelligence, logical thinking ability, creativity, cognitive style, personality, values, attitudes and interests. Creative thinking in mathematics and other fields is a skill that continues to be developed in the face of the information age and increasingly fierce competition (Andinaya et al., 2018). According to Putra et al. (2018) stated that efforts in training creative thinking skills, students are given problems that have different or diverse solutions according to individual thoughts and abilities.

This will result in the process of creating ideas that can be classified as divergent thinking and when the process of convergent thinking will obtain a single answer. This stage becomes a benchmark for the divergent process in solving problems. Creative thinking ability is one of the important thinking skills needed in learning mathematics. Faturohman and Afriansyah (2020), stated that the importance of creative thinking skills in all fields, especially the mathematical field. Teachers must be creative in designing lessons and have the right assessment instruments to improve students' thinking skills (Sutrisno, 2022). However, so far, the teaching and learning process still emphasizes

procedures, calculations in solving routine problems in textbooks and LKS. Thus, students when faced with non-routine problems have difficulty in solving the problem.

The stages of creative thinking according to Munandar in Uloli et al. (2016) are three, namely (1) Fluency. The ability of students to come up with several answers. (2) Flexibility. Students' ability to come up with answers in various ways. (3) Originality. Students' ability to generate new and unique ideas. The stages developed based on Wallas' theory are one of the most common theories to determine the creative thinking process, namely there are four stages, namely the preparation stage, incubation, illumination, and verification. Other creative thinking stages based on those developed by Siswono (2008) include building an idea, synthesizing an idea, planning the application of the idea, and applying the idea to produce something new.

Rahmatina (2014) defines cognitive style as a person's characteristics in receiving, analyzing, and responding to a given cognitive action. Each individual has a different cognitive style in accordance with the circumstances it has. Woolfolk (1993) states that cognitive style is a person's way of receiving and organizing information from around him. According to Chika (2017), cognitive style refers to a person's process of storing, receiving information that will be used to respond to a problem. Thus, it can be seen that cognitive style is a special trait that a person has to analyze, accept, process information and respond from cognitive actions received in a learning so that it becomes a useful skill for oneself.

Each student in the class actually has a variety of differences in activities and absorb and analyze information about cognitive, it is based on different cognitive abilities and cognitive styles that students have are also different. Because of the opinion of Rahmatina (2014) also says every child has different talents and abilities and the classification of a person's cognitive style is also different, this means that it is possible that children who have different cognitive styles will have a picture of creative thinking solving different problems. Nurhidayah (2018) states that students' cognitive development is very important in determining the success of mathematics learning. According to Witkin (1971), cognitive style field dependent and cognitive style field independent is one of the teacher factors in considering a lesson. Cognitive style field dependent is a person who thinks globally in action, accept structure or information that already exists, have a social orientation, choose a profession that is social skills, prioritize social motivation, and tend to follow the goals and information that already exists. Cognitive style field independent is a person who is individual, prioritizing motivation from within oneself. Based on the description above, this study aims to determine how the creative thinking process of students in solving problems on integer operations and fractions in terms of cognitive style Field Dependent (FD) and cognitive style Field Independent (FI).

Method

This type of research is descriptive research with a qualitative approach, researchers want to describe students' creative thinking in solving problems. This research was conducted at MTs Darul Falah Sukorejo which is located on Jalan Mangga No. 05 Sumberejo Sukorejo, Sukorejo District, Ponorogo Regency. The subjects in this study were taken using purposive sampling technique, namely the technique of taking subjects as data sources with certain considerations. The research subjects used in this study were students of class VIII E MTs Darul Falah Sukorejo in the 2022/2023 school year. The data to be collected in this study are student test results, observations, interviews with research subjects and documentation during the research implementation process. To obtain the data and information needed in the study, the researcher determines the data collection technique that is in accordance with the problem to be studied. In this study, researchers used data collection techniques, namely questions and interviews. Qualitative data analysis in this research is data reduction, data presentation and verification.

In this study, the main instrument is the researchers himself or the researcher as a key instrument who is actively involved in this research including determining the subject, collecting data, analyzing, and providing interpretations of the research results. While the supporting instruments in this study are initial ability tests, creative thinking test questions and interview guidelines. In addition to analyzing the data, researchers must also test the validity of the data in order to obtain valid data. To determine the validity of the data, inspection techniques are needed. Test the validity of data in qualitative research using triangulation techniques. Triangulation is defined as checking data from various sources in various ways, and various times (Sugiyono, 2016). Triangulation in this study uses method triangulation, which is done by comparing the test results and interviews that have been done by the subject to check the validity of the data.

Results and Discussion

Table 1. List of Research Subject

Initial Subject	Subject Code	GEFT Score
QKAR	FD_1	7
CV	FD_2	7
RLA	FI_1	13
FSN	FI_2	16

Description: FD_1 as First field dependent cognitive style student; FD_2 as Students cognitive style field dependent second; FI_1 as First field independent cognitive style student; FI_2 as Second field independent cognitive style student.

In this study, researchers determined the subject by using the acquisition of initial test results, namely the GEFT (Group Embedded Figures Test) test given to students in class VIII E MTs Darul Falah Sukorejo which was attended by 27 students. The data in this study are the results of written work and the results of interviews with four research subjects, namely two subjects of field dependent cognitive style students and two subjects of

field independent cognitive style. Determination of four research subjects is also based on the consideration of the mathematics teacher MTs Darul Falah Sukorejo, then obtained the research subjects (Table 1).

Subject Field Dependent 1 (FD_1)

In the Figure 1, it can be seen that subject FD_1 has understood the meaning of the problem given well. This can be seen from the answer of subject FD1 who answered in a way along with the completion of the problem. Subject FD_1's answer was written briefly and simply, what was asked was understood but subject FD_1 did not write the information completely so it was still difficult to understand. Furthermore, in solving the problem, it is not systematic or sequential, so it is directly on the multiplication result. Subject FD_1 assumed that if a problem has a known direction and solution then there is no need to write down the solution coherently.

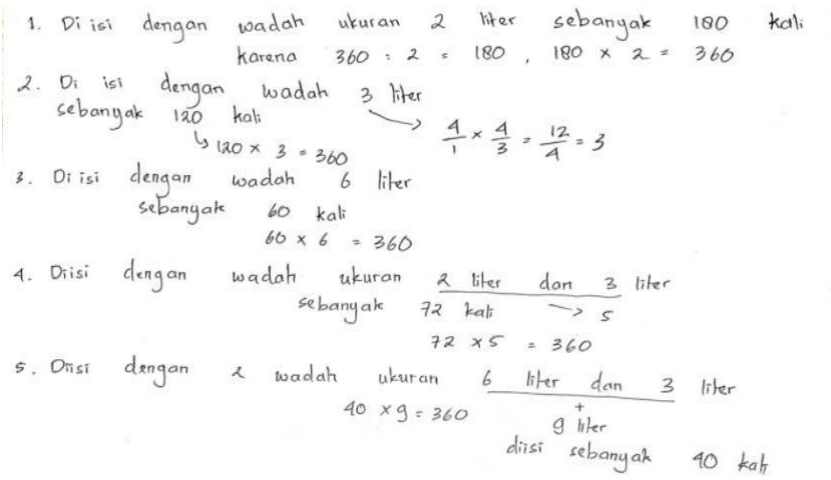

Figure 1. Written answer of Subject FD_1

To find out whether or not the two aspects were really fulfilled, the researcher conducted an interview. Subject FD_1 said that he had never worked on a problem like the problem before, but subject FD_1 said that he understood the meaning of the problem. Based on the answers given by subject FD_1, the indicators of creative thinking shown are fluency and flexibility, where in the fluency indicator students can provide many answers and are correct. While in the aspect of flexibility with a moderate value, namely providing more than one relevant idea and the solution is correct but the method written is less clear.

The FD_1 subject's thought process in finding answers by understanding the problem first and then answering the problem with various answers. According to the results of the FD1 subject's work, it has indeed provided many answers and is correct, but students do not write the method completely so it is difficult to understand so that the flexibility indicator does not reach the maximum value. When subject FD_1 was asked about other ways besides the method that had been written down, subject FD_1 answered that there were no other answers. Based on this answer, subject FD_1 did not get the maximum score on the flexibility indicator.

From the results of the description and analysis carried out by researchers related to student answers, it can be concluded that subject FD_1 is able to show indicators of creative thinking fluency and flexibility so that based on the Level of Creative Thinking Ability according to Siswono (2008), subject FD_1 is categorized as Level 3 of Creative Thinking Ability which contains being able to show indicators of fluency and flexibility in solving problems.

Subject Field Dependent 2 (FD_2)

In the Figure 2, it can be seen that subject FD_2 did not understand the meaning of the problem given well. This can be seen from the answer of subject FD_2 who answered in a way and without completion. The FD_2 subject's answer was written briefly, what was asked was not understood by the FD_2 subject as evidenced by the results of the FD_2subject's interview who answered questions about the purpose of the problem with hesitant answers. Based on the results of the work, subject FD_2 was able to answer with three different answers.

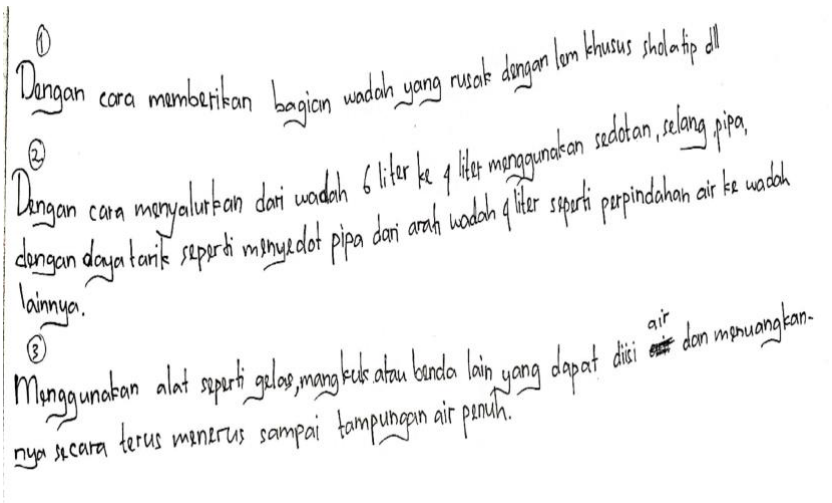

Figure 2. Written answer of Subject FD_2

Based on the answers given by subject FD_2, the indicator of creative thinking shown is flexibility, where other indicators such as fluency are not fulfilled because the subject can provide many different answers but are wrong. While in the novelty indicator students do not show the latest strategies and steps that are relevant and can answer the questions of the given problem. In the flexibility indicator with low scores, namely providing more than one idea that is not in accordance with the meaning of the problem, providing answers without completion. To find out whether or not one of these indicators was actually fulfilled, the researcher conducted an interview. Subject FD_2 said that he had never worked on a problem like the problem before and subject FD_2 said that he did not understand the meaning of the problem.

Based on the in-depth interview, Subject FD_2 in finding the answer did not understand the meaning of the question so that the answer given was not as expected. The results of the FD_2 subject's work have indeed provided many answers but are still not correct, the FD_2 subject did not write the method completely so it is difficult to understand.

When subject FD_2 was asked about other ways besides the method that had been written down, subject FD_2 answered that there were no other answers. When the subject was asked about the answer written down, subject FD_2 replied that he was still unsure of the answer given and also did not understand the answer written down by himself Based on these answers, subject FD_2 did not fulfill the three indicators of creative thinking.

From the results of the description and analysis carried out by researchers related to student answers, it can be concluded that subject FD_2 has not been able to show the three indicators of creative thinking fluency, flexibility and novelty so that based on the Level of Creative Thinking Ability according to Siswono (2008), subject FD_2 is categorized as Level 0 of Creative Thinking Ability, which is not able to show the three indicators of creative thinking in solving problems.

Subject Field Independent 1 ($F1_1$)

From the Figure 3 it can be seen that the FI_1 subject has understood the meaning of the problem given well. This can be seen from the answer of subject FI_1who answered with the solution and completion. The answer of subject FI_1 was written in detail, what was asked was understood by subject FI_1 as evidenced by the results of the interview with subject FI_1 who answered the question about the meaning of the problem with a good answer and explained the meaning of the problem clearly. Based on the results of the work of subject FI_1 was able to answer with six different answers.

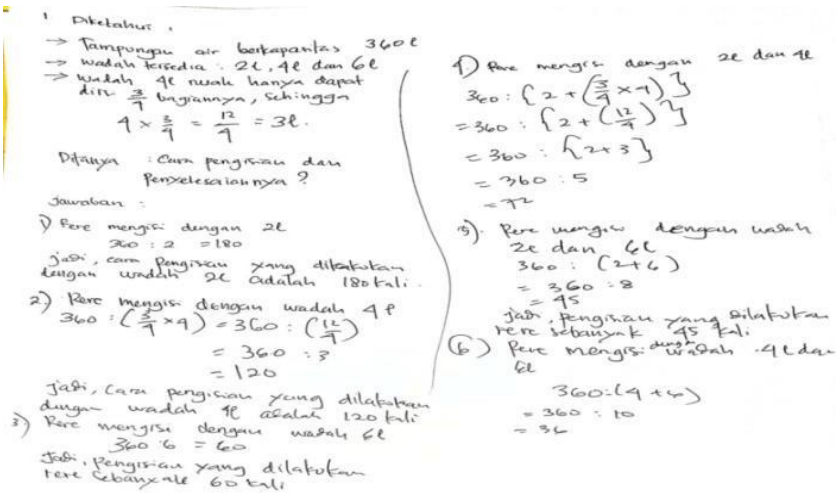

Figure 3. Written answer of Subject FI_1

From the reasons and answers given by subject FI_1, it can be seen that the subject solved the problem well. The indicators of creative thinking shown are fluency and flexibility, where the fluency indicator has been fulfilled because the subject can provide many different answers and is correct. While in the FI_1 subject flexibility indicator provides a different way of solving the problem presented. In the novelty indicator in the work, the FI_1 subject has not shown the latest strategies and steps that are relevant and can answer the questions of the given problem. In the flexibility indicator with a medium score, namely providing more than one idea that is in accordance with the intention of

the problem, the FI_1 subject provides the answer along with the solution. To find out whether or not the two indicators were actually met, the researcher conducted an interview. Subject FI_1 said that he had never worked on a problem like the problem before and subject FI_1 said that he understood the meaning of the problem. Subject FI_1 was able to explain to the researcher clearly how the purpose of the problem given.

Based on in-depth interviews, Subject FI_1 in finding the answer had no obstacles because he understood the meaning of the problem so that the answer he gave was as expected. The results of the FI_1 subject's work have provided many answers correctly, the FI_1 subject wrote the complete method so that it was easy to understand. When the FI_1 subject was asked about other ways besides the way that had been written down the FI_1 subject answered that there were other answers. When the subject was asked about the answer written down, subject FI_1 replied that there was still an answer that he had not written down because he was still in doubt. Based on these answers, subject FI_1 fulfills both indicators of creative thinking fluency and flexibility.

The results of the description and analysis conducted by researchers on the answers of subject FI_1 can be concluded that subject FI_1 is able to show both indicators of creative thinking fluency and flexibility so that based on the Level of Creative Thinking Ability according to Siswono (2008) subject FI_1 is categorized as Level 3 of Creative Thinking Ability which is able to show two indicators of creative thinking, fluency and flexibility in solving problems.

Subject Field Independent 2 ($F1_2$)

Based on the work of the FI_2 subject, it is known that the subject has understood the meaning of the problem given well. This can be seen from the answer of FI_2 subject who answered with the reason along with the solution of the problem (Figure 4.). FI_2 subject's answer was written systematically and sequentially, what was asked was well understood so that FI_2 subject wrote the information given completely. FI^2 subject provides many ways with the solution.

From the reasons and answers given by subject FI_2, the indicators of creative thinking shown are fluency and flexibility, where the fluency indicator has been fulfilled because the subject can provide many different answers and is correct. While in the FI_2 subject flexibility indicator provides a different way of solving the problem presented. In the novelty indicator in the work, the FI_2 subject has not shown the latest strategies and steps that are relevant and can answer the questions of the given problem. In the flexibility indicator with a medium score, namely providing more than one idea that is in accordance with the purpose of the problem, the FI_2 subject provides the answer along with the solution. To find out whether or not the two indicators were actually met, the researcher conducted an interview. Subject FI_2 said that he had never worked on a problem like the problem before and subject FI_2 said that he understood the meaning of the problem.

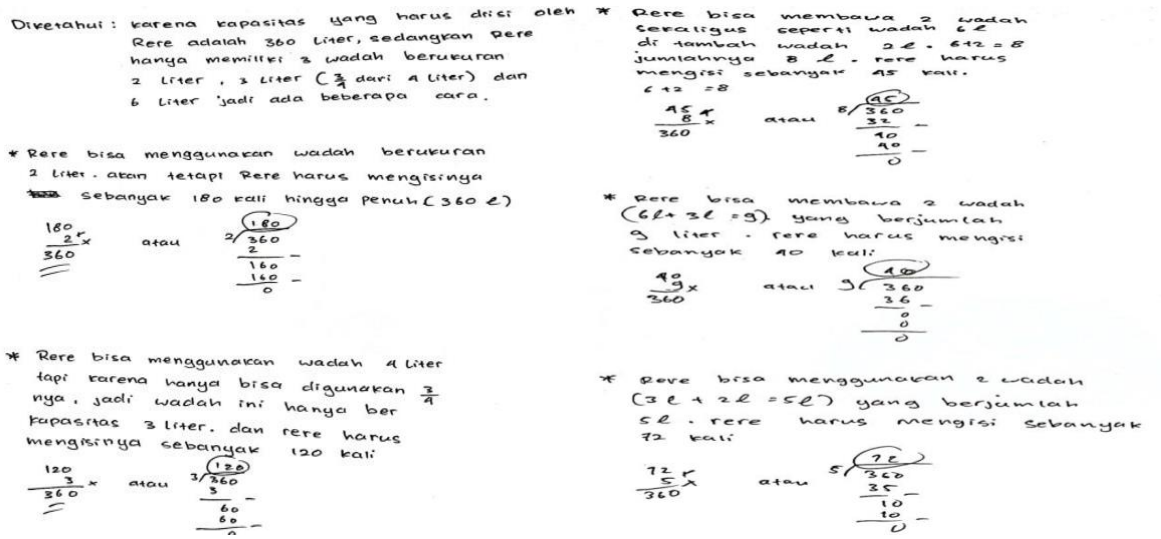

Figure 4. Written answer of Subject FI_2

Based on the in-depth interview, Subject FI_2 in finding the answer had no obstacles because he understood the meaning of the problem so that the answer he gave was as expected. The results of the FI_2 subject's work have provided many answers correctly, the FI_2 subject wrote the method completely so that it was easy to understand. When the FI_2 subject was asked about other ways besides the way that had been written down the FI_2 subject answered that there were still many other answers. When the subject was asked about the answers written down, the subject FI_2 replied that there were many answers that he had not written down because the working time was over. Based on these answers, the FI_2 subject fulfills both indicators of creative thinking.

Conclusion

Based on the research results obtained about the creative thinking process of students in solving integer and fraction operation problems, the results of the description on each creative thinking indicator are obtained, the research subject has not been able to master the novelty indicator. The research subjects have not been able to solve problems that are not usually done at their level of knowledge. In the flexibility indicator, three subjects were able to answer questions with different ways of solving. In the fluency indicator, there were three subjects who answered with different answers and were correct. The three subjects gave answers in more than one way with correct results, but one of the three subjects still did not answer in detail. Of the four research subjects, only one subject has not shown the three indicators of creative thinking.

In accordance with the results of the research obtained from the answers of each research subject, the level of creative thinking of students, namely field independent subjects, are both at level 3, meaning that the subject is able to show fluency and flexibility in solving problems. The first field dependent subject is at level 3 meaning that the subject is able to show fluency and flexibility in solving problems. While the second field dependent subject is at level 0 which means the subject is unable to show fluency, flexibility, and novelty.

Based on the results of the description above, in learning mathematics teachers need to provide treatment that is in accordance with the level of creative thinking of students, so that the potential that exists in students can develop optimally. Teachers should be able to prepare lessons that are in accordance with the level of creative thinking of students. Students are expected to be more active in practicing their creative thinking skills in order to solve the learning problems they face.

Acknowledgement

We would like to thank LPPM UMPO for providing the opportunity to conduct research until the publication of the results of this study.

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