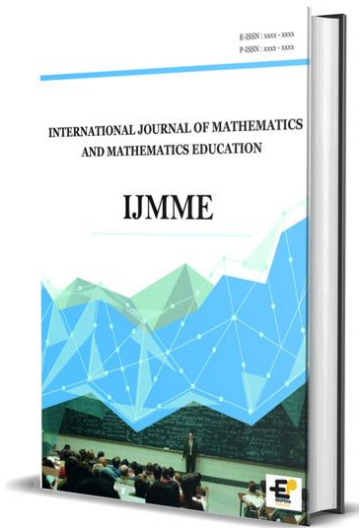

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Analyzing Student Creative Thinking with Wallas Theory

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To cite this article:
Prabandari, Nurhasanah, & Siswanto. (2024). Analyzing Student Creative Thinking with Wallas Theory. *International Journal of Mathematics and Mathematics Education (IJMME), 2*(2), 114-127
https://doi.org/10.56855/ijmme.v2i2.1056

IJMME International Journal of Mathematics and Mathematics Education

June 2024, Vol. 02, No. 02, 114-127 doi: 10.56855.v2i2.1056

Analyzing Student Creative Thinking with Wallas Theory

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Article Info

Article History

Received:
April 31, 2024
Accepted:
Mei 30, 2024

Keywords

Learning style independent,
Creative thinking process,
HOTS,
Wallas's theory

Abstract

Creative thinking can be influenced by students' learning styles, such as Field Independent (FI) and Field Dependent (FD) learning styles. This research aims to describe the creative thinking process of Field Independent learning style students in solving problems with higher-order thinking skills based on the Wallas stages. This qualitative study began by determining student's learning styles using the Group Embedded Figure Test (GEFT) and then selecting three students with Field Independent (FI) learning styles. In this study, subjects with Field Dependent learning styles were excluded due to insufficient data collection. Data was collected using written tests and interviews and analyzed based on Wallas's theory's stages: preparation, incubation, illumination, and verification. Triangulation was used to validate the findings. The results show that students with Field Independent (FI) learning styles exhibit complete characteristics of creative thinking, including fluency, flexibility, and innovation, at every stage. This indicates their capability to think creatively in solving higher-order thinking problems.

Introduction

One of the learning objectives in schools is to instill student's thinking habits, especially creative thinking in dealing with important issues. Creative thinking is an ability based on available data or information to find many possible answers to a problem, where the emphasis is on quantity, effectiveness, and diversity of answer (Munandar, 1999). Systematic problems make students learn to face many challenges in an organized manner, formulate innovative questions, and design appropriate solutions. Students who are able to think creatively fulfill the skills of fluent thinking, flexible thinking, original thinking, and detailed thinking (elaboration) (Munandar, 2014). The thinking process involves the ability to generate original ideas, to understand new and unexpected relation, or to construct unique and improved orders between seemingly unrelated factors (Kargar et al., 2013). The ability to come up with fresh, unique and inventive ideas that have never been explored before is known as creative thinking. A person can innovate and develop new concepts and solutions that were previously

unthinkable using creative thinking. The four characteristics of creative thinking include fluidity, adaptability, originality, and elaboration. (Ghaedi et al., 2014; Saptenno et al., 2019)

Cognitive style is a process or control style that emerges within students which can situationally determine students' conscious activity in organizing, receiving, and disseminating information as well as determining student behavior. Thus, cognitive style can be said to be the way students capture finformation, process information and carry out information in the problem-solving process when learning consistently (Bassey, et al., 2009). Cognitive styles can be divided into several, one of which was discovered by Witkin who identifies and categorizes a person based on the characteristics of continuous comprehensive analysis. Witkin divides cognitive styles into two groups, namely field-dependent and field-independent styles (Witkin, et al., 1977). In this study, researchers are interested in analyzing the creative thinking process on HOTS questions at Muharrikun Najaah Middle School with an independent field learning style.

A process is any change in an object or organism, a change in behavior or psychology, meaning that a process is a change, especially regarding changes in behavior or psychological changes (Chaplin, 2014). Thinking in practice has three meanings, namely: thinking is the activity of exploring formulas, thinking is the activity of interpreting real objects into abstract ones obtained from expressing ideas and images, writing, maps and so on. Thinking is the ability to draw conclusions from facts that have been understood (Purwaningrum, 2016). The thinking process occurs in students' minds when solving problems, so that they can find solutions to mathematical problems. Solving a problem students will practice processing data or processing information, this is called thinking (Herman, 2005). Meanwhile, Yulaelawati said that one of the teacher's roles in learning mathematics is to help students use the processes that are in their minds when solving problems, for example by asking students to tell the steps that are in their minds. For students, expressing their thinking processes is not an easy thing. Positive thinking motivation, self-confidence and good communication skills are needed. Self-confidence can encourage motivation to be able to solve math problems.

Based on the understanding of all those opinions, the researcher concludes that the thinking process is a process or step that begins with receiving data, processing and storing it in memory which is then retrieved from memory if necessary for further processing. Because the thinking process in learning mathematics is a mental activity that exists in students' minds. Therefore, students' thinking processes can be observed through the process of completing tests until results are obtained which are written sequentially and the there is an interview to know how they solve the problems. According to Silver, there are three indicators of creative thinking competence, namely: 1) Fluency is a student who asks questions correctly and has the correct score. 2) Flexibility is a student who can find answers using various techniques and has the right value. 3) Novelty is a student who shows a new way that is different from usual (Richardo, et al., 2014).

The creative thinking process is a stage in how student creativity occurs. One theory of the stages of creative thinking was put forward by Wallas. There are four stages of the creative thinking process based

on Wallas' theory, namely preparation, incubation, illumination, and verification (Sadler-Smith, 2015). These stages are explained as follows (1) in the preparation stage students collect relevant information to solve the problem, (2) in the incubation stage students will temporarily detach themselves from a problem and think about it subconsciously, (3) in the illumination stage students get ideas or thoughts that emerge at the incubation stage, and (4) at the verification stage students test the stage or check the results of the answers (Savic, 2016). Based on this opinion, students' creative thinking processes can be measured using Wallas' theory. Wallas' stages in his book "The Art of Though" are preparation, incubation, illumination, and verification. The stages of the creative thinking process proposed by Graham Wallas consist of four stages, namely preparation, namely this stage, the thinking process will be seen from the start of students receiving questions until students write and state what is asked. Incubation is the stages that will look at students' thinking processes in thinking of ideas to solve problems, illumination is students' thinking processes that will be seen in finding new solutions to problems and information that has been obtained previously. Verification is students' thoughts in reviewing the results that have been written by writing conclusions.

Learning is the process of receiving and processing information into knowledge. This form of psychological perspective suggests that each person has different characteristics in processing information into new knowledge. The characteristics inherent in an individual regarding how to receive and process the information received are called strategies, choices and attitudes which are characteristic of a person in understanding, remembering, and solving problems. Cognitive style has a correlation with intellectual behavior and perception (Hidayat, 2018). Intellectual is a person's ability to think, while perception is a person's ability to perceive well enough. There are two dimensions to cognitive style, field dependent (FD) and field independent (FI). Witkin, Moore, Goodenough and Cox (1975) explained that individuals have elements of context or background context. The characteristics of students who have a field-independent cognitive style are classified as: (1) having the ability to analyze and separate objects from their environment, so that their perception is not affected when the surrounding environment changes; (2) have the ability to organize unorganized subjects and rearrange objects that have been organized independently; (3) tend to be less sensitive, cold, keep their distance from other people, act according to their needs; (4) choose a profession that can be worked on individually with more abstract material or requires theory and analysis; (5) tend to determine their own goals and work but prefer to compete; and (6) tend to work with motivational influences in engineering fields and are more influenced by complex developers.

HOTS (High Order Thinking Skills) is a thinking process that involves mental activity to explore complex experiences. Reflective and creative are carried out consciously to achieve a goal, namely obtaining knowledge that includes analytical, synthesizing, and evaluative levels of thinking. Higher order thinking skills are defined as thinking skills that not only require memory, memorization and understanding skills, but also other better skills. Based on the levels of creative thinking according to Wallas and Silver, the creative thinking process is summarized in the following table.

Table 1. The relationship between Wallas' creative thinking process and the components of creative thinking according to Silver

Creative thinking process according to Wallas	The creative thinking process according to Silver	Information
Preparation		At this stage, the thinking process will be seen starting from students receiving questions until students write and state what they know and what is asked about the subject matter.
	Smoothness	Students explore open-ended problems to create many questions and answer them correctly.
Incubation		At this stage, students' thinking processes will be seen in thinking of ideas to solve problems.
	Flexibility	Students see problems from different points of view, resulting in many thoughts and being able to align with different solutions.
Description		At this stage, students' thinking processes will be visible in finding new solutions to problems and material that has been obtained previously.
	Novelty	Student competence in providing different solutions to their friends and having the right values.
Verification		At this stage, students' thinking processes will be visible in reviewing the results they have written by writing their conclusions.

According to Silver, there are three indicators of creative thinking competence, namely: 1) Fluency is a student who asks questions correctly and has the correct score. 2) Flexibility is a student who can find answers using various techniques and has the right value. 3) Novelty is a student who shows a new way that is different from usual (Richardo, et al., 2014). based on Wallas' theory, namely preparation, incubation, illumination, and verification (Sadler-Smith, 2015). The preparation stage, namely the thinking process stage, will be seen from the beginning of students receiving questions until students write and state what is asked. Incubation is the stages that will look at students' thinking processes in thinking of ideas to solve problems, illumination is students' thinking processes that will be seen in finding new solutions to problems and information that has been obtained previously. Verification is students' thoughts in reviewing the results that have been written by writing conclusions.

Method

Based on the research objectives, the form of this research is qualitative research, while this method is descriptive. This research was conducted at Muharrikun Najaah Junior High School on 10-24 January

2024 in the even semester of the 2023/2024 academic year. The class of research subjects taken was class 8. Totaling 30 students at Muharrikun Najaah Junior High School. Taking research subject using convenience sampling technique. First, the researcher determined Field Independent (FI) student with GEFT test and then the subjects selected in this study were three students with Field Independent (FI) learning style. students who have been selected as research subjects are given a creative thinking test in form of higher order thinking problems. The answers presented by the students were then analyzed based on the indicators of the creative thinking process according to Wallas's theory.

Table 2. GEFT Test Results

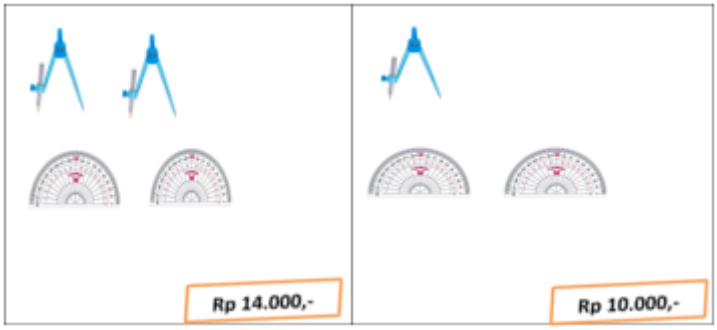
Mark	Learning style	Amount	Percentage
$0 \leq mark \leq 9$	Field Dependent (FD)	13	43,33 %
$10 \leq mark \leq 18$	Field Independent (FI)	17	56,67 %

This research was conducted in three stages, namely: planning, implementation, and completion stages. The planning stages include submitting topics, preparing proposals, compiling instruments, licensing, and testing instruments which are carried out in the range of November to December 2023. The implementation stages of research activities include giving GEFT test for classifying learning styles, creative thinking test with higher order thinking problems, interviews, and observations carried out in January 2024. The completion stages include data analysis activities and preparation of research reports which are carried out in the range of February to Maech 2024.

Table 2. Instrument Test

<table>
<tr><th>Question Number</th><th>Question</th></tr>
<tr><td>1</td><td>Ana is a student who has just graduated from junior high school. Next, Ana wants to enrol in one of her favourite high schools in her city. The high school entrance selection uses a written test consisting of 25 questions. Ana will get 4 points for every question she answers correctly and will get -1 points for every question she answers wrong. The scoring system for this selection is correct times 4 then minus the number of incorrect questions. Determine the minimum number of questions that Ana must answer so that she can pass the selection!</td></tr>
<tr><td>2</td><td>Ani, Budi, and Cita buy prayer equipment. Ani wants to buy a mukena, Budi wants to buy a prayer mat, and Cita wants to buy prayer beads. The three of them bought at three different stores. Below are details of the shopping activities of the three of them:
<table>
<tr><th>Who (Mukena)</th><th>Budi (Sajadah)</th><th>Cita (Tasbih)</th></tr>
<tr><td>Ani bought 2 direct mukena and 1 cut mukena, she handed over three Rp. 100,000.00 bills and got Rp. 15,000.00 in return.</td><td>Budi bought 1 Turkey brand prayer mat and 1 Mecca brand prayer mat by paying the exact amount of IDR</td><td>Cita bought 2 green prayer beads and 2 red prayer beads for IDR 90,000.00. Three days later he bought another 2 green prayer</td></tr>
</table></td></tr>
</table>

Question Number	Question
	Two days later he bought another direct mukena and 2 cut mukenas then handed over IDR 270,000.00 without change. 95,000.00. A week later he bought 2 Turkey-brand prayer mats and 1 Mecca-brand prayer mat and got IDR 10,000.00 back because his money was IDR 150,000.00. beads and 1 red prayer beads for IDR 70,000.00. If Deni also wants to buy 3 different prayer equipment for Rp. 150,000.00, then determine what items Deni will get?
3	Eni wanted to buy some stationery at her school cooperative, Mother then gave Eni IDR 15,000.00. Based on the price information in the image below, arrange a table for Eni's purchase list along with the prices, provided that there is no money left over. 

Question Number	Question
	

The instruments in this research were carried out through expert assessment. (Assessment carried out by experts). Data analysis techniques are used in three stages, namely data reduction, data presentation, and drawing conclusions. (Sugiyono, 2016). Validation and validation of data in this research was carried out using triangulation techniques. The technique used in this research is to compare data collected using test and interview methods.

Results

Creative thinking skills have a very important role in various aspects of life. By thinking creatively, we can generate new ideas, create innovative solutions, and face challenges in various ways. The results of the research analysis of students' creative thinking processes are described in the paragraph below.

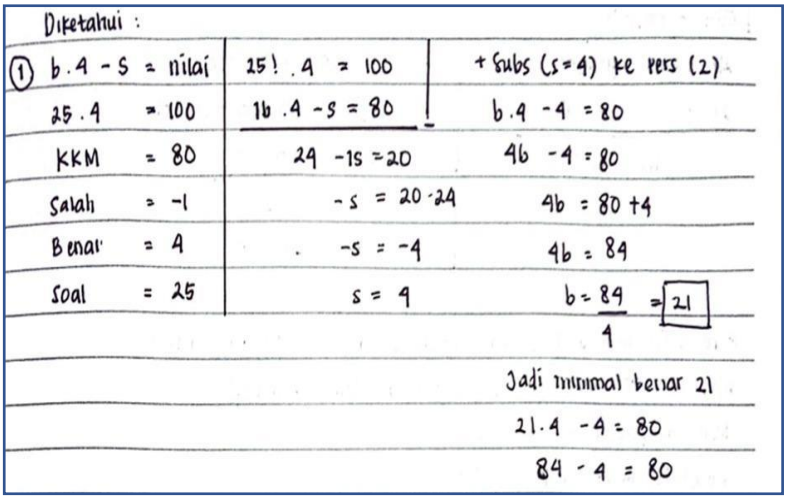


Figure 1. FI-1 Subject Answers

As stated by Siswono (2011), fluency in solving mathematical problems was seen from the ability of students to give many correct answers. Based on the results of subject FI-1's answers, the fluency category was met as seen from a student's answer who could solve the problem. the creative thinking process at the preparation stage was seen to understand the problems in the subject in detail and was able to communicate the information contained in the material in his own language, which was seen

from FI-1 writing down information about the material using previous knowledge and then writing as much information as is available. In line with Puspitasari (2019), F1 showed that students collected the information obtained to complete. In the incubation stage, students stop for a moment to understand the problem and immediately think about how to solve the problem using the material they have studied. It meant that F1 could find new ideas by combining several previously known ideas (Edgar, Faulkner, &Franklin, 2008). FI-1 writes what is known in the material into a linear form of two variables. The system of equations is then solved by elimination and substitution to obtain the minimum questions that must be answered to pass. F1 experienced the verification phase by applying new ideas found at the incubation stage and the previous illumination stage (Bahrudin & Siswono, 2020). Illumination, students solve problems confidently according to the material they study, in a variety of ways. Verification, students can provide conclusions from the problems given and students try to correct them in the right direction.

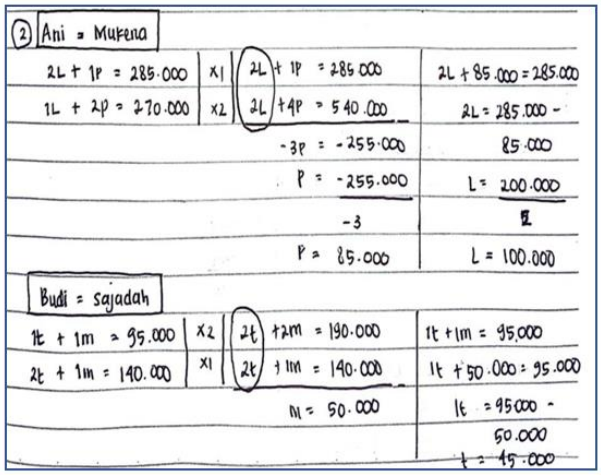


Figure 2. FI-2 Subject Answers

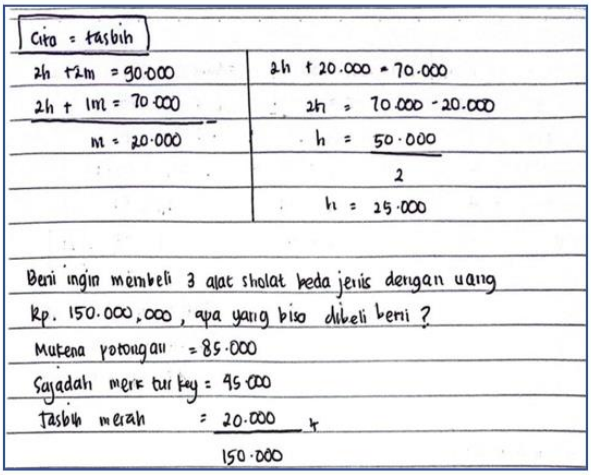


Figure 3. FI-2 Subject Answers

Based on the results of the written answers in Figure 2 and FI-2 observations at the preparation stage, it appears that the subject understands the problems in the questions in detail and can communicate the information contained in the questions in his language, can write and understand what information is needed to solve the questions, it turns out FI-2 can create a mathematical model from what is given in the problem and then arrange it into a system of linear equations in two variables according to the material studied previously. The FI-2 incubation stage, seems to stop for a moment in understanding the problem and immediately think about how to get a solution to the problem using previously studied material, evaluating the information that will be used as a basis for determining the method. At this stage, it might take a few second, minutes, or hour depending on the problem's difficulty (Maharani, Sukestiyarno, &Waluya, 2017). The solution that will be used, looks like FI-2 describes the items purchased by Ana, Budi, and Cita. What Ana and Budi bought were each arranged into two linear variable equations. FI-2 understands that there are 2 linear labeling variables so that it becomes a system of two linear equations. At the illumination stage, FI-2 aims to apply problem solving methods by solving problems confidently according to the material in the problem, but FI-2 is only able to solve problems in one way, namely the elimination-substitution method.

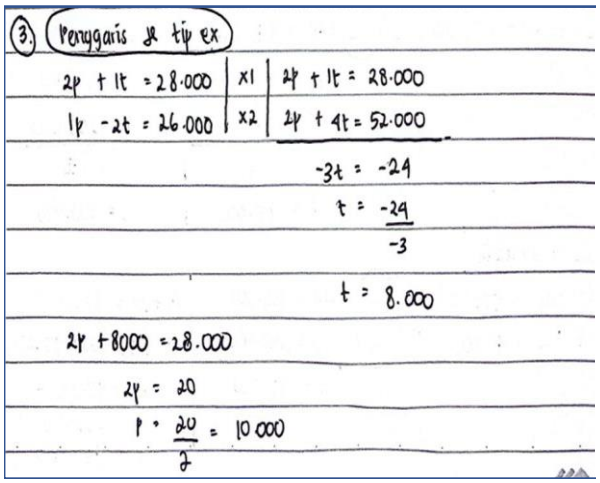


Figure 4. FI-3 Subject Answers

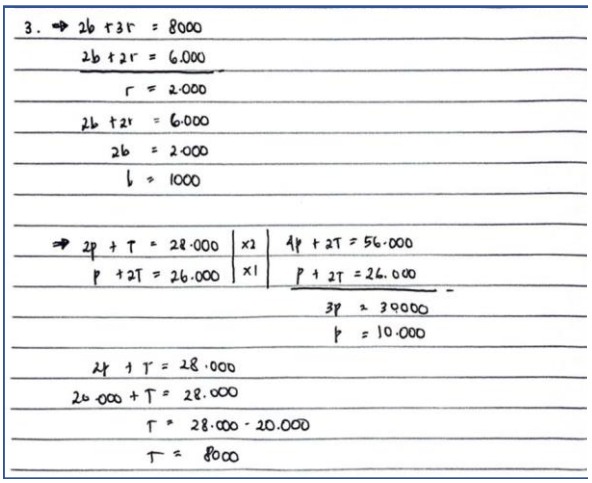


Figure 5. FI-3 Subject Answers

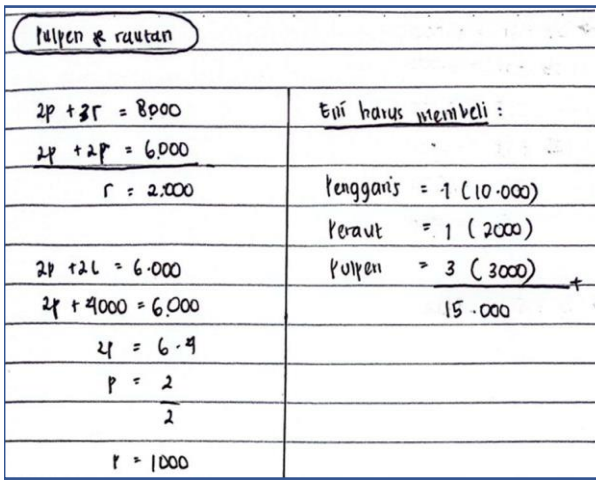


Figure 6. FI-3 Subject Answers

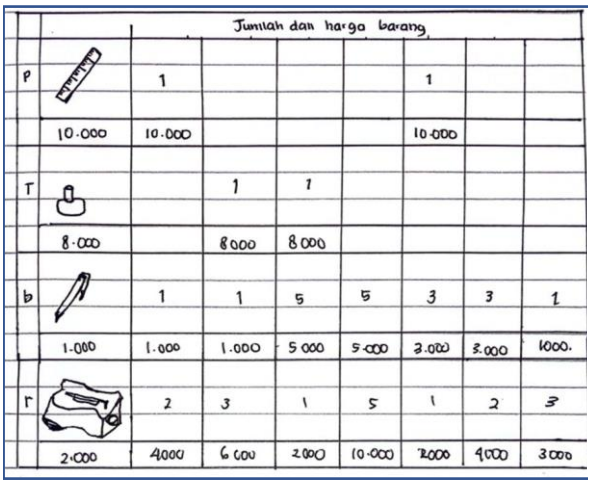


Figure 7. FI-3 Subject Answers

Based on the results of the written answers in Figure 3 and FI-2's observations at the preparation stage, it can be seen that FI-3 understands the problem in question in detail and can convey the information contained in the question in his language. Experience solves the problems in the past was associated with problems encountered and contributed to decision making in preparing the problem-solving process. This statement was consistent with the assumption that there was coordination between learning experience and thought processes (Airasan, Cruikshank, & Mayer, 2001). At the fi-3 incubation stage, it seems that you stop for a moment in understanding the problem and immediately think about how to get a solution to the problem using the material that has been studied previously, evaluating the information that will be used as a basis for determining the method. to solve the problem. He/she experienced the incubation stage every time he/she wanted to draw a new form so that in one problem-solving process, the incubation stage repeatedly occurred (Guilford, 1979). In the illumination phase, FI-3 also applies ways of solving problems confidently and can solve problems in various ways. FI-3 can respond using three ways: elimination, substitution, and a mixture of both. At the verification

stage, FI-3 seems to have been able to draw conclusions and review the solution to the mathematical problem, FI-3 tries to improve it on the right, then list any purchases that cost a total of 15,000.

Discussion

After analyzing the results of written tests and observations and supported by interviews, it can be concluded that subject FI-1 is able to explore open problems to create lots of questions and answers correctly in solving HOTS problems. And the creative thinking process is also complete: preparation, incubation, illumination, and verification. Then FI-1 subjects fulfill the Fluency, Flexibility, Novelty indicators. The researcher tried to ensure validation of the findings of FI students' descriptions, so that the second research subject was required to explore the descriptive data of the creative thinking process of FI's cognitive style so that the findings from the data obtained were identical and it could be said that the data was saturated.

After analyzing the results of written test data collection and observations and supported by interviews, it can be concluded that FI-2 subjects are able to see problems from various points of view so that they produce many thoughts and can respond in various ways. problem solving and creative thinking processes are also complete. On preparation, incubation, lighting. FI-2 courses meet the Fluency, Flexibility and Novelty indicators. Researchers have not seen and confirmed the validity of the descriptive data findings of FI-2 students at the verification stage, so the third research subject is required to explore the cognitive style thinking process until the data findings are stated. become bored.

After analyzing the results of written tests and observations and supported by interviews, it can be concluded that FI-3 subjects are able to see problems from various points of view, resulting in many thoughts to answer in different ways in solving HOTS problems. In the creative thinking process FI-3 meets the indicators of preparation, incubation, illumination, and verification so that FI-3 is said to meet the indicators of novelty.

Researchers can show the validity of FI students' findings at the preparation, incubation, illumination, and verification stages. The research subject was stopped at the third subject because the information or data obtained was saturated, meaning that the information provided by the research subject was like other research subjects.

Table 3. Field independent students' creative thinking process on HOTS issues

Subject	Preparation	Incubation	Description	Verification
FI-1	Visible	Visible	Visible	Visible
FI-2	Visible	Visible	Visible	Visible
FI-3	Visible	Visible	Visible	Invisible

Based on the description above, it can be concluded that students with a field independent learning style from the beginning of the preparation process do not encounter many significant difficulties, students with a field independent learning style are able to solve questions correctly. These results are in accordance with Maharani (2017) who stated that students in the high category from the preparation stage did not encounter many difficulties. This is in line based on research by (Prabawa & Zaenuri, 2017) concluded that student with Field Independent cognitive style students tend to have problem solving abilities better that Field Dependent cognitive style students. They understand the mathematical problem given and what is required, they know that all the information in the problem can be used to solve the problem and the answers given are relatively correct. Albab (2021) states that the thinking process of students with a field independent cognitive style is active in acting, this is shown during the test and interview process, field independent students can immediately get a solution after knowing the problem presented in the question in detail and precisely based on their own thinking. Independent cognitive style students tend to think creatively, which means that students with this cognitive style think in solving HOTS problems can solve it in various ways. Students who have a field independent cognitive style are critical (Yousefi, 2011). This is supported by research of (Agoestanto & Sukestiyarno, 2017) the result showed that the ability of mathematics critical thinking students with Field Independent cognitive style is better than Field Dependent cognitive style on the ability of inference, assumption, deduction, and interpretation.

Conclusion

Students with an independent cognitive style at the creative thinking process stage at the field preparation stage, independent students tend to understand the problems in the questions in detail and can communicate the information contained in the questions in their own language. At the incubation stage, students tend to stop for a moment to deepen the problem and immediately think about how to answer questions using the material they have studied previously. In the illumination phase, students apply problem solving methods with the belief that they solve them according to the problem material and can solve them in various ways. Verification is a re-examination of mathematical problem solving, students try to correct it until it is correct.

Students with an independent field learning style seen in the creative thinking process can reach the stages of the preparation, incubation, illumination, and verification processes. In the case of HOTS, it can complete the analysis, evaluation, and creation levels. So, the components of creative thinking reach the level of fluency, flexibility, novelty. This means that independent field style students tend to understand questions in detail and describe variations in problem solving, can solve them in many ways, and can review written answers. The thinking process of students with an independent field style is also active in action. This is shown during the test and interview process. Students who have independent fields can quickly obtain solutions after studying the problems presented in the questions in detail and accurately based on their own thoughts. Students who are field-independent tend to think creatively, meaning students with this cognitive style think in solving HOTS problems.

Recommendations

The research findings indicate that there are two types of cognition: field dependent and field independent. When explaining the topic of HOTS, students using the dependent cognitive style tend to be more global in their thinking and less variable than those using the independent cognitive style, which tends to be more detailed and can provide a multitude of solutions. Based on these results, the teacher will be able to take an active role in helping the students' cognitive abilities. The teacher will give advice and guidance to the students regarding goal setting and strategy that might help them in the process of developing their creative thinking. In addition, teachers can implement learning activities that enhance students' motivation using field-dependent cognitive processes, such as utilizing dialogues with students to help them understand problems clearly. This can cause students to feel more eager to learn and more motivated to learn.

Acknowledgements or Notes

The researcher would like to thank the member of editorial of IJMME extend the gratitude to all of reviewers who have contribute to the peer review process of the manuscript in this issue and for all parties who have helped in the research process, especially the 8th grade students at MTs Muharrikun Najaah and the research instrument validators.

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