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Creative Thinking Processes in Contextual Problem Posing Based On Adaptive And Innovative Cognitive Styles

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ABSTRACT

This study aims to describe the creative thinking processes of junior high school students in posing contextual mathematical problems of social arithmetic material with cognitive styles. A qualitative descriptive approach was employed. The subjects were two eighth-grade students with equivalent mathematical abilities but different cognitive styles, identified through a cognitive style questionnaire and a mathematics ability test. Data were collected using post-solution problem-posing tasks, video-based observations, and semi-structured interviews. The analysis focused on students' creative thinking processes with indicators of fluency, flexibility, and originality through four stages: preparation, incubation, illumination, and verification. The findings show that both adaptive and innovative students experienced all stages of the creative thinking process. In the preparation stage, students were able to understand and solve the initial problem. During incubation, ideas emerged from the given information, prior knowledge, and personal experiences, accompanied by revisions of initial ideas. In the illumination stage, both students demonstrated fluency and flexibility in posing contextual problems, while originality appeared in problems that modified perspectives or objectives beyond routine calculations. Differences were observed in the characteristics of the posed problems. The adaptive student tended to develop problems within existing structures, whereas innovative student was more inclined to modify conditions and generate less structured problems. In the verification stage, both students rechecked the logic, numerical accuracy, and solutions of the posed problems. These findings indicate that there are differences in the characteristics of students' creative thinking processes in posing contextual mathematical problems in different cognitive styles.

Keywords**:** *creative thinking process; problem posing; cognitive style; social arithmetic; junior high school*.

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ABSTRAK

Penelitian ini bertujuan untuk mendeskripsikan proses berpikir kreatif siswa SMP dalam pengajuan masalah matematika kontekstual dengan gaya kognitif adaptif dan inovatif pada

materi aritmatika sosial. Penelitian ini menggunakan pendekatan kualitatif deskriptif. Subjek penelitian adalah dua siswa kelas VIII yang memiliki kemampuan matematika tinggi yang setara tetapi berbeda gaya kognitif, yang ditentukan melalui angket gaya kognitif dan tes kemampuan matematika. Data dikumpulkan melalui tugas pengajuan masalah tipe post-solution, observasi berbantuan rekaman video, dan wawancara semi-terstruktur. Analisis data difokuskan pada proses berpikir kreatif siswa dengan indikator kelancaran, keluwesan, dan kebaruan yang meliputi tahap persiapan, inkubasi, iluminasi, dan verifikasi. Hasil penelitian menunjukkan bahwa siswa bergaya kognitif adaptif dan inovatif melalui seluruh tahapan proses berpikir kreatif. Pada tahap persiapan, siswa mampu memahami dan menyelesaikan masalah awal. Pada tahap inkubasi, ide pengajuan masalah muncul dari informasi pada soal awal, pengetahuan sebelumnya, dan pengalaman pribadi, disertai perubahan ide. Pada tahap iluminasi, siswa menunjukkan kelancaran dan keluwesan dalam mengajukan masalah kontekstual, sedangkan kebaruan tampak pada masalah yang mengubah sudut pandang atau tujuan soal. Perbedaan karakteristik terlihat pada pengembangan masalah, di mana siswa adaptif cenderung mengembangkan masalah dalam struktur yang ada, sedangkan siswa inovatif lebih berani memodifikasi kondisi. Pada tahap verifikasi, siswa memeriksa kembali logika, perhitungan, dan solusi masalah yang diajukan. Temuan ini menunjukkan bahwa terdapat perbedaan karakteristik proses berpikir kreatif siswa dalam pengajuan masalah matematika kontekstual pada gaya kognitif yang berbeda.

Kata Kunci**:** *proses berpikir kreatif; pengajuan masalah; gaya kognitif; aritmatika sosial; siswa SMP.*

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1. Introduction

Creative thinking is a skill that individuals need in the 21st century (Trilling & Fadel, 2009). In order to reach the highest level of Bloom's revised taxonomy, namely creating (Anderson & Krathwohl, 2001; Wilson, 2016). An effective activity for developing students' creativity in mathematics is problem posing (Ayvaz & Durmuş, 2021). Problem-posing-based learning is more effective in developing creative thinking skills than contextual or expository approaches (Toheri et al.,2020). Therefore, the development of creative thinking skills to produce the resources needed in the 21st century can be done through problem-posing-based learning.

In problem posing, there are three forms of mathematical cognitive activity, namely: (a) pre-solution posing, (b) within-solution posing, and (c) post-solution posing (Silver, 1994). Pre-solution posing occurs when a person generates an original problem from a given stimulus situation. Within-solution posing occurs when a person reformulates a problem while it is being solved. Post-solution posing occurs when a person modifies the objectives or conditions of a solved problem to generate a new problem.

Several things to note regarding problem posing are that students' problem posing performance is highly correlated with their problem-solving performance (Silver, 1996; Ponte & Henriques, 2013), and that students' creativity can be further explored through the process of

modifying the initial problem conditions (Brown & Walter, 2005; Cifarelli & Cai, 2005). Based on this, this study uses the post-solution posing method, in which students are first asked to solve the given problem, then formulate a new, similar problem.

The approach chosen by individuals to solve a problem is influenced by variations in individual cognitive styles (Kirton, 2011; Lamm & Telg, 2015). In problem solving, there are problem-solving activities, so the approach chosen will affect the creative thinking process in problem solving. These cognitive styles are adaptive and innovative cognitive styles (Stum, 2009). Adaptive cognitive style is an individual's tendency to solve problems using common methods. Innovative cognitive style is an individual's tendency to solve problems using methods that differ from common methods.

Adaptive and innovative cognitive styles are possessed by everyone and emerge in any situation involving creativity, problem solving, and decision making (Kirton, 1976). Thus, differences in cognitive styles also influence students' creativity levels, especially in problem-posing activities. Therefore, to determine the extent of the influence of adaptive and innovative cognitive styles on students' creative thinking processes in problem posing, research is needed to describe the creative thinking processes of students with adaptive and innovative cognitive styles in posing contextual mathematics problems.

In previous studies, research on creative thinking has been conducted in the form of processes (Cahyati and Siswono, 2022; Suprapti et al., 2024), abilities (Rahayuningsih et al., 2021; Ayvaz et al., 2021; Winarso et al., 2020; Kharisudin et al., 2022; Maharani et al., 2018) and mathematical skills, namely the creative thinking process in problem solving (Cahyati and Siswono, 2022; Rahayuningsih et al., 2021; Suprapti et al., 2024), the creative thinking process in problem posing (Ferdiani & Khabibah, 2022; Bonotto & Santo, 2014) and creative thinking processes in proving (Waluya, 2020; Nuha et al., 2018). The focus of this study is the creative thinking process in problem posing. This is important because problem posing activities are beneficial for improving creative thinking skills (Winarso et al., 2020; Iswanto 2022). To date, the creative thinking process in problem-posing has been studied by Nuha et al. (2018) using the Wallas problem-posing stages, and by Ferdiani & Khabibah (2022) from the perspectives of activist, pragmatist, theoretician, and reflector learning styles. However, no research has been found that examines this using the Wallas stages in relation to Kirton's cognitive styles. To address this gap, research to which limits understanding of how ideas evolve.

This research is expected to contribute to additional reference sources for other researchers working on similar topics, and to serve as material for evaluation and consideration in learning to plane aimed at developing creative thinking skills, which are among the skills needed in the 21st century. Well-planned learning that meets the needs of the times is expected to be the first step in producing the desired human resources. Based on the above background, this study aims to describe students' creative thinking processes in solving contextual mathematical problems from the perspective of cognitive styles (adaptive and innovative).

2. Method

In line with the study aims, a qualitative approach was used, which assesses the quality of a phenomenon by examining the process in depth and repeatedly to produce a better understanding (Aspers & Corte, 2019). The type of research used in this study is descriptive research. The research subjects were eighth-grade junior high school students in the 2024/2025 academic year. The subjects were determined based on the results of a cognitive style questionnaire and a mathematics ability test. The research subjects selected were two students with different cognitive styles (adaptive and innovative) who had equivalent (high) mathematical abilities and were of the same gender. The choice of adaptive and innovative

cognitive styles is due to the fact that each person possesses these cognitive styles and emerges in any situation involving creativity, problem solving, and decision making (Kirton, 1976). Thus, these differences in cognitive styles also influence students' levels of creativity, particularly in problem-posing activities.

The instruments used were the main instrument (the researcher himself) and supporting instruments (cognitive style questionnaire, mathematics ability test, and problem-posing task). Cognitive style questionnaire used to classify students into two cognitive style groups (adaptive and innovative) and consisting of 9 items on a scale of 1 to 9. Mathematics ability test sheet used to group students into three categories of mathematical ability (high, medium, low) and consisting of 4 essay questions to be completed in 60 minutes. Then, two students with high mathematical ability but different cognitive styles were selected for this study. Problem-posing task sheet consisting of two essay questions (a series of post-solution type problems) was to be completed in 120 minutes. During the completion of the task, the subjects were documented through video recordings, the results of which would be further observed to determine the students' creative thinking processes. (4) Interview guidelines were used to interview the research subjects in a semi-structured manner after completing the questions to confirm things that did not appear from the results of the students' work on the problem-posing Task. All interview activities were recorded using voice recording devices and the results were analyzed to explore data on students' creative thinking processes in problem posing.

The research instrument was validated by two lecturers who are experts in thinking processes and problem development, as well as one mathematics teacher. Validation was conducted to ensure the validity of the instrument. This study also used time triangulation to ensure data reliability and the validity of the research findings. Time triangulation aims to examine data from the same source at different times or in different situations (Sugiyono, 2013). Time triangulation was conducted in two stages, with a minimum interval of seven days between each stage. In the first stage, subjects were asked to complete TPM-1. Interviews were then conducted to gain a deeper understanding of students' creative thinking processes when posing mathematical problems. In the second stage, research subjects were asked to perform similar steps when given TPM-2.

Research data analysis was conducted following these guidelines, with cognitive style grouping based on AI-W questionnaire scores presented in Table 1 (Xu & Tuttle, 2012).

Table 1. Cognitive Style Categories

Total Questionnaire Score (s)	**Cognitive Style Groups**
$9 \leq s \leq 44$	Adaptive
$45 < s \leq 81$	Innovative

The grouping of students' mathematical abilities is presented in Table 2 (Ratumanan, & Laurens, 2006).

Table 2. Mathematical Ability Category

Category	Value Range
Low	$0 \leq test\ score < 60$
Medium	$60 \leq test\ score < 80$
High	$80 \leq test\ score \leq 100$

The results of the students' problem-solving assignments will be analyzed based on indicators of creative thinking in solving contextual mathematics problems in Table 3.

Table 3. Indicators of Students' Creative Thinking Processes in Contextual Mathematics Problem Posing

Creative Thinking Stage	Problem Posing Stage	Description	Code
Preparation Stage	Understanding the initial problem and its solution	• Students identify what is known and what is being asked in the problem-posing Task.	P1
		• Students explain the process of understanding the problem, such as underlining the information needed to solve and pose the problem, reading the problem-posing Task repeatedly, highlighting the information needed to solve and pose the problem, observing the instructions and information in the images in the problem-posing task, and so on.	P2
		• Students rephrase the meaning of the question in the problem-posing task in their own words.	P3
		• Students solve the initial problem given in the problem-posing Task.	P4
Incubation Stage	Planning to create a new issue	• Students explain the connection between the information provided in the initial problem and their knowledge to get ideas for proposing problems.	K1
		• Students explain the process of coming up with new ideas for proposing problems.	K2
		• Students get ideas for proposing problems.	K3
Illumination Stage	Creating new problems	• Students can create many contextual mathematical problems (Fluency).	M1
		• Students can pose many contextual math problems with different categories (Flexibility).	M2
		• Students can pose unique, unusual contextual math problems that few students can do (Originality).	M3
	Solving new problems	Students can solve the problems presented.	M4
Verification Stage	Double-check	• Check the proposed mathematical questions (problems).	V1
		• Check the numbers in the proposed mathematical questions (problems).	V2
		• Check the wording of the proposed mathematical questions (problems).	V3
		• Check the answers to the proposed mathematical questions (problems).	V4

To reveal things that could not be seen from the students' written test results and video observation results during the assignment, semi-structured interviews were conducted using the interview guidelines in Table 4.

Table 4. Interview guidelines

The Process of Creative Thinking in Problem Posing	Sample Interview Questions
Preparation Stage	What do you understand from the question? What are the instructions or tasks given in the question? What do you do to understand the meaning of the question? Explain the solution you have used!
Incubation Stage	Explain where you got the idea to create that question. Explain how you came up with the idea to ask that question.
Illumination Stage	Explain the purpose of the question you are asking!

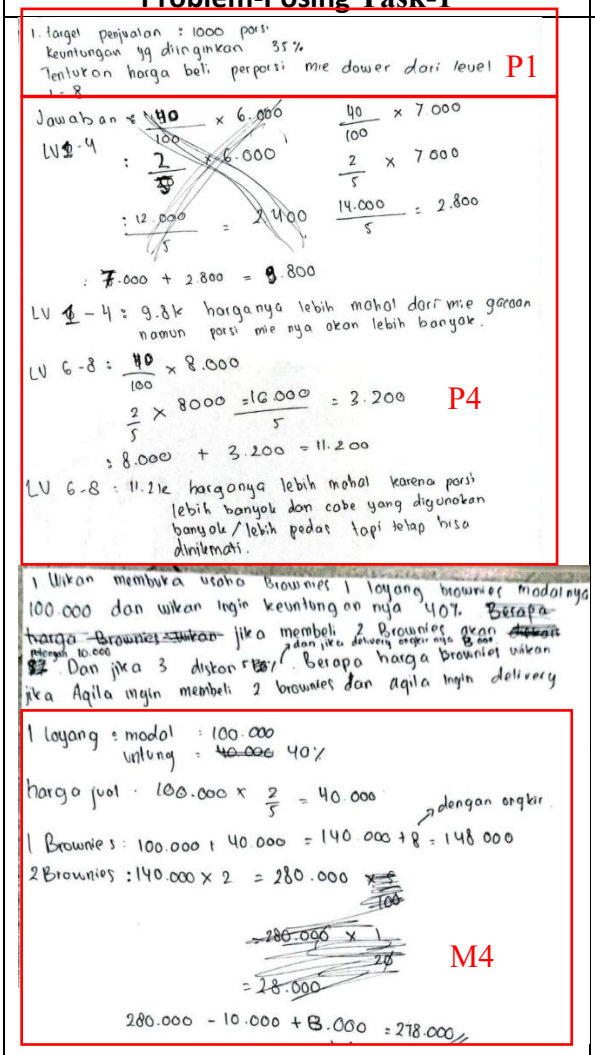
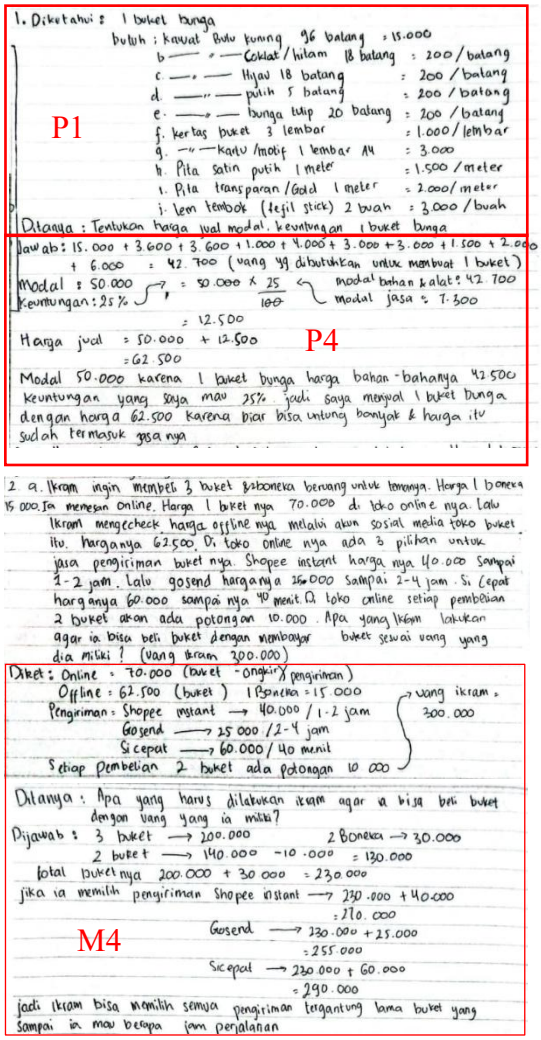
The Process of Creative Thinking in Problem Posing	Sample Interview Questions
Verification Stage	Explain the solution to the problem you have raised! Did you double-check the problem you raised and its solution? How do you double-check the problems you raise and their solutions?

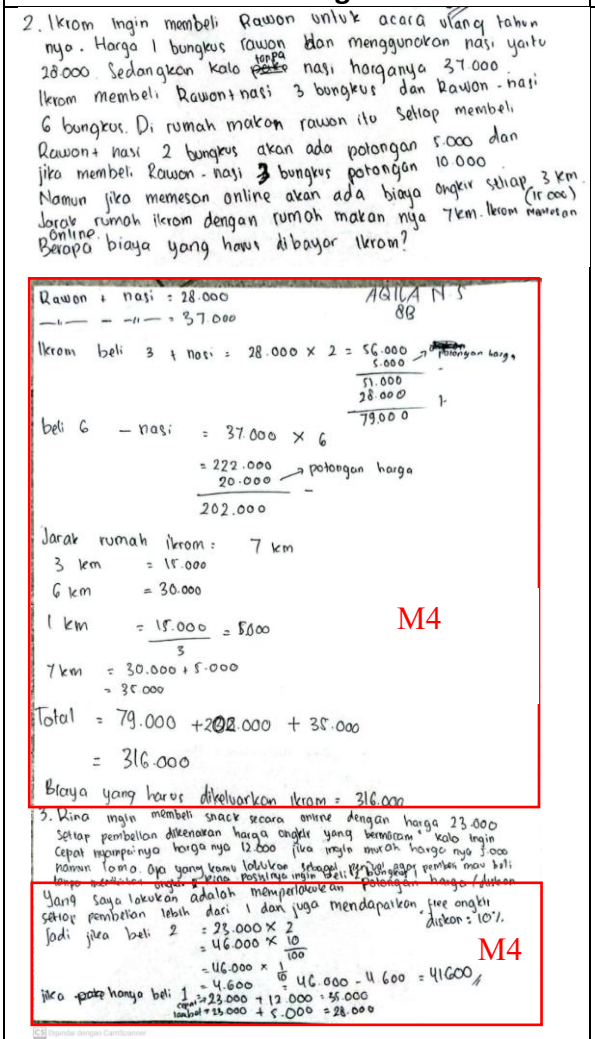
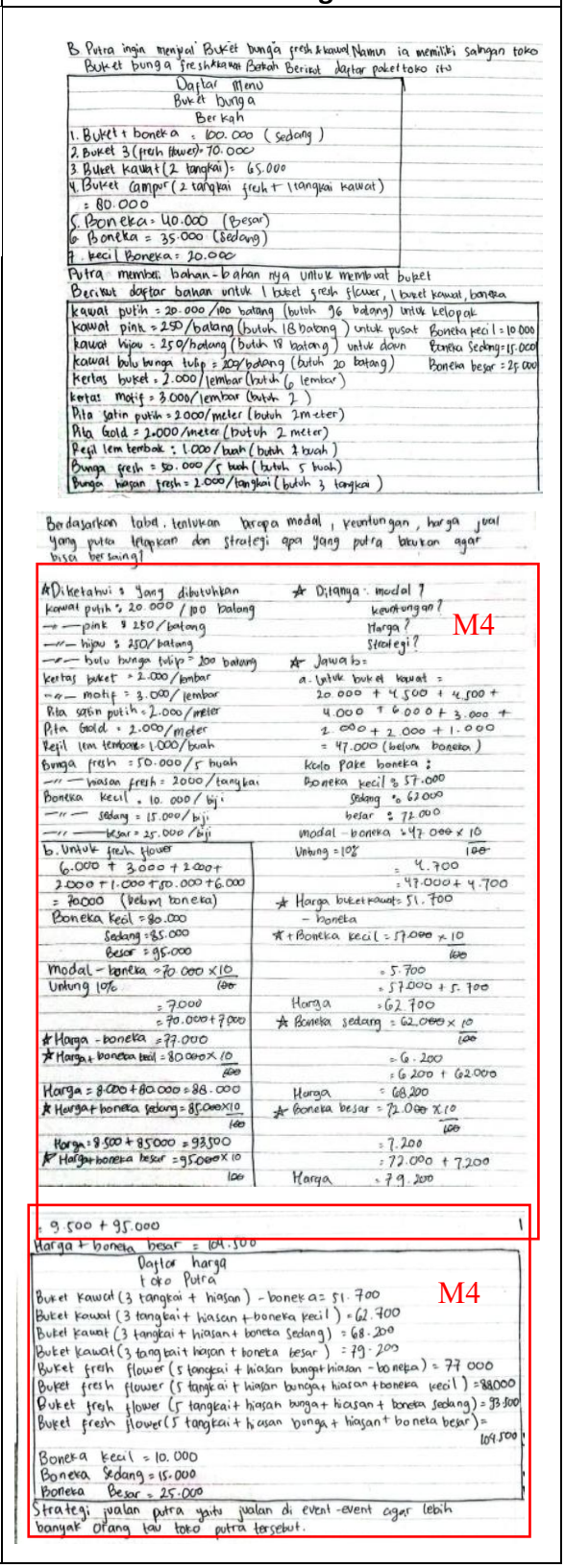
3. Result and Discussion

3.1 Adaptive Student's Creative Thinking Process in Problem-Posing Tasks

The problem submission test was conducted twice to observe the consistency of the adaptive student's work results to ensure the validity of the research findings. The results of the students' work are shown in Table 5.

Table 5. Adaptive Student's Creative Thinking Process in Problem-Posing Tasks

Problem-Posing Task-1	Problem-Posing Task-2
	

Problem-Posing Task-1	Problem-Posing Task-2
	

In the preparation stage, problem posing Tasks 1 and 2, the adaptive subject can identify what is known and what is being asked, as shown by the results of the student' work. An adaptive subject can explain the process of understanding the problem by reading it repeatedly

3-4 times in Task-1 and twice in Task-2. According to Septyanggraeni's (2023) research, students with adaptive cognitive styles can determine the known and asked elements of a given problem. An adaptive subject can explain the meaning of the questions in both problems in their own words and can solve the initial problems given in the problems, as evidenced by the student' work and interview. This is in line with the research by Puspita & Kurniasari (2025), which states that adaptive subjects, in understanding problems, can explain the meaning of the question in their own words. Thus, the adaptive subject performed well in this preparation stage.

In the incubation stage, in problem posing Task-1, the adaptive subject explained that the idea used to pose problem number 1 was based on their experience of selling brownies, but the price used in the question was different from the price of the brownies they had sold. Then, from question 1 of problem posing Task-1, students were inspired to change their profit percentage. Then, for problem posing number 2, the subject adaptive got the idea from her experience of subscribing to rawon near her house and the application of discounts and shipping costs. The price of rawon that she used in problem posing number 2 was not inspired by problem-posing Task 1 number 1, but from her personal experience of making purchases at the rawon restaurant. The subject adaptive also explained that she wanted to develop a problem that had more than one answer (open-ended), like problem posing number 3 that she submitted, but she had doubts because she thought it would be complicated to solve the problem. For problem posing number 3, subject adaptive suddenly had an idea after waking up. The adaptive subject also explained that the application of discounts was based on consumer interest, namely Rina's desire to continue buying snacks at the store, without considering whether the application of discounts would result in a loss or not.

In problem posing Task-2, the adaptive subject explained that the idea used to pose problems was inspired by problem posing Task-2 number 1. Adaptive subject were inspired to take the context of selling buckets. Then, for the modification of problems related to the addition of discounts and shipping costs, the subject was inspired by the idea of yesterday's problem posing Task-1, which she did not have time to write down because she was afraid that she would not be able to write down the solution to the problem. Next, for problem posing number 2, the subject got the idea from problem posing Task-2 number 1. The subject was inspired to take the context of selling bouquets and modify it by adding fresh flower buckets. The price of the bucket materials was inspired by the list of bucket material prices provided in problem posing Task-2 number 1. This inspiration came after she thought of using the context of chicken noodles, but the ingredients for making chicken noodles were too many, and she lacked the knowledge to estimate the price of the ingredients for making chicken noodles, so she used the context of a bucket instead.

During the incubation stage, adaptive subjects are often inspired by information contained in the initial questions provided. In addition, the process of generating ideas for questions varies, namely (a) based on the subject's personal experience, (b) based on the subject's knowledge, (c) suddenly getting an idea after taking a short break. Point C corresponds to the first attribute of incubation according to Wallas (1926) in Sadler (2015), which is that during incubation, “we do not voluntarily or consciously think about a particular problem.” Points A and B correspond to the second attribute of incubation according to Wallas (1926) in Sadler

(2015), which is that "a series of unconscious and unintentional (or previously conscious and intentional) mental events can occur".

During this incubation stage, subjects experienced several changes in their ideas. This was because subject were afraid of not being able to solve the problems they had created, resulting in a reduction in the complexity of the problems. The fear experienced by subject in problem posing Task-1 was due to the fact that they had never been asked to propose problems before, which resulted in low self-efficacy. Low student self-efficacy is caused by adaptive individual tendencies, namely hatred when their decisions fail (Mcintyre, 2022). However, this did not occur in problem posing Task-2 because problem posing was no longer new to the students. This is in line with the research by Voica et al., (2020) that problem posing activities can increase student self-efficacy.

In the illumination stage, in problem-posing Task-1, the subject can create many contextual mathematical problems (fluency) as demonstrated by the three different problems given. Students can also pose many contextual mathematical problems with different categories (flexibility). Subject creates problems involving percentages, the use of ratios (shipping costs per km), and total price calculations with various deductions/additions (discounts and shipping costs). Although problems 1 and 3 are both strong in percentages, problem 2 introduces linear/ratio cost calculations (distance of 7 km), which distinguishes it from the others. With a significant variety of concepts (percentage, price, discount, distance ratio), the flexibility aspect is fulfilled, meaning that subject do not only create variations of one type of problem.

Subject can pose unique problems, unusual contextual math problems, but only a few students do so (novelty/originality). Problem 3 shows the presence of creative/unique problem posing elements. Subject not only pose problems based on stories (Rina wants to buy snacks), but also propose and solve solutions that demonstrate discount and free shipping strategies that they have devised themselves ("What I did was apply a discount to every purchase of more than 1 item and also get free shipping"). This shows thinking that goes beyond simply asking "How much does it cost?" and shifts to "How can I get the best price?". This action resembles the "What-If-Not?" Problem Posing technique coined by Brown and Walter (1983), in which the conditions or objectives of the problem are changed to generate new problems. This activity demonstrates thinking that goes beyond standard tasks, moving from problem solving to problem finding.

In the illumination stage for problem-posing Task-2, the subject can create many contextual mathematical problems (fluency) as demonstrated by the two different problems given. Although the number of main problems submitted is limited, the Fluency score is qualitatively high due to the complexity and density of data in the problems. The problems posed require the production of multiple sub-solutions, including calculating the selling price for nine product variations (based on flower type and doll size), as well as a comparative analysis of three delivery scenarios. This demonstrates that the subject has the fluency to expand the initial situation into a network of questions that require diverse representations and strategies.

Subject can also pose many contextual math problems with different categories (flexibility). In problem posing number 1, the subject successfully shifted the focus of the problem from the internal business domain (calculation of capital and determination of product selling price) to the external customer domain (purchase optimization problems with budget constraints). In

problem 2, the subject created a problem involving the determination of capital, selling price, profit, and sales strategy. This shows that subject can shift categories when posing problems.

The subject showed adaptive characteristics. Namely, in posing problems, the subject used the same context as the initial problem given with good creativity development. This is in line with the opinion of Kirton & De Ciantis (1986) that adaptors exhibit conservative behavior in specific contexts such as creativity, problem solving, and decision making. Conservative traits describe a tendency to remain within the boundaries of tradition, adapting to customs, traditions, and past practices in general. Supported by Kirton (1976), Kaufmann (2004), Buffinton et al. (2002), adaptive individuals rarely challenge rules, preferring to develop within the existing framework.

Subject can propose unique problems, unusual contextual mathematical problems, which only a few students do (novelty/originality). The subject demonstrates originality by integrating non-cost variables into mathematical optimization problems. Specifically, the posing of problem 1, which considers time and delivery options as critical constraints—in addition to cost and budget—goes beyond the characteristics of conventional story problems. The open-ended formulation of the problem and the requirement for strategic justification in the posing of problem number 2, rather than just a numerical answer, demonstrate high-level cognitive abilities and an appreciation for unexpected solutions. Based on the results of the work and interviews, subject was also able to correctly solve the two problems posed.

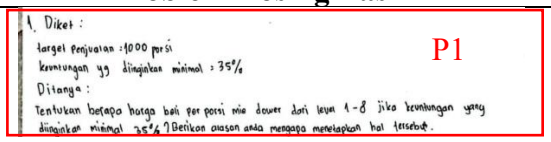
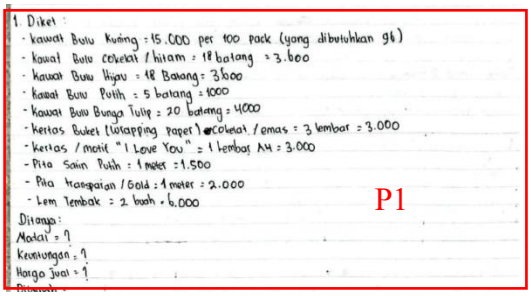
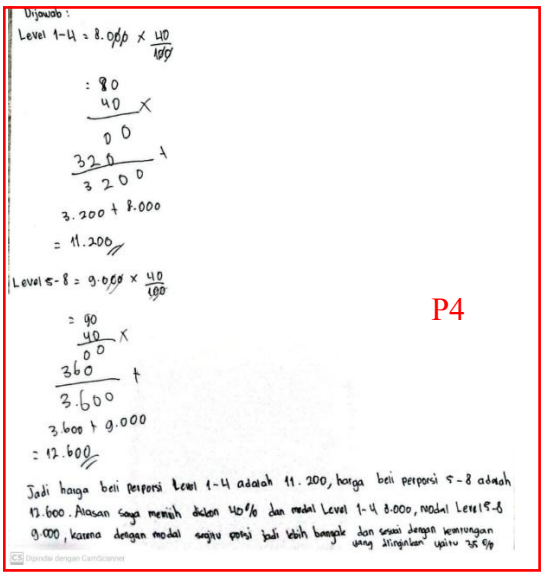
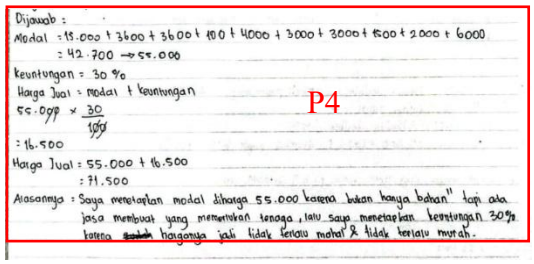
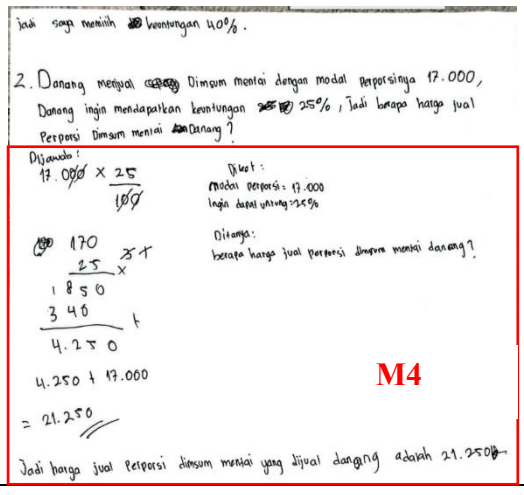
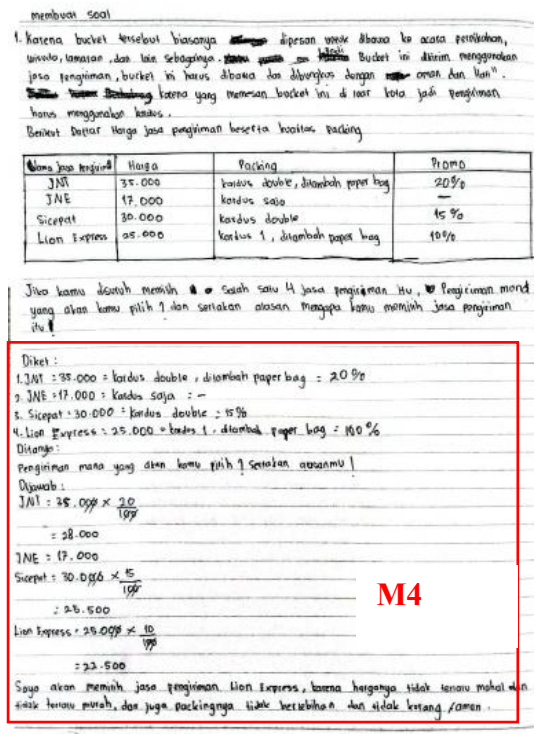
Subjects fulfill the originality aspect in several questions asked, such as questions that ask for the problem solver's point of view on solving the problem, for example, “What would you do as a salesperson to get buyers to buy?”; “Determine the strategy to be implemented in order to compete!”; “How can I get the best price?”. This shows thinking that goes beyond simply asking “How much does it cost?” and shifts to “How can I get the best price?”. This action resembles the “What-If-Not?” Problem Posing technique coined by Brown and Walter (1983), in which the conditions or objectives of the problem are changed to generate new problems. This activity shows thinking that goes beyond standard tasks, moving from problem solving to problem finding. It also shows indicators of flexibility in line with Silver's (1997) opinion that students use the “What-If-Not?” approach to pose problems. In the illumination stage, the subjects also solved the problems posed well.

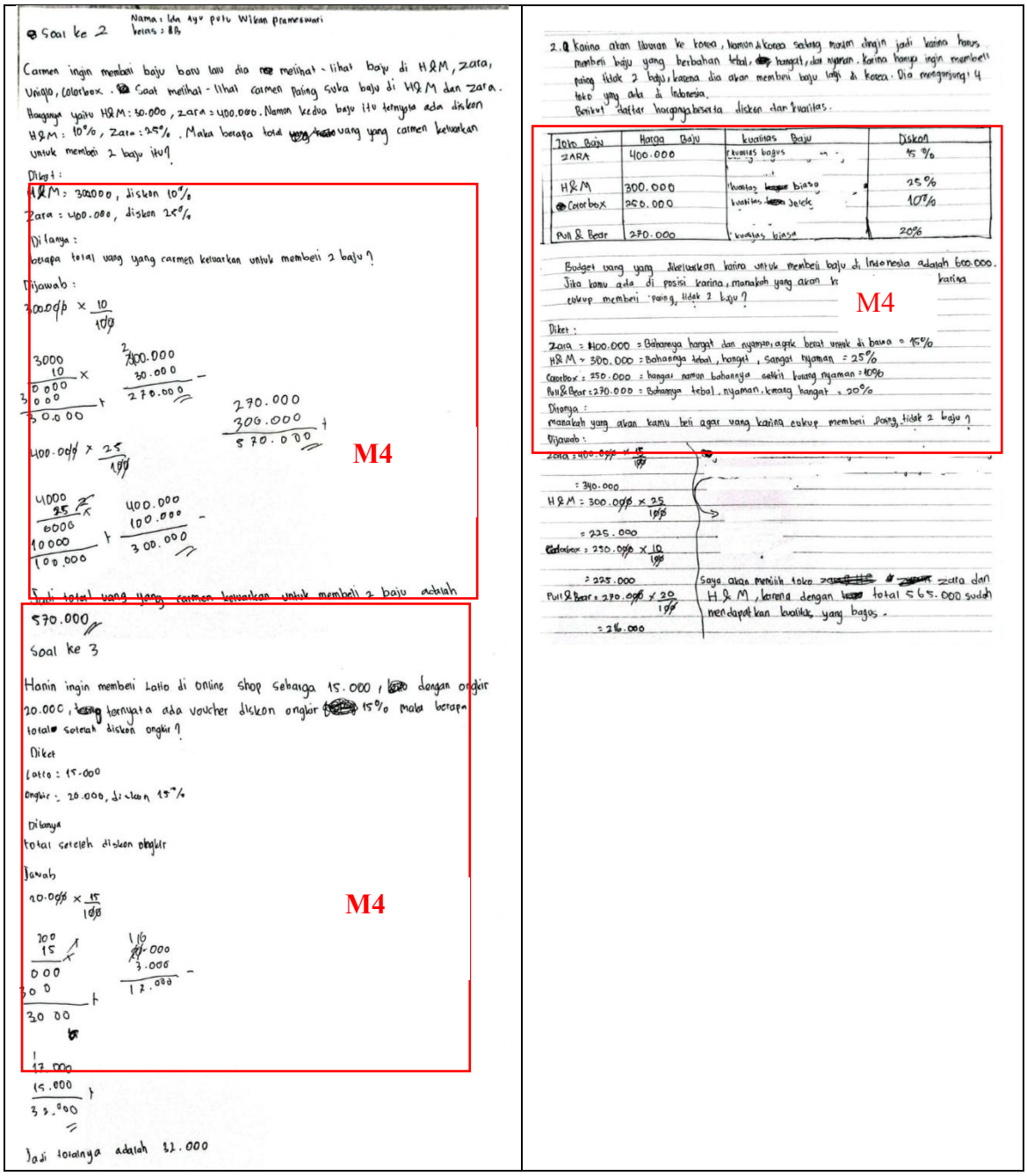
In verification stage, in problem posing Tasks 1 and 2, subject recheck their work by reading and recalculating their results one or two times. The subject checks the problems, answers, numbers used, and wording used. The subject also explains that the main thing to pay attention to when rechecking is the logic of the story in the problems posed. This is in line with the research by Ningsih et al. (2018) where students with high learning motivation at the verification stage read and revise the mathematics questions that have been submitted, explain verbally the procedure for solving the mathematics questions submitted on the answer sheet, and revise and correct the questions and solutions they have submitted. In this study, the subjects had high mathematical abilities, so there was a moderate positive relationship between academic achievement and high learning motivation (El-Adl & Alkharusi, 2020).

3.2 Innovative Student's Creative Thinking Process in Problem-Posing Tasks

The problem submission test was conducted twice to observe the consistency of the innovative student's work results to ensure the validity of the research findings. The results of the students' work are shown in Table 6.

Table 6. Innovative Student's Creative Thinking Process in Problem-Posing Tasks

Problem-Posing Task-1	Problem-Posing Task-2
 P1	 P1
 P4	 P4
 M4	 M4



In the preparation stage, in problem-posing Task 1 and 2, an innovative subject can identify what is known and what is being asked, as shown by the results of the student's work. According to Septyanggraeni's (2023) research, students with innovative cognitive styles can determine the known and unknown elements of a given problem. An innovative subject can explain the process of understanding the problem by reading it repeatedly, 5 times for Task-1 and 4-5 times for Task-2. The subject can explain the meaning of the questions in both problems in their own words and can solve the initial problems given in the problems, as evidenced by the student' work and interviews. Thus, the subject performed well in this preparation stage.

In the incubation stage, in problem-posing Task-1, the subject explained that the idea used to create posing problem number 1 was inspired by problem-posing Task-1 number 1, which

asked them to determine the selling price based on the given capital and profit. The context of mentai dimsum was chosen, inspired by personal experience, namely a friend who sells mentai dimsum, and the price used in the question was taken from the original price but made slightly more expensive. In addition, there was a change in the idea, which initially used the context of spaghetti to mentai dimsum because the subject preferred mentai dimsum. Then, for problem-posing number 2, the student was inspired by problem-posing Task-1 number 1 to apply discounts to buying and selling activities. Then, for the context of purchasing branded clothing, the subject was inspired by the character used in the question, Carmen. Carmen is a K-Pop idol from Indonesia whose full name is Nyoman Ayu Carmenita, who is a member of the girl group Hearts2Hearts under SM Entertainment. Because the character used is a celebrity, the subject thought that the clothing brands purchased must be branded, so those brands were chosen.

During the incubation stage of posing problem number 2, there was a change in the idea. Initially, the question was about adding a type of discount per store and asking what decision would be made if the student wanted to get the cheapest item with good quality. However, it was changed to asking how much money would need to be spent to buy the clothes. This happened because the subject was afraid during the process of completing the question. The subject was afraid of not being able to complete the question. During the incubation stage of posing problem number 3, the subject suddenly thought of this idea. The subject explained that in posing problem number 3, she did not think deeply just to add answers, because she had already submitted two questions previously. The context of the latiao seller was inspired by a friend who was a food delivery service provider. Latiao itself is a popular Chinese snack, which means “spicy stick” or “spicy pieces.” During the incubation stage of posing problem number 3, there was a change in the idea, which was initially to add a context such as the subject's experience, but was changed to using shipping discounts only because the subject was afraid of not being able to complete the question.

During the incubation stage of problem-posing Task-2, the subject explained that the idea used to create the posing problem number 1 was inspired by problem-posing Task-2 number 1. Subject was inspired to take the context, which was a bucket. Then, the addition of shipping costs was inspired by the creative thinking example given at the beginning as a treatment so that students would know the indicators of a creative question. The subject also thought about making this problem an open-ended question by adding the context of differences in packing materials for buckets with different prices, and the questions asked were directed towards making the best packaging decision.

Next, for posing problem number 2, the subject was inspired by the idea in completing problem-posing Task-1. The subject realized an idea that she did not have time to write down the problem-posing Task-1. In addition, there was a change in the idea, which initially used the context of buckets inspired by problem posing Task-2 number 1, which was modified by adding that the bucket store also sells bucket materials. Then there was another idea, namely that this bucket shop also sells through Shoope, because offline sales are already very good, with the question asked being “how to balance sales in offline and online stores?”. However, neither idea was implemented because the subject was afraid of not being able to complete the question on time, so the subject used the idea in problem-posing Task-1 that she had not yet realized. There was also a change in the numbers in question, namely the budget, which was originally

Rp600.000,00 and was to be changed to Rp500.000,00 but this did not happen because other numbers would also change if the budget changed. In addition, changes also occurred in the clothing quality column. Initially, detailed material specifications (thick, thin, warm, etc.) were provided, but these were changed to non-specific terms (poor quality, good, average, etc.) with the aim of making the problem more difficult for those working on it because the quality provided could not be measured (using adjectives), thus making it more difficult.

During the incubation stage, subject are often inspired by information contained in the initial problem given. In addition, the process of generating ideas for problems varies, namely (a) based on the subject's personal experience, (b) based on the subject's knowledge. Points A and B correspond to the second attribute in incubation. According to Wallas (1926) in Sadler (2015) that "a series of unconscious and unintentional (or previously conscious and intentional) mental events can occur." During this incubation stage, the subjects experienced several changes in ideas. This was influenced by several factors, namely (a) the student was afraid of not being able to solve the problems she had posted, resulting in a reduction in the complexity of the problems, which occurred consistently in both problem posing Task-1 and problem posing Task-2; (b) there was a change in the level of difficulty of the problems and a desire to create open-ended questions. Point b is in line with Wallas' (1926) opinion that incubation is a fertile resource for creative thinkers. Therefore, raising problems in conscious thought (preparation) as early as possible maximizes the time to expand and enrich the mental operations of subconscious thinking. Wallas argues that the first form of incubation (distraction) is more effective for less difficult forms of creative thinking (Wallas, 1926).

In illumination stage, in problem-posing Task-1, the subject can create many contextual mathematical problems (fluency) as demonstrated by the 3 different problems she poses. Although she posed 3 problems, their fluency score was qualitatively low because the complexity and density of data in the problems were insufficient. Problem posing that demonstrates high fluency will be seen if the subject is able to generate many different problems or questions from one given story stimulus or contextual situation. These results indicate that the subject tends to focus on one calculation goal.

Subject can also pose many contextual math problems with different categories (flexibility). However, the subject's flexibility level is rated low. The subject generated problems that focused on two main sub-concepts of social arithmetic: profit, loss and discounts. These two sub-concepts are closely related because they both involve calculating percentages of the initial value, namely one-step linear calculations based on discounts or profits without changing perspectives, without varying conditions, and without different mathematical relationships.

This occurred because the subject is afraid that she would not be able to solve the problems if they were complex or more difficult. In line with Mcintyre's (2022) opinion that innovators like to realize things, rely on intuition, see decisions as something that is "not black and white," are willing to break out of existing structures, and are not afraid of making mistakes. The subject chooses to create problems by deviating from the instructions to create problems that show creativity rather than trying to follow the instructions but failing.

Subject can propose unique, unusual contextual mathematical problems, but only a few students do so (novelty/originality). The level of novelty of the problems is categorized as low. The problems tend to be well-structured, showing limitations in producing original, ill-

structured problems, or those requiring deep interpretation. Although the context is taken from real life (contextual) as suggested by Balka, the problems generated do not show uniqueness, complexity, or perspectives that are rarely raised. The problems tend to be goal-specific and well-structured, in contrast to novel problems that are often non-standard or ill-structured and challenge existing hypotheses. This is because innovative cognitive styles are less disciplined and less concerned with efficiency (Reddin, 1970). Efficiency here means that subjects are too fond of experimenting and generating many ideas, thus spending too much time in the incubation stage. This is in line with Rogers' (1954) opinion that an adaptive person has an experimental nature that manifests itself in playing with ideas and generating many ideas, many of which are original, extra-paradigmatic, and thus violate consensus (Kirton, 1976).

In the illumination stage for problem posing Task-2, the subject can create many contextual mathematical problems (fluency) as demonstrated by the two different problems posed given. The two problems posing are not just two versions of one pattern, but are two separate problems containing different information, objectives, and contexts. In addition, each problem posed is open-ended, providing opportunities for a variety of approaches and possible answers. For example, in the first problem, subject answers may vary depending on the focus of the assessment (lowest cost, packaging safety, promotional efficiency, etc.). Similarly, in the second problem, the subject may arrive at different answers based on considerations of the combination of price and quality of clothing.

Subject can also pose many contextual mathematical problems with different categories (flexibility). The subject is able to generate two problems with different objectives, structures, and variables, but the differences are still within the same domain of purchasing and costs. In the two problems submitted, the subject showed shifts in the following aspects: (1) Change in problem purpose, namely the first problem focused on selecting the best service based on multiple criteria (price, promotion, packaging quality) and the second problem focused on optimizing purchases within budget constraints to obtain at least two items; (2) Change in problem structure, namely the first problem was a decision-making problem and the second problem was an optimization problem; (3) Change in variable focus, namely the first problem: promotions, final price, packaging quality, item security, and the second problem: discount price, budget, clothing quality, purchase quantity; (4) Change in context, namely the first problem is in the context of delivery services and the second problem is in the context of purchasing clothing items. These variations show that the subject is not fixated on one way of thinking, but is able to see social arithmetic material from various sides: the service side, the goods side, the decision side, and the optimization side. This illustrates cognitive flexibility in formulating problems.

The subject can propose unique, unusual contextual mathematical problems, but only a few students do so (novelty/originality). In the first problem, the subject proposed a problem about choosing a delivery service based on promotions and packaging quality. This situation is relatively rare in social arithmetic problems at school, mainly due to the combination of non-mathematical variables such as packaging security level, service quality, and type of promotion. This shows a fairly strong element of novelty in the selection of context and problem formulation. In the second problem, the context taken is more general, namely the purchase of clothing at a discount. However, the subject added the elements of clothing quality and

minimum purchase restrictions, which provided a slight modification and contributed to the level of originality, although not as high as the first problem. Based on the results of their work and interviews, the subject was also able to correctly solve the two posed problems.

In the verification stage, in problem posing Tasks 1 and 2, the subject rechecked her work by reading and recalculating the results. The subject checks the problems, answers, numbers used, and wording used. The subject also explains that to submit a problem, she first calculates the solution on a scrap sheet to determine the numbers used in the submitted problem, and the main thing to pay attention to when rechecking is the problem (the story behind the problem). This is in line with the research by Ningsih et al. (2018) where students with high learning motivation at the verification stage read and revise the mathematics questions that have been submitted, verbally explain the procedure for solving the mathematics questions submitted on the answer sheet, and revise and correct the questions and solutions they have submitted. In this study, the subject had high mathematical abilities, so there was a moderate positive relationship between academic achievement and high learning motivation (El-Adl & Alkharusi, 2020).

Comparison of creative thinking processes in contextual mathematical problem posing of junior high school students with adaptive and innovative cognitive styles in Table 7.

Table 7. Comparison of Creative Thinking Processes in Contextual Mathematical Problem Posing of Junior High School Students with Adaptive and Innovative Cognitive Styles

Observed Aspects	Creative Thinking Process in Contextual Mathematical Problem	
	Adaptive Student	Innovative Student
Preparation Stage	- Students with adaptive cognitive style identify what is known and what is asked in problem-posing tasks.	- Students with innovative cognitive style identify what is known and what is asked in problem-posing tasks.
	- Students with an adaptive cognitive style explain the process of understanding problems by reading the questions repeatedly 2-4 times.	- Students with an innovative cognitive style explain the process of understanding problems by reading the questions repeatedly 4-5 times.
	- Students with an adaptive cognitive style re-explain the meaning of the questions in the problem-posing task in their own words during the interview.	- Students with an innovative cognitive style re-explain the meaning of the questions in the problem-posing task in their own words during the interview.
	- Students with adaptive cognitive style solve the initial problem given in the problem-posing task.	- Students with an innovative cognitive style solve the initial problem given in the problem-posing task.
Incubation Stage	- Students with an adaptive cognitive style explain several processes for the emergence of new ideas to pose problems, namely 1) Inspired by information on the initial problem, 2) Inspired by personal experience, 3) The AHA moment process occurs.	- Students with an innovative cognitive style explain several processes for the emergence of new ideas to propose problems, namely 1) Inspired by information on the initial problem, 2) Inspired by personal experience, 3) Inspired by other people's experiences, 4) The AHA moment process occurs.
	- In carrying out this process, changes in ideas occur.	- In carrying out this process, changes in ideas occur.
Illumination Stage	- The contextual problems posing fulfill the aspects of fluency, flexibility, and novelty.	- The contextual problems posing fulfill the aspects of fluency, flexibility, and novelty, but not all the questions proposed are open-ended.

Observed Aspects	Creative Thinking Process in Contextual Mathematical Problem	
	Adaptive Student	Innovative Student
Verification Stage	- Student with adaptive cognitive style can solve the problems presented, as proven by the results of the work of students with adaptive cognitive style.	- Student with an innovative cognitive style can solve the problems presented, as evidenced by the results of subject I's work.
	- Student with an adaptive cognitive style check the math problems they are asked by rereading the problem or recalculating the solution to the problem.	- Student with an innovative cognitive style check the math problems they are asked by rereading the problem or recalculating the solution to the problem.
	- Student with an adaptive cognitive style check the numbers in the math problems posed by recalculating the numbers used in the problem.	- Student with an innovative cognitive style check the numbers in the math problems posed by recalculating the numbers used in the problem.
	- Student with an adaptive cognitive style check the language wording of the math questions (problems) they are asked by rereading the questions.	- Student with an innovative cognitive style check the language wording of the math problems they are asked by rereading the problems.
	- Student with an adaptive cognitive style check the answers to the math questions (problems) posed by recalculating the numbers used in the questions.	- Student with an innovative cognitive style check the answers to the math questions (problems) posed by recalculating the numbers used in the questions.
	- The main thing to pay attention to when carrying out the re-examination process is the logic of the story regarding the problem being raised.	- The main thing to pay attention to when carrying out the re-examination process is the logic of the story regarding the problem being raised.
	- Student with an adaptive cognitive style determine/calculate the solution first to determine the numbers used in the problem so that the solution given is appropriate.	- Student with an innovative cognitive style determine/calculate the solution first to determine the numbers used in the problem so that the solution given is appropriate.

The process flow for submitting subject issues can be seen in Figure 1.

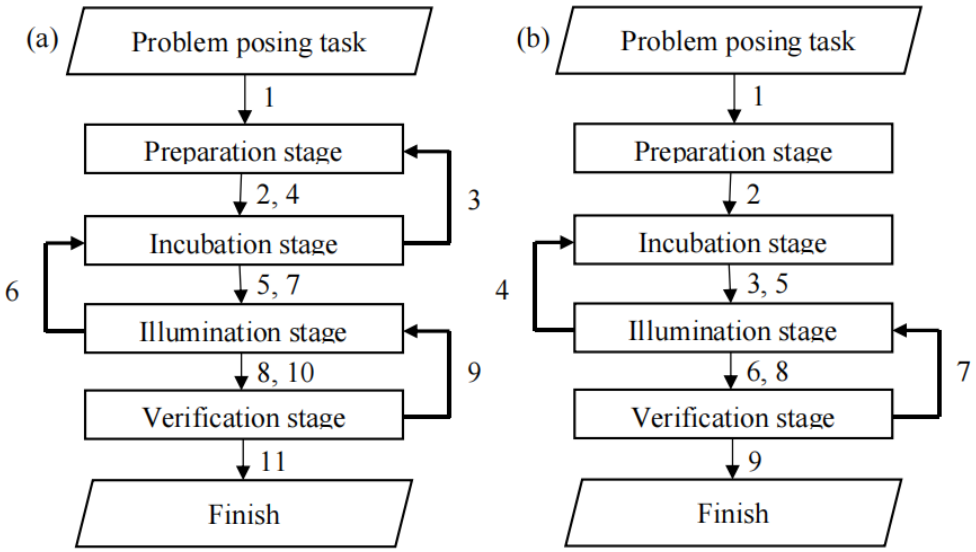


Figure 1. Comparison of Creative Thinking Processes Flow in Contextual Mathematical Problem Posing of Junior High School Students with Adaptive (A) And Innovative (B) Cognitive Styles

Figure 1 shows that students with adaptive and innovative cognitive styles have a creative thinking process flow in posing repetitive (non-linear) problems. In students with adaptive cognitive styles, repetition occurs at all stages. Upon reaching the incubation stage, students return to the preparation stage to search for ideas through problems that have been solved. In the illumination stage, students return to the incubation stage because there is a change in the idea for the problem posing. In the verification stage, students return to the illumination stage because they encounter errors in the process of re-examining the problems that have been posing and their solutions. Meanwhile, in innovative students, repetition does not occur in the preparation stage.

4 Conclusion

4.1 Creative Thinking Processes in Problem Posing by Student with Adaptive Cognitive Style

In the creative thinking process, student go through four stages, namely preparation, incubation, illumination, and verification. In the preparation stage, the student identifies what is known and what is asked in the problem posing task, explain the process of understanding the problem by reading the question 2-4 times, explains the meaning of the question in the problem posing task in their own words during the interview, and solving the initial problem given in the problem posing task.

During the incubation stage, the student explains several processes involved in generating new ideas for posing problems, namely: (1) inspiration from information on the initial problem, (2) inspiration from personal experience, and (3) an “Aha!” moment. During the incubation process, ideas also undergo changes. These changes occur for several reasons, namely: (1) the student fears that she will not be able to solve the problem, and (2) the student lacks sufficient knowledge to develop their initial ideas.

At the illumination stage, the student proposes contextual problems that meet the aspects of fluency, flexibility, and originality, and solve the proposed problems as evidenced by the results of their work. When posing problems, student rarely use new contexts; instead, they adapt by developing on existing contexts. The development involved adding variables to the problems and changing the purpose of the problems.

At the rechecking stage, the student checks the math questions (problems) by rereading the questions or recalculating the solutions. The student checks the numbers in the math questions (problems) by recalculating the numbers used in the questions. Students check the wording of the math questions (problems) by rereading the questions. The student checks the answers to the proposed mathematical questions (problems) by recalculating the numbers used in the questions, and the student determines/calculates the solution first to determine the numbers used in the questions so that the solution provided is correct. The main thing to pay attention to when conducting the rechecking process is the logic of the story in the proposed problem.

4.2 Creative Thinking Processes in Problem Posing by Student with Innovative Cognitive Style

In the creative thinking process, the student goes through four stages, namely preparation, incubation, illumination, and verification. In the preparation stage, the student identifies what is known and what is asked in the problem posing task, explain the process of understanding the problem by reading the question 4-5 times, explain the meaning of the question in the problem posing task in their own words during the interview, and solving the initial problem given in the problem posing task.

During the incubation stage, the student explains several processes involved in generating new ideas for posing problems, namely: (1) Inspired by information on the initial problem, (2) inspired by personal experiences, (3) inspired by the experiences of others, (4) an AHA moment occurs. During the incubation process, changes in ideas also occur. These changes occur for several reasons, namely: (1) the student fears that she will not be able to solve the problem, and (2) the student does not want to experience difficulties when posing problems.

At the illumination stage, student propose contextual problems that meet the aspects of fluency, flexibility, and originality. However, not all questions asked are open-ended. The student solves the problems proposed, as evidenced by the results of their work. When posing problems, the student often use new contexts and create new storylines. With the desire to develop new contexts, a lot of time is spent selecting one idea from among the many that come up, resulting in suboptimal development.

At the rechecking stage, the student checks the math questions (problems) by rereading the questions or recalculating the solutions. The students checks the numbers in the math questions (problems) by recalculating the numbers used in the questions. Student check the wording of the math questions (problems) by rereading the questions. The student checks the answers to the proposed mathematical questions (problems) by recalculating the numbers used in the questions, and the student determines/calculates the solution first to determine the numbers used in the questions so that the solution provided is correct. The main thing to pay attention to when conducting the rechecking process is the logic of the story in the proposed problem.

4.3 Suggest

Based on the research results, adaptive students' creative thinking processes in posing questions tend to easily adapt to the questions given, and their development often uses the same context. Meanwhile, innovative students' creative thinking processes in posing questions tend to be innovative and do not use the same context as the initial questions. Consequently, they spend more time generating ideas for posing questions than adaptive students. Therefore, when designing learning activities, teachers must consider student characteristics, so that adaptive students can use the post-solution problem-posing method, and innovative students can use the pre-solution problem-posing method.

For future researchers, the results of this study can serve as a reference for conducting similar research with a broader scope, for example, on other mathematics materials or at different grade levels. Furthermore, it can add research variables, such as mathematics anxiety, self-efficacy,

learning motivation, and others. Based on the limitations of the study, subject preparation was not carried out properly. Therefore, further research can be improved by properly preparing subjects, namely selecting subjects who are already familiar with question-posing.

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