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The Creative Thinking Process of Students with Adversity Quotient Personality and Metacognition Level in Solving Open-Ended Problems Reviewed from the Information Processing Theory

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Abstract

The issue of creative thinking encompasses various contexts, including those about Adversity Quotient students, necessitating further elucidation of the problem to ascertain students' metacognitive levels. This research constitutes a qualitative descriptive exploratory study aimed at delineating the creative thinking process of students, with a focus on students' Adversity Quotient and metacognition levels, as examined through the lens of information processing theories. The study participants were 29 students from the 11th grade of SMA. The research methodology involved administering tests to students, with subsequent analysis of the results utilizing the exploratory descriptive method, wherein the researcher categorized students based on their Adversity Quotient and metacognition levels. Data collection in this study employed instruments in the form of open-ended questions and interview guidelines. Initial test results revealed that seven students could provide comprehensive answers to the questions, nine offered partial responses, and 13 did not respond. Further analysis of the test results indicated that one subject classified as the "climbers" type exhibited the reflective use level of metacognition, one subject of the "campers" type demonstrated the semi-reflective use level of metacognition, and one subject of the "quitters" type displayed the tacit use level of metacognition.

Keywords

Adversity Quotient; Creative Thinking; Information Processing Theory; Level of Metacognition; Open-Ended

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1. INTRODUCTION

Creative thinking is a cognitive process that aims to generate new and unique ideas, develop solutions, and formulate innovative strategies by considering various consequences that may arise (Mumford et al., 2013). According (Sukma et al., 2024)Students' creative thinking skills can be developed by formulating questions. A person's creative thinking process grows as they engage in a new approach

to problem-solving. Creative thinking can be categorized into two main approaches, namely process and product (D. P. Wulandari et al., 2021). From a process standpoint, creative thinking is characterized by students' problem-solving responses using the right methodology. Meanwhile, from a product perspective, Nur Nabila et al. (2023) explained that creative thinking emphasizes aspects of fluency, flexibility, novelty, and elaboration (Palwa et al., 2024).

The creative thinking process in this study can be measured through four stages, namely the first stage is preparation, the second stage is incubation, the third stage is illumination, and the fourth stage is verification (Gunawan et al., 2025). In the preparation stage, students determine information, formulate problems, and collect and connect information (Tselykh, 2019) (Rusdyi et al., 2023). In the incubation stage, students conceptualize problem-solving ideas, arrange a sequence of solutions based on the chosen ideas, and choose the ideas that are considered most appropriate (Hélie & Sun, 2010). In the illumination stage, students solve problems using steps that correspond to pre-selected ideas. The verification stage involves evaluating the results obtained as well as testing solutions using other alternatives (Şahin & Kılıç, 2024).

Students are required to engage in creative thinking in order to be able to adapt and deal with various situations that arise in the learning process effectively (Revenko et al., 2024). One of the main problems in this study is the low ability to think creatively caused by habits in facing challenges, as well as the ability or metacognitive level of the students themselves (Rusdyi et al., 2023). This is also strengthened by the results of previous research, which showed that the application of inquiry-based learning and the eliciting activities (MEAs) model is effective in improving students' creative thinking skills and problem-solving skills (Triyono, 2019); (Triyono et al., 2024); (Ayuningtyas et al., 2023). The goal is to understand the creative thinking process of students through the presentation of mathematical problems that do not have specific procedural solutions or are included in the category of non-routine problems (Arifin et al., 2021).

Non-routine questions describing students' creative thinking processes are open-ended (Arilaksmi et al., 2021). Open-ended questions are characterized by various alternative solutions (Saleh & Nur, 2023). Students seek various alternative solutions by comprehensively utilizing their knowledge to explore relevant information or concepts (H. T. Wulandari et al., 2024). In addition, the application of open-ended questions provides students with the opportunity to expand their knowledge through the application of mathematical expressions.

The presentation of open-ended questions requires students' ability to solve problems. According to Gagné (1985), the process of learning and problem-solving involves a sequence of internal information processing stages, including attention, memory encoding, retrieval, and response generation (Gagné, 1985). When students face problems, they are prompted to activate these cognitive processes to understand the problem, explore possible strategies, and produce solutions. However, each student processes information differently due to individual characteristics and experiences. These variations can be analyzed through information processing theory, which emphasizes how learners receive, process, store, and retrieve information. One of the key individual differences that influences problem-solving is the Adversity Quotient (AQ), which reflects how well an individual withstands, navigates, and overcomes challenges (Stoltz, 1999). Moreover, metacognitive skills also play a crucial role in guiding and monitoring the cognitive processes during problem-solving (Flavell, 1979). Therefore, investigating students' creative thinking processes in solving open-ended problems through the interaction of AQ and metacognition—viewed from an information processing perspective—offers valuable insights into their cognitive functioning. Individual differences in problem-solving abilities are conceptualized as the Adversity Quotient (Rusdyi et al., 2023). Suryaningrum et al. (2020) define Adversity Quotient as a person's capacity to endure and overcome difficulties (Suryaningrum et al., 2020) Overcome challenges and exceed expectations in their efforts and potential (Windasari & Cholily, 2021). The Metacognition Level refers to a person's self-awareness of their cognitive processes and understanding of the strategies used in problem solving (Suryaningtyas & Setyaningrum, 2020).

Several previous studies have addressed related topics. Damayanti et al. (2020) investigated students' metacognition levels in solving mathematical problems based on Adversity Quotient (AQ), focusing on the categorization of AQ levels among high school students (Damayanti et al., 2020). Huda et al. (2021) analyzed metacognitive characteristics in mathematical problem-solving from the perspective of personality types, showing how personality influences metacognitive behavior (Huda et al., 2021). Rusdyi et al. (2023) examined the creative thinking process of students with different AQ profiles in solving open-ended problems, viewed through the lens of information processing theory (Rusdyi et al., 2023). Additionally, other studies such as Ma'ruf et al. (2023) and Handajani et al. (2018) have demonstrated that innovative learning models—like flipped classroom and problem-based learning—enhance students' problem-solving and creative thinking abilities (Ma'ruf et al., 2023) (Ruayruay et al., 2020). Similarly, Munir et al. (2021) confirmed the role of Model Eliciting Activities (MEAs) in developing students' mathematical creativity (Munir et al., 2021), while Ruayruay et al. (2020) emphasized the need for higher-order thinking skills as a key 21st-century competence (Nugraheni et al., 2018).

Although previous studies have offered useful insights, most examine Adversity Quotient (AQ) or metacognition separately, without exploring their dynamic interaction in open-ended problem solving. There is also a lack of research on how students with varying AQ types and metacognitive levels process information during creative thinking, particularly within the framework of information processing theory. The present study analyzes students' creative thinking processes by considering their AQ personality and metacognitive level through information processing theory to address this gap. This approach aims to provide a deeper understanding of how individual differences influence cognitive processes in complex problem-solving (Wang & Chiew, 2010).

Another study by Schmoelz (2018) emphasized a positive correlation between the application of exploration-based learning and an increase in students' mathematical creativity (Schmoelz, 2018). Kholid et al. (2024) also added that creative thinking skills can be developed through systematic practice of non-routine questions (Kholid et al., 2024). Then, Grégoire (2016) stated that basically, mathematical thinking is a complex form of creative thinking, so a learning strategy is needed that can encourage students to discover new ideas independently (Grégoire, 2016).

In addition, Tindowen et al. (2017), in the context of 21st-century education, emphasize the importance of metacognitive skills and creativity as key pillars in readiness to face global challenges (Tindowen et al., 2017). Hadar & Tirosh (2019) also assert that creative thinking in mathematics requires a combination of divergent thinking and problem-finding skills (Glasser & Doerfler, 2019). The results of the study by Nadjafikhah et al. (2012) revealed that mathematical creativity can be enhanced through learning that provides space for students to explore ideas without rigid procedural limitations (Seridi et al., 2012).

Finally, Lucas et al. (2022) affirm that a learning environment that fosters curiosity and open exploration will greatly contribute to the sustainable development of students' creative and metacognitive thinking (Lucas, 2022).

The research results show that students with different levels of Adversity Quotient and metacognition show diverse creative thinking processes. Windasari & Cholily (2021) define Adversity Quotient as an individual's perseverance when facing obstacles in achieving success (Windasari & Cholily, 2021). Metacognition, as explained by Idelia Cahyati & Yuli Eko Siswono (2022), is a high-level cognitive function related to self-awareness of problem-solving strategies (Cahyati & Siswono, 2022). Therefore, the level of Adversity Quotient and metacognition is thought to provide great motivation for individuals in facing challenges, thus potentially contributing to their success (Purwasih, 2019). Furthermore, the level of Adversity Quotient and metacognition can also help improve students' creative thinking abilities (Damayanti et al., 2020).

Based on the description above, research on students' creative thinking processes still needs to be

developed, especially considering the role of Adversity Quotient personality and metacognition level in solving open mathematics problems. Although there have been previous studies that discuss the relationship between Adversity Quotient and metacognition and creative thinking skills, there are still limited studies that integrate these two aspects in the context of solving non-routine problems using the perspective of information processing theory (Rusdyi et al., 2023). Therefore, this study aims to analyze the creative thinking process of students with Adversity Quotient personalities and different levels of metacognition in solving open mathematics problems, reviewed from the information processing stages, which include preparation, incubation, illumination, and verification.

2. METHODS

This study uses a qualitative approach with an exploratory descriptive design to provide an in-depth picture of the studied subject. The subjects in this study were all students in class IX-1 of SMA Negeri 5 Tidore Kepulauan, North Maluku Province, which amounted to 29 students, consisting of 9 male students and 20 female students.

The instruments used in this study include open-ended questions about the two-variable linear equation system, originally arranged in three question items and validated by two experts. After validation, two questions were declared valid, and one question was selected for use in the research. In addition, researchers also used open-ended interviews to dig deeper into information from students.

The research procedure begins with giving participants a preliminary test to assess their mathematical ability and classifying them based on *the type of Adversity Quotient* (AQ) using the following criteria:

Table 1. Determination of Type Adversity Quotient Based on the test score

No	Scores	Types
1	81 – 100	*climber*
2	61 – 80	*camper*
3	< 60	*quitter*

Based on the test results, participants were categorized into AQ types, followed by interviews based on their answers. If the answer does not match the research focus, the researcher provides a commensurate question with a different redaction. Conversely, if the answer is appropriate, the researcher deepens the exploration of the information.

Furthermore, students' cognitive structure is analyzed based on information processing theory to understand the creative thinking process of students with the AQ personality type at the metacognition level. The creative thinking process is explained through the following components:

Table 2. The Creative Thinking Process of Students Reviewed from Its Components

Stages of the creative thinking process	Information processing components	Description
Preparation Stage	*Attention*	Students carefully and meticulously examine the questions regarding the provided information, subsequently identifying and articulating the known elements and specific inquiries presented in the questions.
Incubation Stage	*Perception*	Students formulate or articulate problem-solving strategies using methodologies that facilitate processing acquired information.

Stages of the creative thinking process	Information processing components	Description
Illumination Stage	*Retrieval*	The retrieval process of information stored in long-term memory is subsequently required in short-term memory for cognitive processing.
Verification Stage	*Encoding*	The student elucidates each step undertaken and subsequently draws conclusions from the results.

Finally, the metacognition levels of students with the AQ type were analyzed based on the creative thinking process associated with information processing theory, using the following classification:

Table 3. Determination of Students` *Metacognition* Level

No	Level of Metacognition	Description
1	Level *reflective use*	Students actively reflect and consider strategies before taking action.
2	Level *semi-reflective use*	Students have self-awareness, but they may not always reflect deeply before acting.
3	Level *tacit use*	Students in this category intuitively employ knowledge and skills without substantial reflection.

3. FINDINGS AND DISCUSSIONS

Findings

Initial Mathematics Ability

Initial mathematical ability refers to students' skills before assessing their creative thinking and is categorized into high, medium, and low levels (Rusdyi et al., 2023). In this study, 29 eleventh-grade students were tested on linear equations in word problems to evaluate their cognitive processes based on Adversity Quotient (AQ). The results classified students into three AQ categories: (1) climbers—able to face and solve problems, (2) campers—willing to try but imprecise and easily satisfied, and (3) quitters—easily give up and lack motivation. From the test, seven students (24.1%) were climbers, nine students (31%) were campers, and 13 students (44.8%) were quitters. Three students were selected to represent each AQ category in demonstrating their creative thinking process based on their thinking potential and communication skills.

Table 4. Determination of Type *Adversity Quotient* Based on the Test Scores

No	Scores	Number of Students	Categories
1	81 – 100	1 student	*climber*
2	61 – 80	1 Student	*camper*
3	< 60	1 Student	*Quitter*

This study analyzes the creative thinking process of students in solving open-ended problems based on information processing theory, which includes four stages: attention (understanding the problem), perception (strategizing), retrieval (remembering information from memory), and coding (explaining steps and concluding).

Table 5. The Creative Thinking Process of Students with Adversity Quotient Personality Reviewed from the Information Processing Theory

Stages of the creative thinking process	Information processing components	Description
Preparation Stage	*Attention*	Students focus on carefully and meticulously reading the questions regarding the received information, subsequently documenting or articulating the known elements and the inquiries presented in the questions.
Incubation Stage	*Perception*	Students formulate or articulate problem-solving strategies using methodologies that facilitate processing acquired information.
Illumination Stage	*Retrieval*	The retrieval process of information stored in long-term memory is subsequently required in short-term memory for cognitive processing.
Verification Stage	*Encoding*	Students elucidate each step they have undertaken and subsequently derive conclusions from the outcomes of their work.

Subsequently, an analysis of the metacognition levels of students with an Adversity Quotient personality was conducted based on the students' creative thinking process, examined through the lens of information processing theory, utilizing the following metacognition level table:

Table 6. Determination of Students` Metacognition Level

No	Level of Metacognition	Description
1	Level *reflective use*	Students actively reflect and consider strategies before taking action.
2	Level *semi-reflective use*	Students have self-awareness, but they may not always reflect deeply before acting.
3	Level *tacit use*	Students in this category intuitively employ knowledge and skills without substantial reflection.

Analysis of the Occurrence of Creative Thinking Processes in Students with an Adversity Quotient Personality

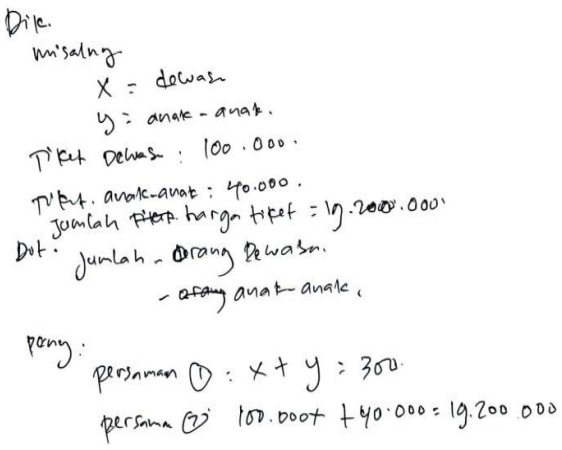
The subjects whose data were analyzed in the creative thinking process of students with an adversity quotient personality in solving open-ended problems comprised the climber category of creative thinking process, the camper category of creative thinking process, and the quitter category of creative thinking process. The analyzed data on the climber, camper, and quitter creative thinking processes were derived from think-aloud protocols, field notes, interviews, and subject answer sheets in solving open-ended problems.

Description of the Creative Thinking Process of Climber Students

The creative thinking process exhibited by climber students was analyzed through the lens of information processing theory components. These components include attention, perception, retrieval, and encoding. The problem is as follows: "The ticket price for a show is IDR. 100.000,00 for adults and IDR. 40 000.00 for children. One day, 300 people attended the show, and IDR. 19 200,000.00 was generated from ticket sales. What is the number of adults and children who attended the show that day?

a. Preparation Stage

During the preparation stage, the cognitive process of high-achieving students commences with attentiveness, wherein these students focus on observing and reading questions thoroughly and meticulously. The creative thinking process of high-achieving students is illustrated in Figure 1.



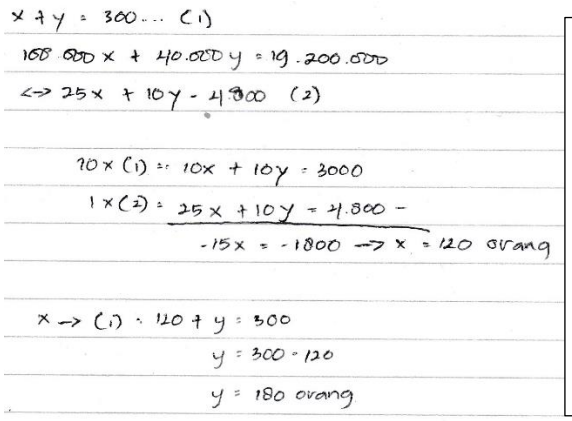
Translate version
Known:
For Instance:
x= adult
y = Children
The ticket price for adults = 100.000
The ticket price for children = 40.000
The total ticket revenue = 19.200.000
Problems:
The total number of adult tickets sold.....?
The total number of child tickets sold.....?
Solution:
Equations (1). x+y = 300
Equations (2). 100.000x + 40.000y = 19.200.000

Figure 1. The Creative Thinking Process of Climber Students Occurs in the Attention Component

The creative thinking process of climber students is evident in the attention component, where they carefully read the questions, noted the given information, and understood what was being asked. The student provided concrete examples and utilized previously learned knowledge. Based on the interview, the student demonstrated a good understanding of the problem. According to theory, attention involves selecting relevant information for processing while ignoring irrelevant details. New information must be meaningful to be retained in memory (Arilaksmi et al., 2021),.

b. Incubation Stage

During the incubation stage, the cognitive process of the climber students commences with perception. These students conceptualized problem-solving strategies by connecting with previously acquired information and recollecting applicable methodologies. As the strategies employed by climber students constitute initial plans for processing the received information, their creative thinking process is depicted in Figure 2.



Translate version
$x+y = 300$ .....(1)
$100.000x + 40.000y = 19.200.000$
=> $25x + 10y = 4.800$ .....(2)

10 x (1) : $10x + 10y = 3000$
1 x (2) : $25x + 10y = 48.000$
$-15x = -1800$ => x = 120 people

x => (1) : $120 + y = 300$
$y = 300 - 120$
y = 180 people

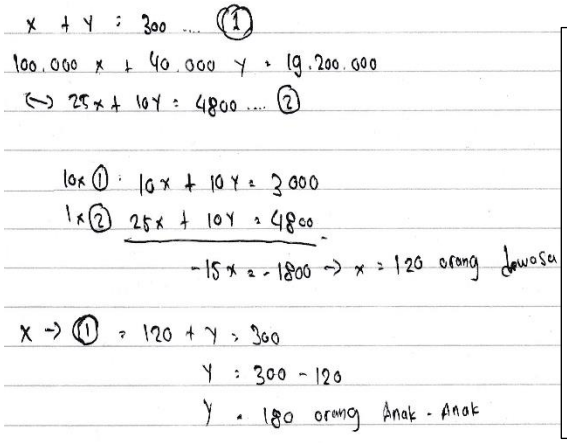
Figure 2. The Creative Thinking Process of Climber Students Occurs in the Perception Component

Perception by climber students occurs after the process of attention. Climber students' allocated perception of the received information as an initial strategy to determine the approach to obtain the correct problem-solving method. Climber students attempt to organize a sequence of solutions per the chosen strategy by directly addressing the problems presented in the questions. According to (Febriani & Ratu, 2018)Organizing a plan to solve a problem necessitates students to possess the ability to generate novel strategies or ideas pertinent to the problems they encounter. The climber student articulated the problem-solving plan by formulating equation (i) x + y = 300, and equation (ii) 100,000x + 40,000y = 19,200,000. Before calculation, the climber student simplified equation (ii) to 25x + 20y = 4800. Subsequently, the climber student employed the elimination method, multiplying equation (i) by 10 to

equalize variable y's coefficients to eliminate y. Following the elimination of y, x = 120 was derived. The subsequent step for the climber student was to substitute the value of x = 120 into Equation (i), which is x + y = 300, yielding the value of y = 180. Information about the number of adults and children's ticket prices has been stored in long-term memory and transferred to short-term memory for further processing.

c. Illumination Stage

During the illumination stage, the cognitive process of high-achieving students commences with retrieval, wherein they execute steps according to a previously selected strategy. This is evidenced by the students' ability to comprehend the concepts utilized in problem-solving effectively. The retrieval component occurs when information stored in long-term memory is recalled to short-term memory or, conversely, when information in short-term memory is transferred to long-term memory. The creative thinking process of high-achieving students is illustrated in Figure 3.



Translate version

$x+y = 300$ .....(1)

$100.000x + 40.000y = 19.200.000$

=> $25x + 10y = 4.800$ .....(2)

10 x (1) : $10x + 10y = 3000$

1 x (2) : $25x + 10y = 48.000$ -

$-15x = -1800$ => $x = 120$ adults

x => (1) : $120 + y = 300$

$y = 300 - 120$

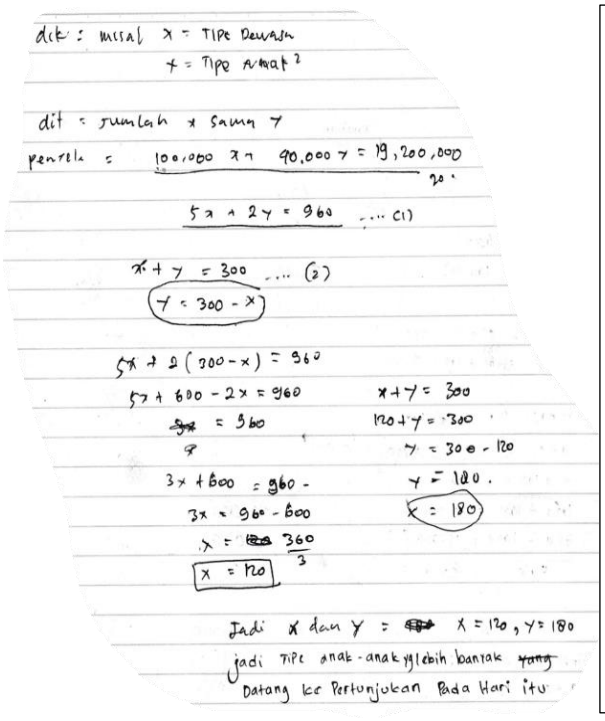
$y = 180$ Children

Figure 3. The Creative Thinking Process of Climber Students Occurs in the Retrieval Component

Climber students retrieve information by transferring concepts from long-term to short-term memory. In solving problems, they recall the elimination method from long-term memory, determine x=120x = 120x=120, and substitute it into the equation to find y=180y = 180y=180, concluding that there are 120 adults and 180 children. Their ability to recall and apply concepts accurately shows effective memory use, leading to correct solutions. They also explain their answers with clear reasoning, and the recalled information is then stored back into long-term memory (Damayanti et al., 2020).

d. Verification Stage

During the verification stage, the cognitive process of climber students commences with encoding, wherein they elucidate each step they have undertaken and subsequently derive conclusions from their completion results. The creative thinking process of the climber students is illustrated in Figure 4.



Translate version

Known: For Instance, x = Adult ticket
y= Child ticket
Problem = the amount of x and y

Solution = $\underline{100.000x + 40.000y = 19.200.000}$: 20.000

= 5x + 2y = 960 ..... (1)

x + y = 300 ... (2)
y = 300 - x

$5x + 2(300-x) = 960$
$5x+600-2x = 960$
$3x + 600 = 960$
$3x = 960-600$
$x = 360/3$
$x = 120$

$x + y = 300$
$120 + y = 300$
$y = 300-120$
$y = 180$

So, x = 120, and y = 180, where more children visitors came to the show on that day

Figure 4. The Creative Thinking Process of Climber Students Occurs in the Encoding Component

Based on the statement above, the encoding process undertaken by the climber students involved concluding by explicating their methodological steps and accurately summarizing the results of their completion. The conclusion derived from the climber students indicates that the number of adults is 120, and the number of children is 180, thus demonstrating that the number of child visitors exceeds that of adults. The requisite knowledge for information processing is effectively stored in the memories of climber students. The information retained in short-term memory was subsequently transferred to long-term memory, indicating that the climber students successfully encoded it.

e. The metacognition level of climber students

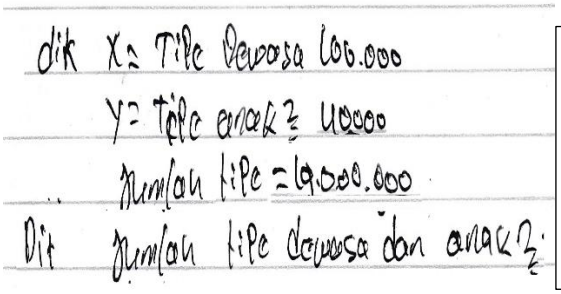
Upon analyzing the creative thinking process of climber students utilizing the information processing theory and comparing it with the metacognition level of students, it was determined that students in the climber category exhibit a reflective metacognition level. Students in the climber category actively consider strategies before taking action, ensuring that each step in problem-solving is executed consciously and deliberately, resulting in comprehensive and accurate responses.

Description of the Creative Thinking Process of Camper Students

The description of the creative thinking process undertaken by the camper students was analyzed based on the components of information processing theory. The components of information processing theory encompass attention, perception, retrieval, and encoding. The analysis pertains to the following problem: "The ticket price for a show is IDR 100.000,00 for adults and IDR 40.000,00 for children. One day, 300 people attended the show, and IDR 19.200.000,00 was obtained from ticket sales. What is the number of adults and children who attended the show that day?

a. Preparation Stage

During the preparatory phase, the cognitive processes of climber students commence with attentiveness, wherein climber students identify pertinent information and formulate problems by documenting known elements and specific inquiries posed in the question. The creative cognitive processes of the camper students are illustrated in Figure 5.



Translate version

Known x : The ticket price for adults is 100.000
y : The ticket price for children is 40.000
the total amount of ticket sale = 19.000.000

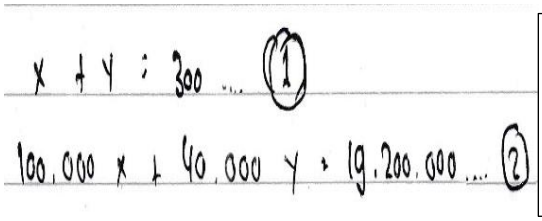
Problems. The number of adult and children tickets sold?

Figure 5. The Creative Thinking Process of Camper Students Occurs in the Attention Component

The cognitive process of creative thinking exhibited by camper students occurs in the attention component, wherein students focus carefully and meticulously on reading questions regarding the information received, and subsequently documenting or articulating the known elements and inquiries within the questions. The manifestation of attention in climber students demonstrates that the known information in the question comprises the number of adult and child visitors, totaling 300 individuals, as well as the ticket prices for adults being 100,000 and for children 40,000, with the total revenue from ticket sales that day amounting to 19,000,000. The student erroneously recorded 19,000,000 at this stage, when the correct figure should have been 19,200,000. Subsequently, the camper student identified that the question sought to determine the number of adult and child visitors. This indicates that the climber students adequately comprehended the questions.

b. Incubation Stage

During the incubation stage, the cognitive processes of the camper students commence with perception, wherein they document or articulate the problem-solving strategies utilized to process the received information. This approach was employed because the strategies adopted by camper students function as the initial framework for information processing. The creative thinking process of the camper students is illustrated in Figure 6.



Translate version

$x + y = 300$ ..... *equation* (1)
$100.00x + 40.000y = 19.200.000$ ..... *equations* (2)

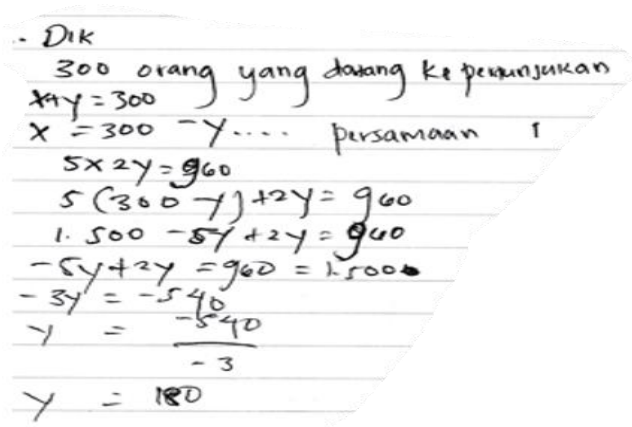
Figure 6. The Creative Thinking Process of Camper Students Occurs in the Perception Component

The perceptions of the camper students occurred after the results of attention. Camper students perceived the received information as an initial plan to determine the strategy for obtaining the correct problem-solving approach. Camper students attempted to arrange the sequence of the solution plan according to the chosen strategy by directly addressing the problem presented in the question. Camper students express their problem-solving plans by formulating the equations 100,000x + 40,000y = 19,200,000 and x + y = 300. However, when information is transferred to short-term memory, the student campers spontaneously generate equations (i) and (ii), decisions made without prior verification or examination. This error constitutes an activity of information addition. According to (Idelia Cahyati & Yuli Eko Siswono, 2022)The behavior of adding information to problems performed by students is a component of the problem-solving strategy.

c. Illumination Stage

During the illumination stage, the cognitive process of the camper students commences with retrieval, wherein they execute the steps per the previously selected strategy. This occurs because the retrieval component is activated when information stored in long-term memory needs to be recalled in

short-term memory or when information in short-term memory is transferred to long-term memory. The creative thinking process of the camper students is illustrated in Figure 7.



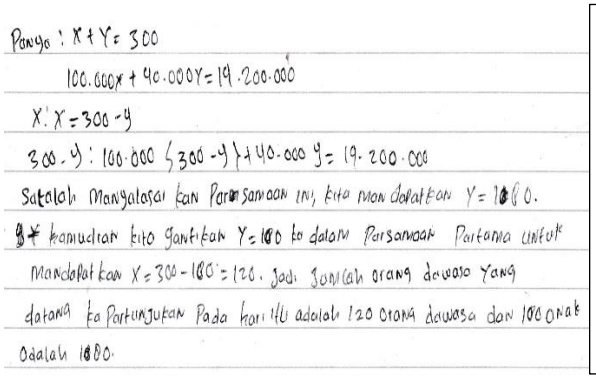
Translate version
Known.
300 people who come to the show
$x + y = 300$
$x = 300 - y$ ..... *equation* 1
$5x + 2y = 960$
$5 (300-y) + 2y = 960$
$1.500 -5y + 2y = 960$
$-5y+2y=960-1500$
$-3y =-540$
$y = \frac{-540}{-3}$
$y = 180$

Figure 7. The Creative Thinking Process of Camper Students Occurs in the Perception Retrieval Component

Retrieval in camper students occurs when the process of recalling information from long-term memory is transferred to short-term memory, or vice versa. To determine the value of the variable x, the multiplication and addition methods were stored in the long-term memory of the camper students. The retrieval of the multiplication concept to determine the number of children was accomplished by substituting the value x = 300-y into the equation. (i). The camper students' work results demonstrate that long-term memory effectively retains the acquired information, enabling students to utilize retrieved concepts in short-term or working memory. However, the students did not consider alternative approaches to solving the problem, resulting in an incorrect solution.

d. Verification Stage

During the verification stage, the cognitive process of the student participants commences with encoding, wherein they elucidate each step they have undertaken and subsequently derive conclusions from the outcomes of their completion. The creative thinking process of the student participants is illustrated in Figure 8.



Translate version
Solution: $x + y = 300$
$100.000x + 40.000y = 19.200.000$
$x = 300-y$
$300-y$: $100.000 (300-y) + 40.000y = 19.200.000$
After solving the equation above, we get the value y=180. By substituting y=180 into the previous equation, we get x=300−180=120. So, the number of adults who came to the show that day is 120, and the number of children is 180..

Figure 8. The Creative Thinking Process of Camper Students Occurs in the Perception Encoding Component

Based on the statement above, the encoding performed by the camper students comprised conclusions derived from elucidating the steps undertaken and accurately summarizing the results of their completion. The conclusion reached by the camper students indicated that they recorded 120 adults and 180 children. The requisite knowledge for processing information is effectively stored in camper students. Information stored in short-term memory is subsequently transferred to long-term memory; in other words, the camper students successfully encoded it.

e. The metacognition level of Camper students

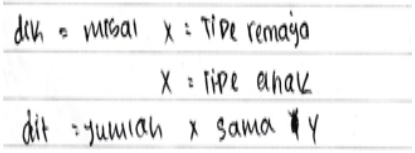
Upon analysis of the creative thinking process of Camper students utilizing information processing theory and subsequent comparison with the students' metacognition levels, it was determined that students in the Camper category exhibit a semi-reflective use of metacognition. Students in this category demonstrate self-awareness; however, they may not consistently engage in deep reflection before taking action. This tendency can result in errors when transcribing information in questions, leading to inaccuracies in determining the final results.

The Creative Thinking Process of Quitter Students

The creative thinking process exhibited by quitter students is analyzed based on the components of information processing theory. These components include attention, perception, retrieval, and encoding. The analysis was conducted regarding the following problem: "The ticket price for a show is IDR. 100,000.00 for adults and IDR. 40,000.00 for children. One day, 300 people attended the show, and IDR. 19200,000.00 was obtained from ticket sales. What is the number of adults and children who attended the show that day?",

a. Preparation Stage

During the preparation stage, the cognitive process of students who discontinue their efforts initiates with attention, wherein these students identify information and formulate problems by documenting the known elements and inquiries posed in the question. The creative thinking process of such students is illustrated in Figure 9.



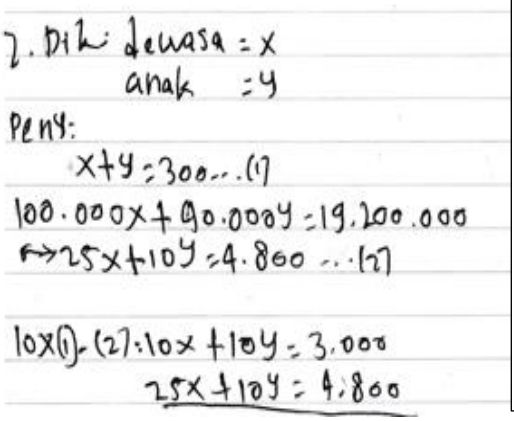
Translate version
Known: For Instance x = Adults
y = children
Problems: the amount of x and y?

Figure 9. The Creative Thinking Process of Quitter Students Occurs in the Attention Component

The creative thinking process carried out by quitter students occurs in the attention component, where students focus on reading the questions carefully and meticulously regarding the received information, then writing analogies and creating mathematical models for the questions where the students defined variable x as adults and variable y as children. Next, the student quitter mentioned that what was asked in the question was the number of x and the number of y that were inquired about. This shows that the attention of the quiet students understand the question well.

b. Incubation Stage

During the incubation stage, the cognitive process of students exhibiting quitting behavior commences with perception, wherein these students document or articulate the problem-solving strategies utilized to process the received information. The strategies employed by students prone to quitting represent their initial approaches to processing the acquired information. The creative thinking process of such students in the perception component is illustrated in Figure 10.



Translate version
Known : adults = x
Children = y
Solution:
$x+y = 300$ .....(1)
$100.000x + 40.000y = 19.200.000$
=> $25x + 10y = 4.800$ .....(2)

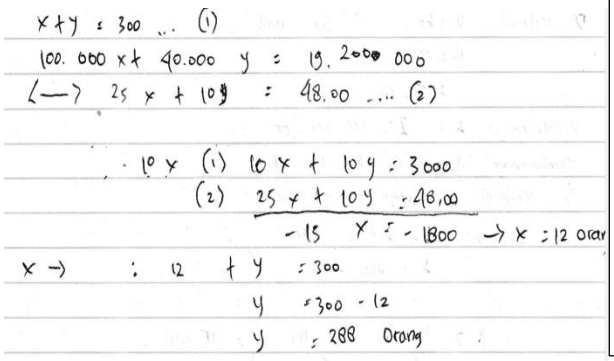
10 x (1) : $10x + 10y = 3000$
$25x + 10y = 48.000$ -
$-15x = -1800$ => $x = 120$ adults

Figure 10. The Creative Thinking Process of Quitter Students Occurs in the Perception Component

The students who discontinued their efforts perceived the received information as a plan to determine an appropriate strategy for addressing the problem. This student articulated a plan to solve the equations (i) x + y = 300 and (ii) 25x + 10y = 48000, where equation (ii) was derived from simplifying 100,000x + 40,000y = 19,200,000. The information obtained by the student is stored in long-term memory and subsequently transferred to short-term memory for further processing. However, students fail to consider alternative problem-solving strategies upon transfer to short-term memory, resulting in incomplete outcomes.

c. Illumination Stage

During the illumination stage, the cognitive process of students who discontinue their efforts initiates with retrieval, wherein they execute steps based on the previously selected strategy. This retrieval component occurs when information stored in long-term memory needs to be recalled in short-term memory. The creative thinking process of students who persist to a certain extent can be observed in Figure 11.



Translate version
$x+y = 300$ .....(1)
$100.000x + 40.000y =$
$19.200.000$
=> $25x + 10y = 4.800$ .....(2)

10 x (1) : $10x + 10y = 3000$
(2) : $25x + 10y = 48.000$ -
$-15x = -1800$ => $x = 120$
people

x => (1) : $12 + y = 300$
$y = 300 - 12$
y = 288 people

Figure 11. The Creative Thinking Process of Quitter Students Occurs in the Retrieval Component

Retrieval in students exhibiting quitter behavior occurs when recalling information from long-term memory is transferred to short-term memory, or vice versa. To determine the value of variable x, the retrieval process of these students resulted in incomplete and insufficient outcomes; specifically, the written result was 12 adults. The work products of students demonstrating quitting behavior revealed that long-term memory effectively stores acquired information; however, when retrieving concepts for application in short-term or working memory, these students cannot utilize the information effectively. Furthermore, students exhibiting quitting behavior do not explore alternative problem-solving

approaches, resulting in incorrect solutions.

d. Verification Stage

At the verification stage, *quieter* students perform encoding by explaining their steps and drawing conclusions. However, they do not evaluate or recheck their solutions using other methods, indicating that they do not fully engage in the verification process.

e. The Metacognition Level of Quitter Students

Based on the analysis of the creative thinking process using information processing theory, students in the *quitter* category are at the **tacit use** metacognition level, meaning they use knowledge intuitively without deep reflection. They can understand the questions, but lack strategy use, resulting in often incomplete and inaccurate outcomes.

Discussion

This research resulted in three main findings. First, in the analysis of creative thinking processes and Adversity Quotient (AQ), it was found that students with high AQ (climbers) were able to complete all four stages of the creative thinking process—preparation, incubation, illumination, and verification—with a level of metacognition reflective use. Students with moderate AQ (camper) only completed the first three stages and were at the semi-reflective use level. In contrast, students with low AQ (quitter) only completed the preparation and incubation stages, with the level of tacit use of metacognition. This shows that climber students have better problem-solving skills than campers and quitters (Damayanti et al., 2020). These findings support the idea that resilience and perseverance (AQ) contribute to improving creative thinking skills, especially in open-ended questions. The practical implication is that teachers must understand the student's AQ profile to design an appropriate learning strategy. For example, quitter students need more support to build resilience, while climber students can be given more complex challenges to optimize their creative thinking potential.

Second, in the information processing stage, climber students can undergo the entire process: attention (focusing attention on relevant information), perception (developing a completion strategy), retrieval (accessing information from long-term memory), and encoding (deducing results). Meanwhile, camper and quitter students experience obstacles in several stages, especially in processing information effectively. This shows that students who can undergo the complete information processing stage—especially climbers—are more successful in solving problems thoroughly (Amaliyah et al., 2022) Therefore, through these stages, from attention to encoding, math learning can be designed systematically through explicit exercises and guidance to develop a systematic and effective problem-solving approach.

Third, variations in the level of metacognition have been shown to affect the effectiveness of information processing in solving open-ended problems. Students with high metacognition (reflective use) show a more thorough creative thinking process and can well plan, evaluate, and verify their solutions. This is in line with the findings (Suryaningrum et al., 2020) This states that students at the reflective use level can evaluate and strategize solutions effectively. In contrast, students with low metacognition (tacit use) tend to rely only on intuition without deep reflection, which results in incomplete solutions. Therefore, improving metacognitive awareness needs to be an important part of the learning process. Teachers can use activities such as group reflection, critical thinking exercises, or self-assessment to encourage students of all levels of metacognition to develop more reflective problem-solving approaches. Strong metacognitive abilities are also important in lifelong learning, especially amid dynamic and rapidly changing global challenges.

These three findings demonstrate the importance of creating an adaptive learning environment to maximize students' potential by developing resilience, information processing skills, and metacognitive awareness. However, this study has three main limitations. First, use only three categories of AQ

(climber, camper, quitter), which may not reflect the overall variation of AQ among students. Second, the limited sample size (29 students) limited the generalization of the findings to a wider population or different educational backgrounds. Third, the study focused only on analyzing open-ended mathematical problems and limited the classification of metacognition to three levels, which may oversimplify the actual complexity. Therefore, follow-up studies should use a larger and more diverse sample, a longitudinal approach, and extend the study context to other areas to comprehensively deepen the understanding of this process.

4. CONCLUSION

This study explored the creative thinking processes of students with varying adversity quotient personalities and metacognitive levels in solving open-ended problems, using information processing theory as a framework. Findings revealed that "climber" students, with reflective metacognition, completed all four stages of creative thinking: preparation, incubation, illumination, and verification. "Camper" students, showing semi-reflective metacognition, reached only the first three stages, while "quitter" students, with tacit metacognition, progressed only through the preparation and incubation stages. The study suggests future research should further investigate these stages and metacognitive levels, possibly using components of information processing theory, and include a larger sample size, as this study involved only three participants.

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