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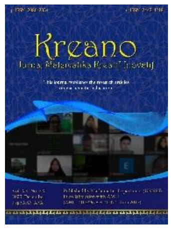

Didactic Design for Developing Students' Creative Thinking Ability in Solving Open-Ended Problems: An Adversity Quotient Perspective

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Abstract

This study aims to develop students' creative thinking skills, address their learning obstacles, and describe their creative thinking abilities in relation to their adversity quotient. A qualitative approach was employed using the Didactical Design Research (DDR) method, which consists of three stages: prospective analysis, metapedadidactic analysis, and retrospective analysis. The participants were students from class XA DPIB, selected based on preliminary findings indicating variations in creative thinking skills and levels of adversity quotient (the ability to endure and overcome challenges). Data were collected through both test and non-test techniques, including observation, interviews, questionnaires, and documentation. Data analysis was carried out through the stages of data reduction, data display, and conclusion drawing or verification. The results of the prospective analysis revealed the existence of learning obstacles among students, emphasizing the need to identify, analyze, and address these barriers in the learning process. The metapedadidactic analysis indicated that the developed didactical design was effective in overcoming students' learning difficulties. Meanwhile, the retrospective analysis demonstrated an expansion in the prediction of student responses and an improvement in the quality of didactic-pedagogical anticipation by the teacher. The findings imply that the implementation of a didactical design based on students' learning obstacles and adversity quotient can serve as an effective strategy for enhancing students' mathematical creative thinking skills. It can be concluded that the didactical design developed in this study not only succeeded in addressing students' learning barriers but also effectively improved their mathematical creative thinking skills when viewed from the perspective of their adversity quotient.

Keywords: Didactic Design; Creative Thinking Skills; Open-Ended; Adversity Quotient; Learning Obstacle.

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Abstrak

Penelitian ini bertujuan untuk mengembangkan kemampuan berpikir kreatif siswa dan mengatasi hambatan belajarnya, serta mendeskripsikan kemampuan berpikir kreatif siswa ditinjau dari adversity quotient. Penelitian ini menggunakan pendekatan kualitatif dengan metode DDR (Didactical Design Research) yang terdiri dari tiga tahapan, yaitu prospective analysis, metapedadidactic analysis, dan retrospective analysis. Subjek dalam penelitian ini adalah siswa kelas XA DPIB. Pemilihan subjek ini didasarkan pada temuan awal bahwa kelas tersebut menunjukkan variasi dalam kemampuan berpikir kreatif dan tingkat adversity quotient (kemampuan bertahan dan mengatasi kesulitan). Teknik pengumpulan data dilakukan melalui tes dan non-tes, meliputi observasi, wawancara, angket (kuesioner), dan dokumentasi. Analisis data dilakukan melalui tahapan reduksi data, penyajian data, dan penarikan kesimpulan atau verifikasi. Berdasarkan hasil analisis prospektif, ditemukan adanya hambatan belajar pada peserta didik, yang menunjukkan pentingnya identifikasi, analisis, dan penanganan faktor-faktor penghambat dalam proses pembelajaran. Selanjutnya, dari hasil analisis metapedadidaktik diketahui bahwa desain didaktis yang dikembangkan terbukti efektif dalam mengatasi hambatan belajar siswa. Sementara itu, hasil analisis retrospektif menunjukkan adanya perluasan dalam prediksi respon siswa dan peningkatan kualitas antisipasi didaktis-pedagogis oleh guru. Implikasi dari penelitian ini adalah bahwa penerapan desain didaktis berbasis hambatan belajar dan karakter adversity quotient siswa dapat menjadi strategi yang efektif dalam meningkatkan kemampuan berpikir kreatif matematis. Dengan demikian, dapat disimpulkan bahwa desain didaktis yang dikembangkan dalam penelitian ini tidak hanya mampu mengatasi hambatan belajar siswa, tetapi juga berhasil meningkatkan kemampuan berpikir kreatif matematis siswa ditinjau dari adversity quotient-nya.

INTRODUCTION

Creative thinking is an intellectual process that enables individuals to discover new experiences, ideas, concepts, and knowledge. Mathematical creative thinking skills often serve as the primary orientation of mathematics learning, aiming to enhance students' creativity in mathematics (Ibrahim, Khalil & Prahmana, 2024). The ability to think creatively facilitates individual learning by actualizing imagination and providing opportunities for innovative thinking. Creative thinking is often treated as a complex cognitive process that requires specific input and produces creative output (Pinkow, 2023).

Creative thinking ability is one of the cognitive competencies that allows individuals to act flexibly, identify opportunities within limitations, and contribute to creating added value that impacts socio-economic competition. This perspective aligns with Peter (2012) assertion about the importance of creative thinking: "Students who are able to think creatively are able to solve problems effectively." To compete successfully in both professional and personal contexts, students must possess problem-solving skills and demonstrate creative thinking abilities. Creative thinking aims to establish new relationships between concepts, discover novel solutions to problems, develop new systems, and create innovative artistic forms. Therefore, through creative thinking, students can discover and determine innovative approaches to problem-solving. The development of creative thinking skills has been regarded as one of the most substantial objectives of education for over a century (Larraz-Rábanos, 2021). The development of creative thinking skills has been a significant objective in education for over a century, with increasing emphasis in recent decades. This focus is driven by the recognition that creativity is essential for problem-solving, innovation, and adaptability in a rapidly changing world (Fasko, 2016; Kalimullin & Utemov, 2017; Kanematsu & Barry, 2016)

Creative thinking skills can be developed through exercises that focus on fostering students' creative thinking abilities. Mathematical creative thinking involves cognitive processes that enable individuals to generate novel ideas and solutions. It requires a balance between logical reasoning and intuitive thinking, engaging both hemispheres of the brain to solve complex problems creatively. Creative thinking allows individuals to approach mathematical problems unconventionally, leading to innovative solutions. Creative thinking is essential for innovative problem-solving in mathematics. By implementing problem-solving approaches, fostering independent learning, and using specific educational models, educators can significantly enhance students' creative thinking abilities. This, in turn, leads to more effective and innovative solutions to mathematical problems (Asare et al., 2025; Newton et al., 2022; Wigert et al., 2022)

To cultivate students' mathematical creative thinking, it is essential to equip them with the capacity to solve open-ended problems that permit various valid approaches (Shimada, 1997; El Turkey, Karakok, Cilli-Turner, *et al*, 2024; Karakok, Tang, Cilli-Turner, Turkey, Satyam, Savić, 2022). The implementation of such inquiries has been demonstrated to foster exploration, enhance problem-solving capabilities, and nurture diverse strategies. Saragih et al. (2021) posited that learning with open-ended problems promotes student autonomy and interaction between mathematics and students. As asserted by Getenet et al. (2025), this pedagogical approach has been shown to enhance creative activity, facilitate diverse responses through the utilization of extensive knowledge, and promote reasoning through classroom discussions.

The development of creative and mathematical thinking skills supports students in solving open-ended problems. However, in practice, such problems remain challenging for educators. This aligns with (Munroe, 2015), who observed that some teachers struggle to implement the Open Approach in mathematics instruction. For students, developing creative thinking can also be difficult, often leading to frustration or giving up. Thus, students need additional competencies to turn challenges into opportunities. Pradiarti et al. (2024) found that students' creative thinking in solving complex problems is still lacking. This is supported by Trends In International Mathematics and Science Study (TIMSS), which placed Indonesian students in the lowest quartile among 49 countries, with an average mathematics score of 397 (below the international standard of 500) (Mullis et al., 2016). Similarly, Programme for International Student Assessment (PISA) ranked Indonesia 70th out of 80 countries in mathematical literacy, highlighting the ongoing need to strengthen students' reasoning and creative thinking skills (OECD, 2023).

In addition to the student perspective, it is imperative to acknowledge the role of educators in cultivating learning environments that foster creative thinking. A significant number of teachers continue to encounter challenges in the design of open-ended problems that promote students' exploration of ideas, the identification of indicators of creative thinking within the context of mathematics, and the adaptation of learning strategies to suit the diverse needs of students. Nakul et al. (2024) revealed that some teachers tend to opt for procedural approaches because they are considered easier to measure and teach, with the result that aspects of developing student creativity are neglected. Indeed, it is the responsibility of teachers to design didactic situations that can encourage students' creativity and resilience in solving complex and open-ended mathematical problems.

Based on the above discussion, the researcher argues that enhancing creative thinking can be achieved by focusing on students' Adversity Quotient (AQ). According to AQ theory, one's ability to survive, rise, and grow through adversity reflects their AQ (Saxena & Rathore, 2025). Likewise, the capacity to generate original, flexible, and effective ideas in complex situations reflects creative thinking. Parvathy & Praseeda (2014) emphasized AQ's crucial role in students' academic and emotional success, noting that individuals with high AQ persist through failure a key trait in creative thinking. Ummi (2023) found that students with high AQ show resilience, flexible thinking, and openness to various problem-solving approaches, all of which support success in open-ended mathematics problems. The link between AQ and creative thinking highlights that learning must address not only cognition but also mental endurance and adaptability. Thus, integrating AQ-focused strategies into learning can effectively nurture students' creative thinking in a sustained and meaningful way.

In the learning process, students must overcome all problems, difficulties, and obstacles that arise at any time, significantly when solving math problems, so the adversity quotient is considered important for students to have. Adversity quotient, in addition to being a person's role in facing challenges, can also be a mental coaching for students to avoid psychological problems. Mulyani et al. (2019) stated that someone with a high adversity quotient will always try to complete the assigned task even if they find difficulties. By having an adversity quotient, students are considered more able to see from the positive side and more daring to take risks, so demands and expectations are used as support. According to Stolz (2007), the way to strengthen the Adversity Quotient (AQ) can be done with the term LEAD, "Listened, Explored, analyzed, Do," by trying to listen and be aware of the difficulties that occur. In this case, the question difficulty is the learning difficulty/obstacle known as a learning obstacle.

A learning obstacle is an obstacle experienced by students during the learning process where students have difficulty understanding a concept and determining the solution to the problem, causing learning goals not to be achieved. In line with that, Septiani and Nurhayati (2019) define a learning obstacle as a situation where students receive information that they consider correct but is wrong due to their limited knowledge. That is why learning obstacles are referred to as difficulties experienced during the learning process that make students unable to understand a concept (Kim How et al., 2022).

Given the above considerations, it is essential to examine learning obstacles thoroughly so that educators can understand student difficulties from cognitive, emotional, and pedagogical perspectives. Identifying these obstacles supports the development of adaptive strategies and helps prevent misconceptions that hinder concept mastery. This study serves as a foundation for designing learning that meets individual student needs. Therefore, a systematic and contextual approach is needed to identify, analyze, and anticipate such obstacles. Didactical Design Research (DDR) was chosen as the guiding framework, as it allows for the design, implementation, and revision of learning based on students' actual learning situations. This approach emphasizes not only material delivery but also the creation of learning situations that help address and prevent learning obstacles.

Didactic design serves as an effective approach to address students' learning barriers by guiding them toward comprehensive understanding. Teachers are expected to design learning that not only achieves objectives but also anticipates potential obstacles (Prabowo, Suryadi, Dasari, Juandi, & Junaedi, 2022). As emphasized by Luthfia & Zanthy (2019) anticipating students' errors is essential to prevent repetition. Integrating didactic design with Adversity Quotient (AQ) and creative thinking analysis introduces a research novelty, as previous studies have rarely explored this combination. This study links students' conceptual responses with their AQ and creativity in solving open-ended problems, making the didactic design more contextual and responsive to individual learning characteristics. Thus, it contributes to the development of adaptive mathematics instruction that aligns with diverse student needs.

The problem in this study lies in students' limited ability to generate multiple solutions due to a lack of creative thinking training, especially in solving open-ended math problems. This is partly because teachers rely solely on textbook materials without considering students' readiness or learning obstacles. One such obstacle is students' lack of focus, often due to the neglect of their affective aspects, such as the adversity quotient. To improve the quality of mathematics learning, it is essential to develop students' creative thinking and increase teachers' attention to open-ended problems and students' adversity quotient. Therefore, this study focuses on didactic design and students' mathematical creative thinking in solving open-ended problems, viewed through the lens of adversity quotient.

The research questions in this study are as follows: 1) What are the learning barriers experienced by students in learning mathematics?; 2) How should the hypothetical didactic design in mathematics learning be considered based on learning barriers that can develop students' mathematical creative thinking skills in solving open-ended problems in terms of Adversity Quotient?; and 3) How should the implementation of didactic design be considered to overcome learning barriers and develop students' computational thinking abilities?. Theoretically, this research contributes to the study of the role of AQ in the mathematical creative thinking process. In practice, the results of this study can serve as a reference point for educators in designing learning experiences that are more adaptable to students' levels of readiness and the challenges they face in their learning.

METHOD

This study employs a qualitative approach using the Didactical Design Research (DDR) method to generate descriptive data in the form of narratives. Didactical Design Research (DDR) is a methodology aimed at designing and improving teaching-learning arrangements while generating theoretical contributions to understand the initiated teaching-learning processes for specific topics. DDR focuses on creating and refining educational interventions to enhance the effectiveness of teaching and learning processes (Prediger, 2019). It involves modeling educational settings to strengthen the interplay between content, students, and teachers (Vallance, 2021). DDR aims to uncover and address learning obstacles through the teacher's thought process, which occurs in three phases: before, during, and after instruction (Diana & Suryadi, 2020).

The research process begins with a

prospective didactical analysis that investigates the initial conditions of learning, student learning obstacles, and the characteristics of the subject matter through observations, document analysis, and teacher interviews (Pratiwi et al., 2019; Puspita et al., 2023). Based on this analysis, a Hypothetical Learning Trajectory (HLT) is constructed, consisting of a sequence of learning activities, anticipated student responses, and teacher strategies to address potential responses (Permana & Retnawati, 2020; Rohimah & Juandi, 2024). The next phase involves the implementation and revision of the didactical design (metapedadidactic analysis), during which interactions in the classroom are carefully documented and compared with the initial predictions. Revisions are made when significant discrepancies or unanticipated student responses are observed. Following the learning implementation, a didactical situation analysis is conducted through two stages: actual analysis and retrospective analysis, which are used to evaluate the effectiveness and adaptability of the developed design. The researcher identifies changes in student understanding as well as the validity of the piloted design.

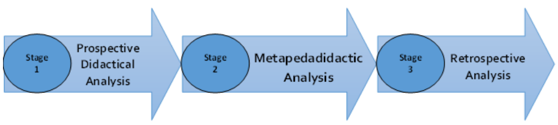


Figure 1. Research Stages

This study focuses on learning design development, particularly the interaction among students, teachers, and teaching materials. The Didactical Design Research (DDR) framework was chosen for its flexibility in adapting to student responses, systematic assessment of learning outcomes, and iterative design improvement based on classroom realities (Alhaj & Sharah, 2020; Günaydin & Karamete, 2016; Loukomies et al., 2015). Unlike approaches that emphasize only outcomes, DDR emphasizes both product and process, making it suitable for educational innovation. The research was conducted at SMK Negeri 04 Enrekang with 30 grade X DPIB students. Four students were selected for interviews based on their adversity quotient profiles. Data were collected through tests, observations, interviews, and documentation. The test measured students' mathematical creative thinking in number pattern topics. Observations focused on the implementation of the learning design and emerging learning obstacles, while interviews helped identify the specific difficulties students faced after completing the test.

In qualitative research, data analysis occurs before, during, and after fieldwork. Researchers began by preparing instruments such as interview guidelines and observation sheets aligned with the research focus. Throughout the process, empirical evidence was documented through direct observation, including student responses and identified learning obstacles.

After data collection, analysis proceeded with data reduction—filtering and selecting information relevant to the research objectives while eliminating redundant or insignificant content. The reduced data were then organized into clear formats such as narratives, tables, or matrices to support further analysis. Finally, conclusions were drawn and verified through triangulation to ensure accuracy and consistency. This interactive and ongoing process ensured that the analysis reflected actual field conditions.

RESULT AND DISCUSSION

Results

Prospective Didactical Analysis

The analysis phase involved several activities: (1) selecting the research material, namely sequence number patterns and arithmetic series, as the foundation for designing instruction; (2) determining the research site, chosen due to relevant learning challenges identified through preliminary observations and teacher discussions; (3) identifying research subjects, involving 30 students who completed open-ended tasks to assess creative thinking, from which four were selected for in-depth interviews based on their responses; (4) preparing open-ended test instruments designed to measure students' mathematical creative thinking ability, consisting of four items; (5) administering the tests to students; and (6) analysing test results in relation to students' adversity quotient.

Based on AQ analysis, subject AR was classified as a Climber and selected for further examination due to representative responses, as confirmed through questionnaires and interviews. The outcomes of the analysis pertaining to mathematical creative thinking skills in question number 1 categorized AR within the medium category. This can be seen from the following answer sheet.

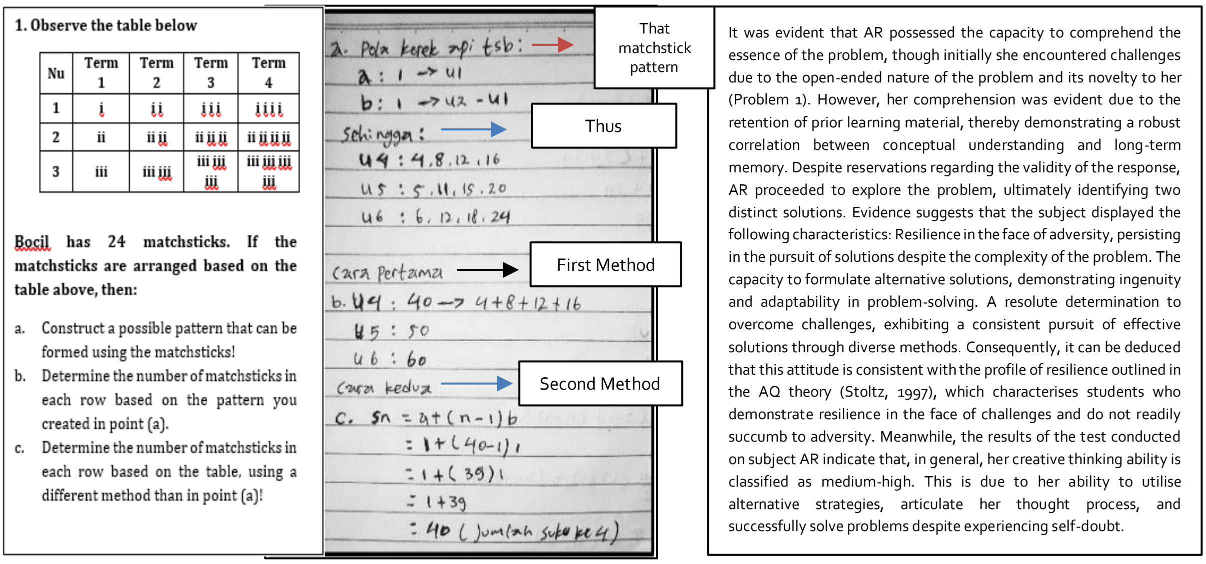
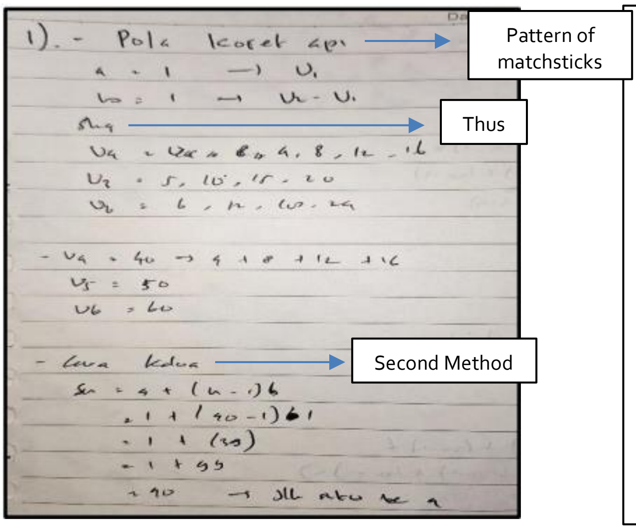


Figure 2. Subject AR's Answers in Question Number 1

The AR subject could answer question 1a by making a pattern matching each line defined by U4, U5, and U6 and the correct value. In question 1b, the AR subject only answered the number of number patterns in line U4, but they were not summed in rows U5 and U6. Furthermore, in number 1c, AR subjects could give answers differently, namely indicators of flexibility in creative thinking skills. However, AR subjects only answered the number pattern in the U4 sequence, while U5 and U6 were not summed. Students AR can get the desired understanding when the learning obstacle is implemented because some can already provide answers. Meanwhile, based on the interview results, the AR subject showed that question 1 could not be understood correctly. AR subjects found it difficult to understand problem 56. Then, the subject is not able to understand question number

1. The AR subjects' responses did not indicate that the answers presented were different, but the AR subjects quickly realized the misinformation that there was another way to solve problem number 1. Judging from the written test and interviews conducted by the researcher with AR subjects, it can be shown that AR can provide various answers in more than one way. However, there are still mistakes in answering questions 1b and 1c due to a lack of understanding of the questions presented during the interview, so a score of 3 is given on the fluency indicator and a score of 2 on the flexibility indicator.

Subject 2 (BR) is in the Champer category. BR is the medium category in the BR creative thinking ability test at number 1. This can be seen from the following BR answer:



In a series of problems that yielded different results through various methods, BR subjects did not demonstrate confusion or discouragement. Instead, they demonstrated the capacity to evaluate and select solutions that they regarded as more rational. These findings suggest that the subjects demonstrated a satisfactory level of AQ, particularly with regard to endurance and control, which renders them suitable candidates for further research investigating the relationship between AQ and creative thinking performance. Subject R exhibited a solid comprehension of mathematical principles, as demonstrated by his capacity to think flexibly and solve problems, particularly open-ended ones. Subject R is a student who demonstrates high-level creative thinking ability, flexibility in problem-solving strategies, and high adversity intelligence. This commitment is evidenced by his resilience in the face of unfavorable outcomes, as well as his steadfast dedication to exploring alternative approaches. R exhibited considerable potential in his application as a representation of a student who demonstrated a reflective and independent problem-solving profile.

Figure 3. Subject BR's Answers in Question Number 1

Based on Figure 3 above, subject BR solved the problem at number 1 with various answers, namely the fluency indicator on creative thinking skills. Subject BR can answer question number 1 in two ways of completion: the exponential and manual methods. Subject BR demonstrated an aptitude for mathematical creativity by employing two distinct approaches to solve the problem, thereby evidencing a high degree of flexibility in their thought process.

Preliminary findings from the interview suggest that the subject, BR, demonstrated an ability to comprehend some aspects of the problem, yet lacked a comprehensive understanding of its essence. This suggests that his comprehension of Problem 1 was not yet at a satisfactory level. Preliminary findings from the empirical investigation, in conjunction with the results of the interview, indicate that the subject, BR, exhibited the capacity to propose two distinct methodologies for addressing issue number 1. These methodologies entailed the direct addition of variables and the subsequent utilization of a formula $Sn = a + (n\text{-}1)\ b$. The sum of the first n terms is equal to the sum of the first n terms minus one, multiplied by the first n terms. This finding suggests a degree of adaptability, as the subject is capable of employing multiple solution strategies.

However, an analysis of the interview results suggests that BR's comprehension of the issue may be somewhat compromised, as evidenced by his statement:

P: Did you encounter any challenges in providing a response to this inquiry?

BR: At this juncture, the response is negative.

The question posed to the subject is whether an alternative method exists. It can be demonstrated that an alternative method exists, whereby Sn is equivalent to a plus (n-1) b.

P: With regard to the previous method, what are your thoughts?

BR: The preceding technique employed the plus sign.

It is evident from the response that, while BR did cite two methods, he was unable to provide a comprehensive explanation of his thought process or demonstrate a profound comprehension of the application of formulas. Furthermore, a discrepancy was observed in the final results of the two methods, suggesting an error in the application of the concept or a deficiency in the accuracy of the reading of the problem. This finding suggests that the subject's proficiency in problem-solving may not be at its peak. Consequently, subject BR received a score of 3 on the Fluency indicator, as he demonstrated the ability to provide multiple pertinent responses, though not all of them were accurate. Conversely, a score of 2 was allocated on the Flexibility indicator, as the subject demonstrated the existence of an alternative approach, yet this was not accompanied by a concomitant understanding or adjustment of the appropriate strategy to the context of the problem.

Subject 3 (CM) is in the Climber category. CM was classified as in the medium category in the creative thinking ability test at number 1. This can be seen from the following CM answer:

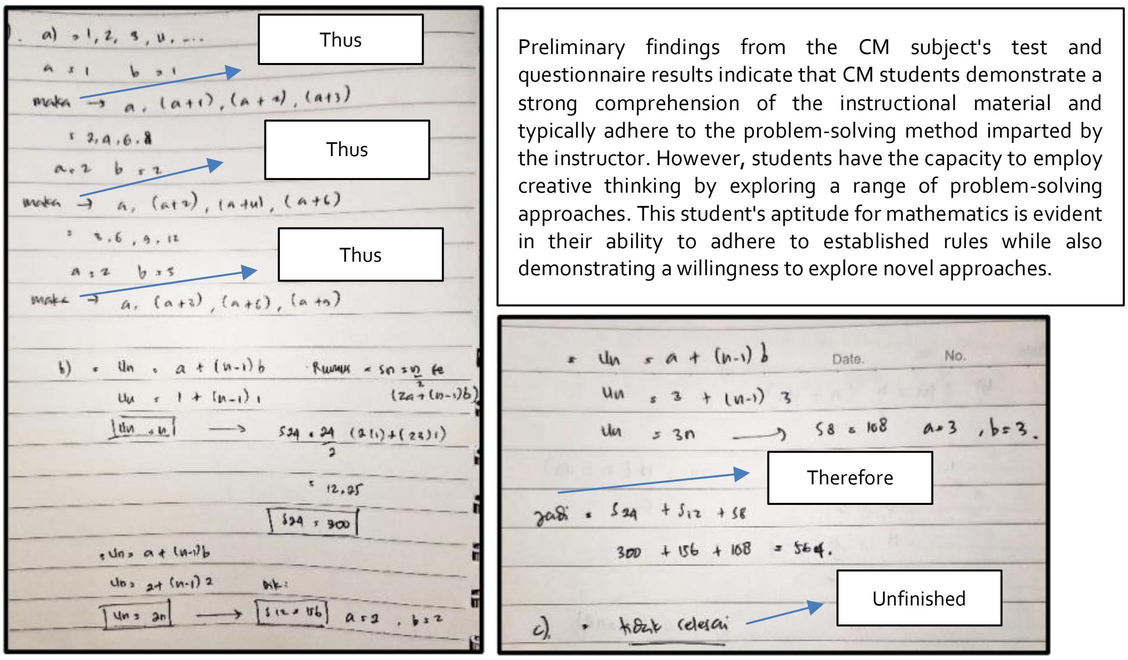
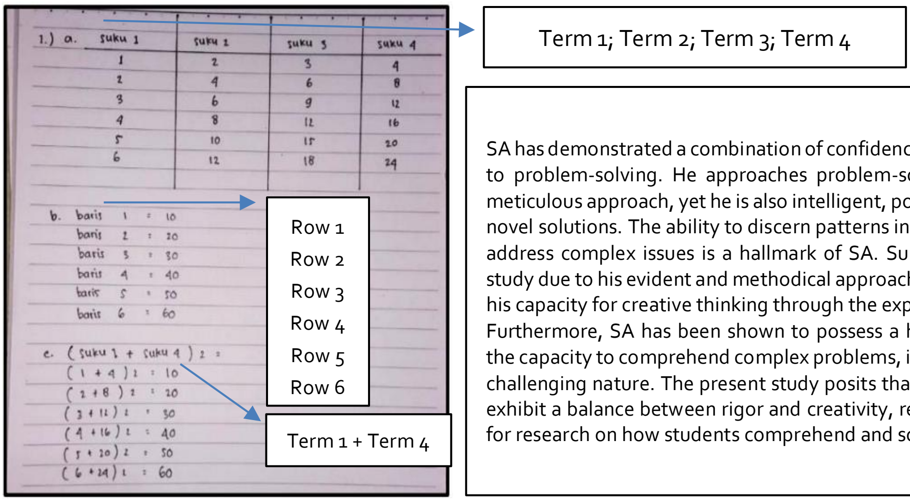


Figure 4. Subject CM's Answers in Question Number 1

Based on Figure 4 above, subject CM solved problem 1 with various answers, namely the fluency indicator on creative thinking skills. Subject CM can make a match pattern with each line explaining the pattern found by reasoning an as a term one and b as a difference in the match arrangement pattern. In question number 1b, subject CM answers the number pattern based on the pattern found in number 1a by using the Un formula to determine Sn, so the answer has an incorrect value. Furthermore, in number 1c, subject CM did not answer differently, so it met the flexibility indicator in thinking ability.

Based on the interview results, subject M showed that question number 1 was not well understood. Subject CM had difficulty understanding the problem that was proven wrong in CM's answer. This was seen when the researcher asked about different ways to answer question number 1. CM's response showed that the answers presented did not have a different way according to the order of the questions. Judging from the written test and interviews conducted by the researcher with the subject CM, it can be shown that CM can provide a variety of answers with one of the correct answers and does not give answers in more than one way. However, because there was a mistake in answering question number 1 due to misinterpreting the question or not being careful in reading the question thoroughly when the researcher conducted the interview, a score of 3 was given on the fluency indicator and a score of 2 on the flexibility indicator.

Subject 4 (SA) is in the Climber category. In the SA creative thinking ability test at number 1, SA is classified as a high category.



SA has demonstrated a combination of confidence and caution in their approach to problem-solving. He approaches problem-solving with a methodical and meticulous approach, yet he is also intelligent, possessing the capacity to devise novel solutions. The ability to discern patterns in problems and to methodically address complex issues is a hallmark of SA. Subject SA was selected for this study due to his evident and methodical approach to problem-solving, as well as his capacity for creative thinking through the exploration of diverse techniques. Furthermore, SA has been shown to possess a high degree of confidence and the capacity to comprehend complex problems, including those of a particularly challenging nature. The present study posits that SA exemplifies students who exhibit a balance between rigor and creativity, rendering it a suitable exemplar for research on how students comprehend and solve mathematical problems.

Figure 5. Subject SA's Answers in Question Number 1

Based on Figure 5 above, the SA subject solved the problem at number 1 with various answers, namely the fluency indicator on the ability to think creatively. Subject SA can answer question number 1 by making a match pattern in the form of a table containing terms 1 to 4 consisting of 6 rows according to the sound of question number 1a with a maximum number of matches of 24 sticks. In question 1b, the subject SA answered the number of number patterns based on the pattern found in number 1a, which is to directly write the number from the 1st to the 6th row. Furthermore, in number 1c, the SA subject answered differently, indicating flexibility in creative thinking skills. Based on the interview results, the subject SA showed that question 1 was good. SA subjects do not find it difficult to understand the problem by presenting a table in order with their terms. Then, the subject can understand problem number 1 well because it requires the subject to determine the number of each line in number 1b and the other way in number 1c. This can be seen when the researcher asks questions about different ways to answer question number 1. The response of the SA subject showed that the answers presented had a different way and according to the order of the question item. Judging from the written test and interviews conducted by the researcher with the subject of SA, it can be shown that SA can answer various correct answers, and there is more than one in each line in question number 1. The SA subject answered question number 1 correctly because he interpreted the question well and answered question number 1 without using the method when the researcher conducted the interview; then, he was given a score of 3 on the fluency indicator and a score of 3 on the flexibility indicator.

Table 1. The results of the presentation of learning obstacles for each subject in all questions

Subject	STKBK 1	STKBK 2	STKBK 3	STKBK 4
Subject Champer AR	a. Did not answer all the answers b. Not able to understand the whole problem	a. Did not answer all the answers b. I am not able to understand all the questions c. Wrong answer to questions b and c	a. Not providing a new way b. Wrong answer to question number 3b	a. It is not appropriate to use the Sn formula b. Mistakes in answering questions
Subject Champer BR	Wrong answer to the question because you do not read the question carefully	Not outlining the problem-solving	a. Not explaining in a unique/new way b. Wrong answer	Wrong answer to the question
Subject Climber CM	a. Errors using formulas b. Not understanding the problem correctly c. Wrong answer to the question	a. Not answering the question until it is finished. b. Not able to understand the problem well	Have not given a detailed answer.	Mistakenly entering numbers in formulas so that the answer is incorrect.
Subject Climber SA				Answering questions in the usual way

The following is a statement of the following:
STBK 1 = Problem I Creative Thinking Ability Test, STBK 2 = Problem II Creative Thinking Ability Test
STBK 3 = Problem III Creative Thinking Ability Test, STBK 4 = Problem IV Creative Thinking Ability Test

(7) The next is develop a learning design based on the analysis results, that is, by learning obstacles. The learning design consists of 2 designs that make the didactic situation or the design of student teaching materials, assignments, response predictions, which are predictions that the teacher has thought to the responses that may be given by students, and pedagogical anticipation, which is the anticipation given by the teacher to students to create an optimal situation. The results of the learning design are presented below in Figures 6.

DESAIN PEMBELAJARAN I

Kompetensi Dasar :

3.6 Menggeneralisasikan pola bilangan dan jumlah barisan aritmetika

4.6 Menggunakan pola barisan untuk menyajikan dan menyelesaikan masalah kontekstual

Indikator :

3.6.1 Menuliskan langkah-langkah penyelesaian dari suatu permasalahan terkait pola bilangan barisan dan deret aritmatika

4.6.1 Menyelesaikan masalah kontekstual terkait materi pola barisan dan bilangan aritmetika

Tujuan Pembelajaran :

- Peserta didik mampu menyelesaikan masalah dan membuat beberapa kemungkinan jawaban jika diketahui susunan beberapa korek api yang disajikan dalam bentuk tabel
- Peserta didik mampu menyelesaikan masalah dan membuat beberapa kemungkinan jawaban jika diketahui susunan beberapa kelereng yang disajikan dalam bentuk tabel

Situasi Didaktis	Penugasan	Prediksi Respon	Antisipasi Pedagogis
Situasi 1 "Perhatikan susunan korek api pada tabel dibawah ini!  Bocil memiliki 24 batang korek api. Jika batang korek api tersebut disusun berdasarkan tabel di atas	Pada point (a) peserta didik diminta untuk membuat pola yang mungkin dari susunan korek api.	**Respon yang diharapkan :** Peserta didik membuat pola berdasarkan korek api **Kemungkinan kesulitan :** Peserta didik kesulitan bagaimana menentukan bagaimana bentuk pola yang dibuat berdasarkan korek api	**Antisipasi kemungkinan kesulitan :** Guru memberikan korek api yang sesuai dengan permintaan soal kemudian meminta peserta didik untuk membuat pola yang mungkin dari korek api tersebut
	Pada point (b) peserta didik diminta mencermati susunan korek api, kemudian membuat pola yang mungkin dari susunan korek api tersebut	**Respon yang diharapkan :** Peserta didik membuat jumlah setiap baris berdasarkan pola yang telah dibuat **Kemungkinan kesulitan :** Peserta didik keuslitan mengidentifikasi pola dengan susunan korek api kemudian menghitung jumlah korek api	**Antisipasi kemungkinan kesalahan :** Guru membuat simulasi pada korek api yang memungkinkan peserta didik untuk berkesperimen dengan susunan korek api
	Peserta didik diminta menemukan cara lain selain cara pada point (b), Jika ada maka peserta didik diminta menentukan jumlah korek api di setiap baris berdasarkan pola yang sudah terjawab pada point (a)!"	**Respon yang diharapkan :** Peserta didik menentukan jumlah korek api dengan cara yang lain **Kemungkinan Kesalahan :** Peserta didik kesulitan dalam berpikir kreatif untuk menemukan cara lain dalam menyelesaikan masalah	**Anitisipasi kemungkinan kesulitan :** Guru memberikan penjelasan yang jelas kepada peserta didik yaitu pastikan instruksi diberikan dengan jelas dan mudah oleh peserta didik. berikan contoh yang konkret seperti memberikan korek api secara nyata jika diperlukan untuk memperjelasan konsep atau tugas yang diminta

Figure 6. Learning Design I

(8) The final stage is compiling observation instruments and learning mathematics. The following is a student worksheet consisting of LKPD 1 and LKPD 2.

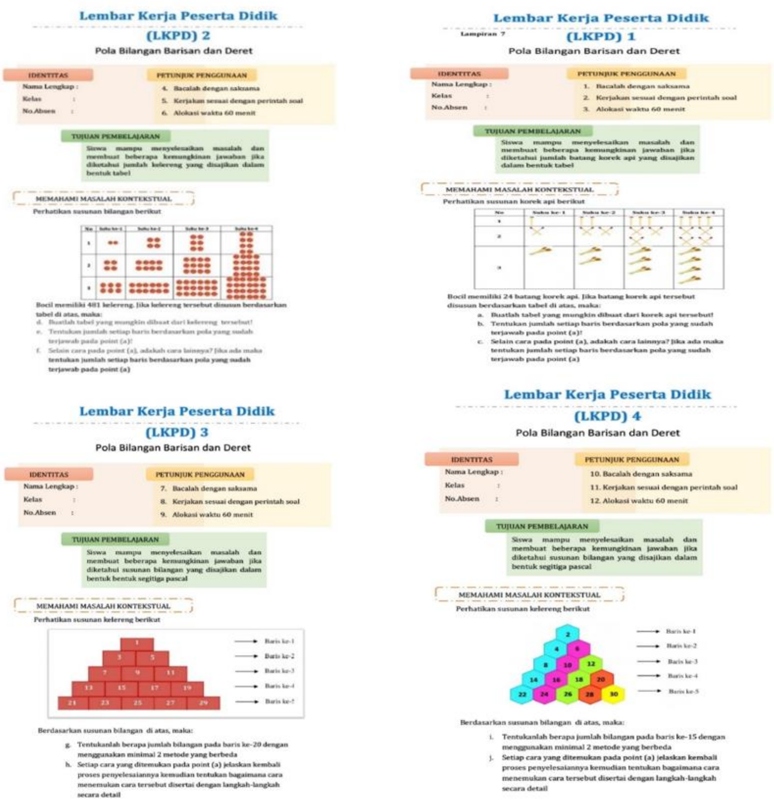


Figure 7. Student Worksheets

Metapedadidactic Analysis

At this stage, the researcher implements the learning design that has been prepared from the results of the analysis of the mathematical creative thinking ability test. This stage includes (1) Implementing the didactic design that has been prepared, (2) Analyzing student responses during mathematics teaching, and (3) Analyzing the occurrence of learning obstacles during learning. The following is an overview of the didactic situation during the learning process.

Table 2. Metapedadic Observation Sheet I

Activity stages	Possible difficulties	Teacher anticipation	Result
Making a pattern out of a match	Difficulty creating patterns	Providing examples of patterns	The teacher provides matches that match the question request and then asks learners to make a possible pattern from the matches (Effective)
Observing the arrangement of matches	Difficulty calculating	Create a simulation	The teacher provides a contextual approach by giving examples of common matchstick patterns, for example, forming triangles (with additional sticks in each row), forming houses (with patterns that can be repeated), forming patterns of interconnecting square rows (Effective)
Determining how to count matches	Difficulty thinking creatively	Giving a real example	The teacher invites students to draw concretely on paper or board and then provides gradual visual practice, from patterns of 3 sticks, 6 sticks, up to 24.
Creating a marble pattern	Difficulty determining patterns	Providing examples of patterns	The teacher teaches how to construct number sequences and trains students to use simple formulas (Effective)
Identifying marble patterns	Difficulty observing the arrangement	Create a simulation	The teacher applies the use of visual, numerical, and logical approaches alternately (Effective)
Determining the alternative way of arranging marbles	Difficulty thinking creatively	Provides a clear explanation	The teacher invites students to physically arrange direct patterns: first row 1 item, second row 2 items, etc. (Effective)

Table 3. Metapedadic Observation Sheet II

Activity stages	Possible difficulties	Teacher anticipation	Result
Counting the 20th row in two ways	Difficulty determining the 20th line	Explain the questions	The teacher addressed this issue by providing a further explanation of the problem, which proved to be an effective approach.
Explain the steps to solve the problem	Difficulty calculating	Invite students to discuss	The teacher encouraged students to discuss the problem together so they could help each other understand it. This method was also effective.
Determining the number of 15th rows in two ways	Difficulty thinking creatively	Using the departure pattern for students	The teacher introduced the multiplication pattern, which made it easier for students to understand and solve the problems. This method also worked well.

Re-explaining the completion process	Difficulty determining patterns	Re-presenting the material that has been taught	The teacher overcame this by repeating previously taught material. As a result, students understood better, and this method was considered effective.

Post-Observation Learning Stage (Retrospective Analysis)

The results of the analysis of the learning obstacles test prior to the implementation of the didactic design revealed that students encountered various impediments during the learning process, including difficulty in comprehending patterns, formulating solution strategies, and exhibiting flexibility in addressing diverse problems. These barriers are closely related to students' low creative thinking skills, because students tend to adhere to a single mode of problem-solving and demonstrate a reduced capacity to generate alternative ideas or approaches.

Revisions to the didactic design were made based on the obstacles that arose during the learning process. These revisions incorporated pedagogical anticipation, emphasising the provision of stimuli for thought, the utilisation of open-ended inquiries, and a learning model that promoted exploration and discussion. The findings of these revisions demonstrate that students' learning barriers can be mitigated, and students are able to adopt more creative approaches in problem-solving. Consequently, it can be concluded that a didactic design that is responsive to learning barriers contributes directly to the improvement of students' creative thinking skills.

Discussion

This study is didactic design research focusing on students' mathematical creative thinking in solving open-ended problems from the perspective of adversity quotient. It aims to create learning designs that address students' learning obstacles, identified through creative thinking tests, interviews, and AQ questionnaires. The design fosters student engagement, collaboration, and resilience in overcoming learning challenges. It integrates both cognitive and non-cognitive aspects and is contextual, based on analysis of students' learning difficulties. The research follows Suryadi (2010), three-stage model: pre-observation, metapedidactic analysis, and retrospective analysis.

The first step is the pre-observation or data collection stage. At this stage, the researcher identifies learning obstacles or obstacles that make it difficult for students to understand the material by analysing the results of students' mathematical creative thinking ability tests and the results of adversity quotient questionnaires/surveys and interviews with 4 selected research subjects. Based on the analysis of the test questions, it can be seen that the learning obstacle experienced by students is an epistemological obstacle. According to Brousseau (2002) the epistemological obstacle is an obstacle that occurs due to the limited knowledge that students have in a particular context. Epistemological barriers occur due to the nature of the concept of knowledge (mathematics) itself (Dewi et al., 2021).

According to Sari et al. (2019), Schaathun (2022), Schneider (2020), there is an epistemological obstacle, namely student knowledge that has a limited context. Such as understanding concepts, theorems, properties, and teaching processes (Hakim et al., 2021). In this study, the epistemological obstacle referred to is the epistemological obstacle in giving the open ended based creative thinking ability test on the material of Number Patterns and Arithmetic Rows and Rows. In line with Kastolan's theory (1992), this study found that there were 3 types of errors or epistemological obstacles in solving the problems given including conceptual errors, procedural errors, and technical errors. As for 1) procedural errors made by students are students are not systematic when working on problems Students are not able to manipulate the steps of solving problems and cannot work on problems in unique or different ways. 2) conceptual errors made by students are wrong in writing formulas and making patterns. 3) Technical errors made by students are less careful reading questions and calculations.

Following an analysis of the students' learning obstacles, the subsequent stage is metapedadidactic analysis. The researcher developed a didactic design in the form of two LKPDs and two metapedadidactic observation sheets, then revised them according to the supervisor's input until they were suitable for use. The observation sheet demonstrated that the teacher's anticipation of students' difficulties was effective in minimising repeated errors. Anticipation in metapedidactic I includes: Firstly, the presentation of examples of patterns is to be included. Secondly, the implementation of simulations is to be incorporated. Thirdly, a comprehensive re-explanation is to be provided so that knowledge is more comprehensive, in accordance with Salmon & Barrera (2021) who states that open questions provide students with opportunities to use knowledge and skills thoroughly. In metapedadidactic II, the teacher invited students to engage in a discussion and to repeat the explanation of the material, in accordance with Waswa & Al-kassab (2023) who stated that class discussion and open questions can serve as an alternative to overcome learning difficulties in mathematics.

The next and final step is the retrospective analysis. After implementing the learning design to the subject to find out whether the didactical design prepared can overcome the learning obstacles that occur in students, a revised learning design is prepared again which is the final stage in this study. Based on the results of the implementation of the initial learning design to the subject, there are several things added to the learning design, namely expanding predictions and increasing the anticipation of learner difficulties so that there are no more new difficulties that are not predicted and all learner difficulties can be resolved properly. Furthermore, the anticipation of learner difficulties in the initial design can be said to be effective in overcoming learning obstacles based on learners' responses when the design is implemented. This standpoint is consistent with the perspective articulated by Fletcher et al. (2021), who elucidate that during the Retrospective Analysis phase, researchers are required to draw conclusions concerning the didactic design that has been previously examined. Subsequent to this, proposals for the didactic design of quadrilateral material are to be made, based on the analysis activities that have been carried out. The aim of this is to reduce the learning obstacles experienced by students. However, it is necessary to add new difficulty anticipation to maximise learning. Therefore, new anticipations are made in the revised learning design so that the learning process runs well as expected.

The revised didactical design that has been developed in this study is expected to help students understand the learning material more easily, overcome learning obstacles, and help students understand the learning material more easily. This is because didactical design can help students visualise abstract concepts and connect with their learning experiences. Improving students' creative thinking skills to analyse information, solve problems and make decisions, as well as giving students the opportunity to explore their ideas and find innovative solutions to a mathematical problem. Because this study significantly showed an increase in students' mathematical creative thinking skills.

The present study aims to address the research gap identified in previous studies, which have predominantly focused on the application of learning design in general, without considering the specific learning barriers experienced by students, particularly in relation to mathematical creative thinking skills. There is a paucity of studies that have directly integrated didactic design with the development of creative thinking, adjusted to the level of students' adversity quotient. Consequently, this research makes a significant contribution to the development of learning designs that not only facilitate student comprehension of the material, but also assist in the overthrow of learning barriers and the cultivation of creative thinking skills. The findings of this research elucidate several significant aspects. This finding can serve as a useful reference point for educators when designing learning materials that are adaptive and responsive to the needs of students facing learning barriers. The didactic design employed in this context affords students the opportunity to conceptualise in an original manner, demonstrating flexibility in their approach to problem-solving, and to explore innovative solutions.

Implication of Research

For educational policymakers, the results suggest the importance of considering students' psychological resilience when designing assessment and intervention strategies. The study provides evidence that addressing learning obstacles through targeted didactic designs can significantly improve student outcomes in mathematics.

Limitation

The limitation of this research is a small sample size, brief implementation, and limited analysis of external factors like motivation and classroom environment. The use of non-standardised instruments for assessing creative thinking and the single-school context further restrict generalisability. Future studies with larger, more diverse samples and rigorous methods are needed to validate these findings.

CONCLUSION

The didactic situation in mathematics learning—focused on developing creative thinking in solving open-ended problems through the lens of adversity quotient—revealed that students experienced learning obstacles, highlighting the need for instructional designs that address such challenges. Based on prospective analysis, obstacles were identified and used to develop didactic designs, including learner worksheets, hypothetical learning trajectories, and response predictions with didactical anticipations. The metapedadidactic and retrospective analyses showed that the design effectively reduced learning obstacles, with student responses generally aligning with predictions, though some new difficulties emerged. Regarding creative thinking abilities, subjects in the Climber category demonstrated varying levels of thinking skills, with some showing medium-level thinking with fluency indicators, while others exhibited high-level thinking with all four indicators: fluency, flexibility, originality, and elaboration. The developed didactic design, grounded in learning obstacles and adversity quotient levels, supported the enhancement of students' mathematical creative thinking. This aligns with previous research findings that well-structured pedagogical designs positively impact creative thinking skills. These findings offer practical guidance for developing learning models that integrate non-routine problems to foster creativity in mathematics learning. The study contributes to the field by demonstrating how the integration of adversity quotient considerations with didactic design research can create more effective and responsive learning environments. The systematic approach to identifying and addressing learning obstacles through iterative design processes provides a valuable framework for mathematics educators seeking to enhance student creativity and resilience in problem-solving.

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