



# Analysing the Mathematical Critical and Creative Thinking Abilities in Problem Solving Introverted Students

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## Abstrak

Penelitian ini bertujuan untuk mengevaluasi kemampuan berpikir kritis dan kreatif dalam konteks matematika ketika menyelesaikan masalah terkait barisan dan deret aritmatika di kalangan siswa yang cenderung introvert di kelas XI di SMA Xaverius 1 Kota Jambi. Permasalahan ini timbul karena perbedaan dalam kemampuan berpikir dan proses kognitif siswa berdasarkan karakter kepribadian, dimana ditemukan bahwa siswa dengan sifat introvert cenderung memiliki kemampuan berpikir kritis dan kreatif matematis yang rendah. Metode penelitian yang digunakan adalah pendekatan kualitatif deskriptif dengan mengumpulkan data berupa angket kepribadian, tes, dan hasil wawancara. Subjek penelitian dipilih dari siswa introvert berdasarkan hasil angket kepribadian dan analisis lembar jawaban, dengan tiga siswa yang mewakili berbagai kelompok jawaban yang ada. Hasil dari penelitian ini menunjukkan bahwa siswa introvert menunjukkan kemampuan berpikir kritis matematis yang baik dalam hal pemahaman masalah, perencanaan, dan implementasi rencana. Namun, mereka memiliki kecenderungan untuk kurang melakukan pengecekan ulang terhadap solusi yang mereka hasilkan. Kemampuan berpikir kreatif matematis pada siswa introvert terutama mencakup kemampuan untuk menghasilkan ide-ide dengan lancar dan fleksibel dalam pemahaman masalah, perencanaan, dan implementasi rencana, meskipun kurang dalam hal orisinalitas dan elaborasi dalam menyelesaikan masalah.

## Abstract

This study aims to evaluate the critical and creative thinking abilities in the context of mathematics when solving problems related to arithmetic sequences and series among introverted students in the 11th grade at Xaverius 1 High School in Jambi City. This issue arises due to differences in thinking skills and cognitive processes among students based on personality types, where it was found that introverted students tend to have low mathematical critical and creative thinking abilities. The research method employed is a descriptive qualitative approach, collecting data through personality questionnaires, tests, and interviews. Research subjects were selected from introverted students based on personality questionnaire results and answer sheet analysis, with three students representing the various response groups. The results of this study indicate that introverted students demonstrate good mathematical critical thinking skills in understanding problems, planning, and implementing plans. However, they tend to overlook rechecking their solutions. The creative mathematical thinking abilities of introverted students mainly involve fluency and flexibility in understanding problems, planning, and implementing plans, although they lack in terms of originality and elaboration in problem-solving.

## INTRODUCTION

The two dimensions of Higher Order Thinking Skills (HOTS) are critical and creative thinking skills (Heong et al., 2012). The ability to think critically and creatively in mathematics is an important ability that students have in dealing with problems. Students are expected to not only become consumers of knowledge but also be able to produce new knowledge. (Kuncel & Cities, 2015); (Faradillah & Humaira, 2021) Creative thinking is an important 21st century skill to prepare children to face complex and rapid changes (Gu et al., 2019); Silvia et al., 2015; (Suherman & Vidákovich, 2022); (Basri & As,ari, 2018). Critical mathematical thinking ability is an undeniable level of reasoning ability that applies past information to conclude, demonstrate, or assess numerical conditions that include testing, clarifying pressing problems, linking each perspective in dealing with it. mathematics problems (Huber & Kuncel, 2016); (Liu & Csikszentmihalyi, 2020).

Researchers conducted a preliminary study on the critical and creative mathematical thinking abilities of class XI introverted students at Xaverius 1 High School, Jambi City with 35 students. This preliminary study was carried out by giving 2 problem solving questions. From this

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preliminary study, students' mathematical critical thinking skills (interpretation, analysis, evaluation, inference, explanation and self-regulation) experience problems in solving mathematical problems in the form of problem solving. The problem of solving mathematical problems in the form of problem solving also occurs in students' mathematical creative thinking abilities, where only a few students are able to fulfill fluency and flexibility, even students are not able to fulfill originality and elaboration in solving problems in the form of problem solving. This means that the indicators of originality and elaboration have not been mastered by introverted students.

Basic and inventive reasoning can be influenced by many variables, including character, which can be influenced by many variables, including personality (Yildiz & Guler Yildiz, 2021). Research by Dossey shows that people who are less persuasive and tend to be less argumentative listen more often than they speak (Dossey, 2016). Providing information about the nature of critical and creative mathematical thinking at any level, mathematical problem solving is an important part of mathematics teaching (García et al., 2019); (Klang et al., 2021).

From this description, it can be understood that the ongoing Mathematics Education is expected for students to be able to think fundamentally and imaginatively which is realized through critical thinking questions, but unfortunately students who are contemplative make it difficult for teachers to understand their students' conditions. thinking skills in mathematics lessons with a personality that is less tolerant of the outside world. Departing from this problem, the researcher intends to conduct research with a focus on analyzing the critical and creative mathematical thinking abilities of introverted students in solving mathematics in the form of problem solving.

## **METHOD**

Descriptive qualitative research is the method of choice. The information gathering instruments used were essay questions and student personality questionnaires that adopted Eysenck's theory or the Eysenck Personality Inventory (EPI). There are three criteria that must be met in order for an instruction sheet to be validated by a validator: substance, language, and substance. For interview guides, there are two criteria assessed by the validator, namely assessing the construction of the interview guide and assessing language use. Each criterion consists of several sub-criteria, and each sub-criterion is given a rating scale in the form of statements of agreement (S) and disagreement (TS).

Based on the student answer sheets from 35 students, it was found that the answers were similar so that prospective subjects were grouped and one subject was taken from each group. Based on the results of a personality questionnaire from 35 students, there were 22 extrovert students and 13 introvert students, so the potential research subjects were 13 introvert students. Based on the student answer sheets of the 13 introverted students, similar answers were found so that prospective subjects were grouped and one subject was taken from each group. The first subject is a group of students who solve the first problem by finding the area of the four circles and solve the second problem by describing the first term, third term and fourth term of an arithmetic series. The second subject is a group of students who solve the first problem by using the concept of the sum of the first  $n$  terms in an arithmetic series and solve the second problem by describing the first term, third term and fourth term of the arithmetic series. The third subject was a group of students who solved the first problem by finding the area of the four circles and solved the second problem using the concept of memorizing the Pythagorean triple. One subject was taken from each group, so that the selected research subjects were three introverted students who represented the three groups of answers. The selected subjects are then interviewed to confirm whether the student can express his argument and as a way to find out the cause of the mistakes made.

**RESULTS AND DISCUSSION**

Based on the results of research conducted by researchers on the three subjects, it can be seen the results of introverted students' critical mathematical thinking abilities in solving mathematical problems in the form of problem solving in Table 1.

**Table 1.** Mathematical critical thinking abilities of introverted students in problem solving

Subject	Indicator Critical Thinking Ability Mathematical	Solution Problem			
		Understand Problem	Make Plan	Carry out Plan	Inspect Return
S1	Interpretation	-	√	√	-
	Analysis	√	√	√	-
	Evaluation	√	√	√	-
	Inference	√	√	√	-
	Explanation	√	√	√	-
	Self Regulation	-	-	-	-
S2	Interpretation	√	√	√	√
	Analysis	√	√	√	√
	Evaluation	√	√	√	√
	Inference	√	√	√	√
	Explanation	√	√	√	√
	Self Regulation	-	-	-	-
S3	Interpretation	-	-	√	-
	Analysis	-	-	√	-
	Evaluation	√	√	√	√
	Inference	√	√	√	√
	Explanation	√	√	√	√
	Self Regulation	-	-	-	-

Information:

√ = meets the indicator                      - = does not meet the indicators

Based on Table 1, there are several mathematical critical thinking skills in problem solving that are not met. The aspects that cause this include:

(1) It is a mistake to assume that the values presented in the question (the area of the circle) are the values that form an arithmetic sequence, because you do not check the correctness of the steps by reviewing the categories of concepts presented in the question; (2) Not checking the arithmetic sequence that was formed again because it rarely solves word problems that require precision and problem-solving steps to solve them; (3) Wrong evaluation of applying concepts from the information given in the question to look for other elements; (4) Wrongly making an inference from the previous step which should be able to meet the needs of the next step (the arithmetic sequence formed from each circle's circumference); (5) Not self-regulating all the answers because they feel that the time given is not enough to operate the numbers which makes introverted students rush and not realize their mistakes in understanding the concepts and instructions on the questions which results in introverted students making mistakes in applying concepts and questions. building meaning from previous steps; (6) Do not use the Sn formula; (7) Not used to solving problems with a variety of different units of length; (8) Introverted students do not want to ask the teacher to check the results of their work, so introverted students do not realize where they might make mistakes.

This cause can be overcome if introverted students are trained to work on questions that require mathematical critical thinking skills in problem solving so that they get used to it and can use the time given well. Re-examination by understanding the problem in the question and paying

attention to each step is very important in order to minimize mistakes made, so that the solution process can be carried out correctly and the results are good. Obtained is in accordance with what is required in the problem. It is best for introverted students to often ask the teacher and ask the teacher to check the answers to be aware of mistakes that students might make when completing answers.

(Dasar, 2020), (Facione, 2023), (Heard et al., 2020) explain indicators of mathematical critical thinking abilities, namely interpretation, analysis, evaluation, inference, explanation, and self-regulation. Based on the results of research conducted by (Arnawati et al., 2022), introverted students are able to understand the material that has been given along with the correct answers, and their level of understanding in problem solving is sufficient. Likewise with the results of (Rudianti et al., 2021) exploration of introverted students capable understand problems, formulating strategies, and implementing strategies. However, considering the introduction of experimental results and encounters with the three samples, not all contemplative students can fulfill the translation in solving problems, making arrangements and checking again.

Research conducted by (Rudianti et al., 2021) states that introverted students have the ability to identify the relationship between statements from material concepts. However, based on the test results and interviews of the three introverted students, not all introverted students were able to identify the reasons needed for problem solving or analyze problem solving where introverted students did not make further plans from the four circles. This cause arises because introverted students find it difficult, rushed and not careful in solving problems that require mathematical critical thinking skills in problem solving. From this discussion, it means that not all introverted students can analyze in problem solving.

Students can decide and utilize relationships between data contained in the explanations given (Amelia & Ismail, 2020). This research has similar results to (Amelia & Ismail, 2020), namely that intelligent students can fulfill their number-determining reasoning abilities in capturing problems, making plans and implementing plans. However, not all introverted students can evaluate well or in this case cannot apply the concept of arithmetic sequences from the information given in the questions.

Contemplative students can develop existing data and compose existing statements (Rudianti et al., 2021). From this discussion, it is implied that not all students who think critically can carry out derivations in critical thinking. Likewise with the explanation where the tests and interviews were given to the three introverted students, there were introverted students who did not fulfill the explanation in checking again.

Students can definitely meet their needs, but students who withdraw may not really be able to provide the right goals (Rudianti et al., 2021). According to (Pangestu & Hasti Yuniarta, 2019), introverted students can use the stages of the critical thinking process – exploring information, understand questions and concepts, plan, and express ideas—to solve problems. It is means that independent students can develop determinant reasoning abilities even if they do not complete all stages in the determinant reasoning interaction. (Arnawati et al., 2022) provides another explanation, why students who withdraw generally do not check their responses less. This is related to differences in educators' treatment of social butterfly students and self-observers. Introvert students are used to studying alone, so teachers devote more time to extrovert students. Some instructors unknowingly and unexpectedly take advantage of individual students dropping out more and providing more prompts to elicit appropriate responses and giving them opportunities to answer accurately.

From the discussion regarding the mathematical creative thinking abilities of introverted students in solving mathematical problems in the form of problem solving which the researcher presents based on the answer sheet and interviews. The results of research conducted by researchers on subjects can be seen in Table 2.

**Table 2.** Mathematical creative thinking abilities of introverted students in problem solving

Subject	Indicator Creative Thinking Ability Mathematical	Solution Problem			
		Understand Problem	Make plan	Carry out Plan	Inspect Return
S1	Fluency	√	√	√	√
	Flexibility	√	√	√	√
	Originality	-	-	-	-
	Elaboration	-	-	-	-
S2	Fluency	√	√	√	√
	Flexibility	√	√	√	√
	Originality	-	-	-	-
	Elaboration	-	-	-	-
S3	Fluency	√	√	-	-
	Flexibility	-	-	-	-
	Originality	-	-	-	-
	Elaboration	-	-	-	-

Information:

√ = meets the indicator                      - = does not meet the indicators

Based on table 2, it is known that the three subjects have different mathematical critical thinking abilities. S1 and S2 still do not meet fluency and flexibility in re-examining as well as originality and elaboration in problem solving. S3 almost does not fulfill all mathematical creative thinking abilities in solving problems, S3 only fulfills fluency in understanding problems and making plans. The reason this happens is because (1) Just guessing the answer without any solution steps; (2) Examples of questions that can be solved in many ways are rarely given; (3) Not given the opportunity to solve the problem in a different or unique way (4) Not knowing the deeper meaning of the information in the question or previous knowledge; (6) Difficult to complete questions with the ability to think creatively mathematically in problem solving.

From these problems, this certainly must be a concern. Through the causes found, it is hoped that this will become knowledge to encourage introverted students to be able to hone their creative mathematical thinking skills through the role of teachers who provide examples of problems that can be solved in many ways and in the correct process. Teachers must more often provide opportunities or examples to students by providing questions that can be solved in many ways or unique ways. Introverted students must understand more mathematical concepts in depth in order to enrich their ideas.

Introverted students only met the fluency and flexibility indicators (Sari et al., 2020). However, there was one introverted student who was unable to answer questions and come up with ideas by carrying out the plans prepared and did not check the correctness of the results of the steps taken previously or it could be said that he did not meet fluency in carrying out plans and checking again and flexibility in solving problems. This is because the introverted student is not careful, does not double-check the correctness of the picture he makes and only guesses the answer.

Originality is giving unusual answers, which most people rarely use (Megawan & Istiyono, 2019). According to (Sari et al., 2020), introverted students only meet the indicators of fluency and flexibility, while the indicators of originality and elaboration are not met. Like this exam where the third subject does not show creativity and elaboration in critical thinking.

(Arnawati et al., 2022) provides another explanation, why students who withdraw generally do not check their responses less. This is related to differences in educators' treatment of social butterfly students and self-observers. Introvert students are used to studying alone, so

teachers devote more time to extrovert students. Some instructors unknowingly and unexpectedly take advantage of individual students dropping out more and providing more prompts to elicit appropriate responses and giving them the opportunity to answer accurately.

## CONCLUSION

Based on the results of research conducted by researchers at Xaverius 1 High School, Jambi City, the researchers concluded that critical mathematical thinking skills in solving problems of arithmetic sequences and series in introverted students include various aspects that need to be considered, namely some introverted students, some introverted students experience errors in assuming values. which are presented in the questions as values that form arithmetic sequences, lack of re-examination, incorrect interpretation of questions, limitations in remembering formulas, lack of self-regulation and lack of consultation with the teacher.

The ability to think creatively mathematically in solving problems of arithmetic sequences and series in introverted students also includes various aspects that need to be taken into account, limitations in originality, lack of examples of varied questions, and some Introvert students can meet the indicators of fluency and flexibility in problem solving.

Teachers are expected to provide more practice questions in the form of problem solving to introverted students, including questions with more than one solution. Apart from that, students need to increase their accuracy in solving problems, check their steps, and dare to consult if they experience difficulties.

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