Cognitive Abilities: Mathematical Anxiety and Self-Concept

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Cognitive Abilities: Mathematical Anxiety and Self-Concept

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Abstract: ***The formation of students' cognitive abilities is influenced by several factors, including internal factors such as mathematics anxiety and self-concept. This study aims to explore the cognitive abilities in relation to mathematics anxiety and self-concept among secondary school students. The study employed an ex post facto research design, using questionnaires on mathematics anxiety and self-concept, as well as a cognitive ability test administered to a sample of 35 seventh-grade students in a secondary school. Multiple regression analysis was used to analyze the data. The results of this study indicate that: (1) math anxiety has a significant negative effect on cognitive abilities partially; (2) there is no significant influence of self-concept on cognitive abilities; (3) simultaneously, math anxiety and self-concept have a positive and significant effect on cognitive abilities.***

Keywords: cognitive abilities, mathematic anxiety, self concept .

1. Introduction

Mathematics is one of the compulsory subjects at every level of education, and mathematics grades also serve as a determining factor for the graduation of secondary school students. Therefore, many students experience anxiety related to this subject (Sari, 2017) This anxiety is caused by various factors such as academic pressure, lack of understanding of concepts, or negative experiences in mathematics (Szczygieł, 2019) In addition, students' self-concept plays an important role in determining their actions. Students with low self-concept in mathematics tend to feel inadequate and unsure of their ability to master the subject, which can affect their cognitive abilities. (Shavelson, 1976) Ability cognitive child different (Passolunghi, 2015) , and therefore it is important to pay attention to providing appropriate approaches to reduce anxiety and enhance self-concept.

So far, there have been several studies conducted by various researchers on the relationship between cognitive abilities, math anxiety, and self-concept. For instance, a study examined the influence of math anxiety on problem-solving abilities among students in middle school, and the results showed that higher levels of math anxiety were associated with lower problem-solving skills. (Al-Tabany, 2014) Another study focused on the impact of anxiety and self-concept during the COVID-19 pandemic on mathematics performance. The findings revealed a significant negative influence of anxiety on mathematics performance and a significant positive influence of self-concept on mathematics performance. (Atmojo & Ibrahim, 2021) Furthermore, another study explored the influence of self-concept on mathematics performance and found that self-concept significantly determined mathematics performance. (Manurung, 2020) However, it is worth noting that the in-depth investigation of the effects of math anxiety and self-concept on cognitive abilities has not been extensively explored in previous studies.

The aim of this paper is to address the limitations of previous studies that have not thoroughly analyzed the influence of math anxiety and self-concept on cognitive abilities. Specifically, this paper aims to answer three questions: (1) What is the impact of math anxiety on cognitive abilities (2) What is the influence of self-concept on cognitive abilities and (3) What is the simultaneous influence of math anxiety and self-concept on students' cognitive abilities. The specific objective of this paper is to analyze the extent to which math anxiety and self-concept contribute to the impact on students' cognitive abilities. By answering these questions, the research findings are expected to provide a comprehensive understanding of the dimensions of factors influencing cognitive abilities. This understanding can serve as a basis for policy-making in the context of further mathematics learning processes.

2. Literature Review

2.1 Cognitive Ability

Cognitive ability refers to mental capacities related to information processing, understanding, problem-solving, and abstract thinking. (Li, 2022) The dimensions of cognitive ability include: (1) Attention: The ability to focus on specific stimuli while ignoring others. Good attention enables more efficient information processing; (2) Memory: The ability to remember and store information, including short-term and long-term memory; (3) Problem-solving: The ability to identify problems, analyze situations, and find effective solutions. Problem-solving involves critical thinking, logic, and creativity (Susanti, 2018) ; (4) Comprehension: The ability to understand and interpret received information. This involves skills such as reading with comprehension, following instructions, and interpreting meaning from given contexts. (5) Abstract thinking: The ability to think conceptually, generate new ideas, and understand complex concepts. Abstract thinking involves the ability to understand symbols, metaphors, and non-literal concepts; (6) Decision-making: The ability to evaluate various options and choose the appropriate course of action. Good decision-making involves the ability to identify goals, gather relevant information, consider consequences, and employ sound reasoning (Zakiah & Khairi, 2019) Various factors such as genetics, environment, dietary patterns, and sufficient sleep also influence an individual's cognitive abilities.

2.2 Mathematical Anxiety

Anxiety is an unpleasant emotion characterized by symptoms such as worry and fear. (Choi-Koh, 2019) Anxiety is also referred to as tension resulting from perceived threats to safety, whether real or imagined. (Collado-Soler, 2022) Meanwhile, math anxiety is the anxiety or fear related to learning, understanding, and performing mathematics. (Bjälkebring, 2019) Math anxiety involves feelings of tension and unease that affect individuals in various ways when solving mathematical problems in real-life and academic contexts. Math anxiety can be influenced by various factors, including past negative experiences in learning mathematics, pressure from the social environment, or individuals' perception of their own mathematical abilities (Rubinsten, 2010)

The dimensions of math anxiety include: (1 Cognitive anxiety: Students paying less attention to the teacher's explanations, having difficulty understanding the presented material, and feeling unable to solve problems on their own; (2) Affective anxiety: Students feeling fear towards the mathematics teacher and lacking confidence in their answers. (Esa , 2017)

2.3 Self-Concept

Self-concept refers to the perception or image that an individual holds about themselves. (Shavelson, 1976) It encompasses the understanding of who we are and how we portray ourselves to others. Self-concept is also referred to as self-esteem or the overall representation of an individual's personality based on their views, perceptions, thoughts, feelings, and beliefs about themselves (Atmojo & Ibrahim, 2021) It simultaneously shapes one's self-worth and self-acceptance. Self-concept is not an innate factor within individuals. (Sutataminingsih, 2009) Individuals develop their self-concept through interactions with the environment and life experiences they go through. Therefore, self-concept plays a significant role in determining individual behavior. The dimensions of self-concept include confidence, bravery, and belief in one's abilities. (Handayani, 2016)

3. Conceptual Framework

The conceptual framework of this study consists of two independent variables and one dependent variable. The independent variables are math anxiety and self-concept, while the dependent variable is cognitive ability. The math anxiety variable is constructed using two indicators: cognitive and affective. The self-concept variable is constructed using three indicators: confidence, bravery, and belief in one's abilities. The cognitive ability variable is constructed using six indicators: attention, memory, problem-solving, comprehension, abstract thinking, and decision-making..

Math anxiety can hinder learning and cognitive abilities. Excessive anxiety can disrupt concentration, reduce self-confidence, and impede problem-solving skills. Self-concept refers to students' perceptions of themselves in the context of their success and mathematical abilities.

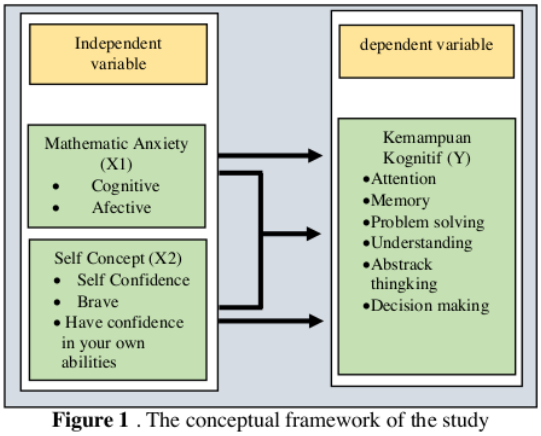

Figure 1 . The conceptual framework of the study

kindly partial , Hypothesis study This namely :

$H_0 : r_{yx1} = 0$ } H_0 : X1 has effect significant to Y
$H_1 : r_{yx1} \neq 0$ } H_1 : X1 no influential to Y
$H_0 : r_{yx2} = 0$ } H_0 : X2 has an effect significant to Y
$H_1 : r_{yx2} \neq 0$ } H_1 : X2 no influential to Y

kindly simultaneous , hypothesis study This namely :

$H_0 : r_{yx1x2} = 0$ } H_0 : X1X2 has effect significant to Y
$H_1 : r_{yx1x2} \neq 0$ } H_1 : X1X2 no influential to Y

4. Methodology Study

4.1 Research Design

This study is a quantitative research with an ex-post facto research design. The population of this study consists of 8th-grade students from SMAN 2 Luwu Timur, East Luwu, South Sulawesi, Indonesia. The sampling technique used is simple random sampling, resulting in a sample size of 35 students.

4.2 Research Instruments

The data collection techniques are as follows: first, a questionnaire using a five-point Likert scale, consisting of two types of statements: positive statements and negative statements. Second, an essay test using a scoring rubric. The instruments used in this study are the math anxiety questionnaire, self-concept questionnaire, and cognitive ability test.

table 1 : Questionnaire Mathematical Anxiety

Variable	Indicator	Sub indicators	item number (+)	item number (−)	Σitem
Mathematical Anxiety	cognitive	Less Paying Attention to the Teacher When Explaining.	1, 5	2, 4	4
		Lack of Understanding Material .	3, 7	6, 8	4
		Can't explain yet Question alone .	10, 14	9, 12	4

	Affecti ve	Afraid with teacher.	11, 15	13 , 15	4
		Less self confidence	17, 19	18 , 20	4
		Honesty .	21, 23	22 , 24	4
Amount					24

Table 2 . Questionnaire Self Concept

Variable	Indicator	Sub indicators	item number		Σitem
			(+)	(−)	
Draft Self	Believe self	Believe To Ability Self alone .	1, 5	3, 10	4
		Value Self and Own Business	2, 4	7, 9	4
	Brave	Able to Complete Problem Alone	6, 11	8, 12	4
		Act Independent in Make a Decision	14, 16	15, 17	4
	Sure will ability self	Know Tasks to Do .	13, 19	18, 23	4
		Have Positive Perspective	21, 24	20, 22	4
Amount					24

Table.3 Test Ability cognitive

Variable	Indicator	Basic Competency	Question
Ability cognitive	Attention	Finish problem contextual related with rows and rows arithmetic	1 - 4
	Memory		
	Solving Problem		
	understanding		
	Think Abstract		
	Decision Making		

4.3 Statistical Analytics

The guidelines for questionnaire categories focus on the characteristics of numerical values that represent the scale values. Scores on a psychology scale determined through scaling procedures will result in numbers at the following measurement levels:

Lowest Score ≤x<μ-1,5(σ) : Very Low Category
μ-1,5(σ)≤x<μ-0,5(σ) : Categories Low
μ-0.5(σ)≤x<μ+0.5(σ) : Medium category
μ+0.5(σ)≤x<μ+1.5(σ) : High Category
μ+1.5(σ)≤x≤ Highest Score : Very High Category

Description :
μ : Lowest Score × 3
σ : (Highest Score -Lowest Score)/6

The data analysis of cognitive ability tests involves testing the research hypothesis using multiple linear regression analysis. The aim is to determine whether there is an influence of the independent variables (X) individually (partial) or together (simultaneous) on the dependent variable (Y). Therefore, T-tests and F-tests are necessary, and their calculations can be performed using SPSS software.

The T-test measures the extent to which an independent variable influences the dependent variable partially. The decision-making criteria are as follows: if the calculated $t_{count} > t_{table}$ and value significant < 0.05 then H_1 accepted H_0 is rejected indicating a significant positive influence. Conversely, if the calculated $t_{count} \leq t_{table}$ and sig value < 0.05 then H_1 rejected, H_0 accepted It means No there is influence significant.

The F-test is used to determine the simultaneous influence of the independent variables on the dependent variable. The decision-making criteria are as follows: if the calculated $F_{count} > F_{table}$ and sig < 0.05 then H_0 rejected and H_1 accepted, however if F count ≤ F table, then H_0 accepted and H_1 rejected.

Equality multiple linear regression :

$$Y = a + b_1 X_1 + b_2 X_2 \quad (1)$$

Furthermore coefficient determination For explain big change from the dependent variable can explained by changes in the independent variable.

$$KD = r^2 \times 100\% \quad (2)$$

The magnitude the number R square (r^2) is prediction big X to Y contribution .

5. Result and Discussion

Descriptive results worry mathematics (X1) students can seen in table 4.

Table 4. Anxiety Image Description Mathematical

Statistics	Statistical Value
N	35
Average	74.06
Standard Deviation	66.97
Variance	44,87
Lowest Value	62
Top Rated	88

The data in table 4 shows that average anxiety mathematical student ie 74.06 is in medium category .

Anxiety interval categories mathematical student grouped to in 5 categories , got seen in table 5.

Table 5 . Worry Mathematical

Score Intervals	Frequency	Percentage	Category
96≤MA≤120	0	0	Very High
80≤MA<96	6	17	high
64≤MA<80	28	80	Medium
48≤MA<64	1	3	Low
24≤MA<48	0	0	Very Low
Amount	35	100%	

The data in table 5 shows No There is experienced child _ worry very high mathematics or very low , 6 people are anxious the math high , 28 people who are , and 1 person who is anxious the math low .

Description Self Concept (X2) students can seen in table 6

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Table 6 . Concept Overview Self-Concept

Statistics	Statistical Value
N	35
Average	73,37
Standard Deviation	76,82
Variance	59.02
Lowest Value	33
Top Rated	96

Interval categories for self-concept student grouped to in 5 categories, got seen in table 7.

Table 7 . Category Self-Concept

Score Intervals	Frequency	Percentage	Category
96≤SC≤120	1	3	Very High
80≤SC<96	8	23	high
64≤SC<80	22	63	Medium
48≤SC<64	3	8	Low
24≤SC<48	1	3	Very Low
Amount	35	100%	

The data in table 7 shows There is One child who has draft very high self-concept , 8 people self-concept high , 22 people medium, 3 people self-concept low , and 1 person is very low.

Descriptive ability cognitive (Y) students can seen in table 8.

Table 8. Capability Description Cognitive Ability

Statistics	Statistical Value
N	35
Average	73,94
Standard Deviation	76,38
Variance	58,77
Lowest Value	45
Top Rated	98

The data in table 8 shows that average ability cognitive student ie 73.94 is located in category enough .
Ability interval category cognitive student grouped to in 5 categories , got seen in table 9.

Table 9 . Category Cognitive Ability

Score Intervals	Frequency	Percentage	Category
91–100	4	11	Very High
81–90	10	28	high
71–80	16	46	Medium
61–70	3	9	Low
0 – 60	2	6	Very Low
Amount	35	100%	

The data in table 9 shows four students who have ability very high cognitive , ten students who have ability cognitive high , six thirteen are medium, 3 people are low and 2 people are very low .
Before do a hypothesis test assumption test is carried out normality with using the Kolmogorov test smirnov , with use SPSS help then the data can be seen in table 10.

Table 10. Data Normality Test Results

One-Sample Kolmogorov-Smirnov Test		
		Unstandardized Residuals
N		35
Normal Parameters [a,b]	Means	0E-7
	std. Deviation	11.09989254
Most Extreme Differences	absolute	, 113
	Positive	,098
	Negative	-,113
Kolmogorov-Smirnov Z		,668
Asymp . Sig. (2-tailed)		,764
a. Test distribution is Normal.		
b. Calculated from data.		

Table 10 shows a significance value of 0.764 > 0.05, indicating that the data follows a normal distribution. Next, a hypothesis test (t-test) is conducted to examine the partial regression coefficients.

Table 11 . t test results (partial)

Variable	coefficient	t	Interpretation
Worry Math (X1)	-0.597	-2,549	Significant
Draft Self (X2)	0.501	1.323	No Significant
Ability Cognitive (Y)	85,373		

Data from the t test results in table 11 above, can be obtained equality the regression with see coefficient value .
Y = 85.373 + (- 0.597) X 1 + 0.501X2
The constant value of variable Y is 85.373 if it is not influenced by the independent variables. The regression coefficient for X1 is -0.597, indicating that a decrease in X1 will decrease Y by -0.597. On the other hand, the coefficient for X2 is 0.501, indicating that an increase in X2 will increase Y by 0.501.
The calculated t-value and its interpretation for the partial effects are as follows: Firstly, the t-value for the relationship between mathematical anxiety and cognitive ability is $|2.549| >$ t-table (2.037), indicating that H_0 is rejected and H_1 is accepted. This means that mathematical anxiety has a significant negative effect on cognitive ability. Therefore, if students experience high levels of anxiety, their cognitive ability will be lower. Secondly, the t-value for the relationship between self-concept and cognitive ability is $|1.323| <$ t-table (2.037), indicating that H_0 is accepted and H_1 is rejected. This means that there is no significant influence of self-concept on cognitive ability.

Table 11 . F test results

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	870,484	2	435,242	3,325	0.049[b]
	residual	4189,059	32	130,908		
	Total	5059,543	34			

From table 11, value F_{count} is 3.325 and F_{table} is 3.28, then $F_{count} > F_{table}$ and value significant 0.049 <0.05, H_0 rejected and H_1 accepted , that is in a manner simultaneous mathematics anxiety and self-concept influential significant to cognitive ability.

Table 12 . Coefficient Test Results determination

R	R Square	Adjusted R Square	std. Error of the Estimate
0.415 [a]	0.172	0.120	11.44151

Coefficient value determination from table 11:
KD = Rsquare x 100%
KD = 17.2%
So, mathematics anxiety and self- concepts influence to cognitive ability is 17.2%.

6. Conclusion

These findings indicate that: Firstly, students' mathematical anxiety and self-concept fall into the moderate category, while their cognitive ability is relatively high. Secondly, the partial effects analysis reveals that mathematical anxiety has a significant negative influence on cognitive ability, while self-concept does not have a significant effect. Thirdly, when considered together, both mathematical anxiety and self-concept have a significant impact on students' cognitive ability. Therefore, it can be concluded that it is important to consider mathematical anxiety and self-concept in order to enhance students' cognitive abilities.

Furthermore, further research is needed to explore the factors that influence mathematical anxiety and self-concept in students and develop more effective interventions. Additionally, longitudinal studies measuring mathematical anxiety can be conducted to understand how changes in mathematical anxiety and self-concept over time affect students' mathematical cognitive abilities

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