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Relationship Between Learning Motivation and Students' Critical Thinking Skills of Mathematics Operations Concepts: A Quantitative Study in Timor-Leste

Aprilia Da Costa Ximenes[1*], Salvador Magno Ximenes[2]
Instituto Católico para Formação de Professores ICFP Baucau
Corresponding Author: Aprilia Da Costa Ximenes
apriliaximenes67@gmail.com

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A B S T R A C T

Learners' motivation is fundamental to the development of mathematics learning, especially to their critical thinking skills. This study aims to understand the correlation between learning motivation and students' critical thinking skills for operations in mathematics education. This study used a quantitative research method with a correlational design. The main data collection involved sixty-three students as a sample for main data collection. Sixty-eight students, as 15% sample of the total population of 455, for the empirical validity test of the instrument. Data were collected using the questionnaire survey method to measure the relationship between student learning motivation and critical thinking skills. The validity, reliability, and normality tests were used for guaranteeing the valid, reliable and normal distribution of the data. The main data was analysed using the Pearson correlation technique to examine the relationship between learning motivation and students' critical thinking skills. Therefore, p-value is 0.602, consequently hypothesis H1 is accepted that learning motivation has strong correlation with the students' critical thinking skills. This result indicates that a student who receives internal and external motivation tends to achieve satisfactory learning outcomes and enhance critical thinking skills in mathematics education. This study contributes to the improvement of mathematics learning for basic education in Timor-Leste

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INTRODUCTION

Education is a procedure to transform individuals, societies and nations that result from a learning and training experience. Education is a planned way to create a favorable learning environment, through which effective learning can develop students' knowledge, critical thinking skills and motivation to learn. In Timor-Leste, efforts are being made to improve the education system to make changes to development so that it can advance like neighboring countries (Ximenes, 2024). Many schools in Timor-Leste are still lacking human resources, learning facilities, and many teachers do not have specialized training in teaching (Ximenes, 2025a). Therefore, many teachers do not use appropriate methods in the teaching process to stimulate students' learning. Especially, teachers who teach mathematics lessons still implement the traditional system, where the teacher is the center of learning, and cannot help students understand the content. Students are interested in learning when the teacher uses a variety of strategies in teaching (Ximenes, 2025b).

Motivation is an action that comes from the self to encourage the individual to pave the way for achieving the desired goals. Learning motivation is a psychological factor that stimulates students to engage intensively in learning activities and make efforts in the process of acquiring knowledge (Santrock, 2011). Motivation is not just a momentary impulse, but a capacity to give meaning and direction to students' efforts, including their active involvement, autonomy, and determination to achieve academic results. Students who are motivated and enthusiastic can be seriously involved in teaching and open to positive changes in thinking and behavior (Ximenes, 2024). Healthy motivation can also contribute to the development of critical thinking, as students will seek alternative ways to solve problems with creativity and logic.

This research aims to understand the relationship between learning motivation and critical thinking skills in students for operations in mathematics lessons. Specifically, the objective of the study is to understand how students' learning motivation in mathematics relates to their critical thinking skills in operations. Then, the study determines whether students' learning motivation has a strong or weak relationship with their critical thinking skills. This study is led by two hypotheses: First, H0: There was no correlation between students' learning motivation and critical thinking skills. Then, H1: there was a strong correlation between students' learning motivation and critical thinking skills.

LITERATURE REVIEW

The Concept of Motivation

Motivation is a process that comes from a person's self to do an action with an objective. Motivation is also a force that encourages and directs the success of a personal activity that can achieve a goal. Nurica (2023) says, motivation is energy that inspires and guides people's behaviours, but motivation is not behaviour; it is a complex internal state that cannot be seen directly but is influenced by external behaviour. According to Cahyono, Hamda & Prahastiwi (2022), learning motivation is the encouragement that arises within the learners themselves and from the outside, which causes enthusiasm for learning and provides direction to learning activities to achieve goals. Thus, Avissina (2015)

said, learning motivation is the impulse to the learning process and the learning goal to benefit from the learning process. Motivation that comes from within is called intrinsic motivation, and motivation that comes from outside is called extrinsic motivation (Ximenes, 2024). Motivation is a psychological factor that activates, guides, and sustains a student's behaviour. According to Santrock (2011), learning motivation can be intrinsic, out of self-interest, or extrinsic, depending on external stimulation. Intrinsic motivation can increase initiative and independent thinking, while extrinsic motivation is often used in situations where clear reinforcement for performance is required.

Types of Learner Motivation

Intrinsic motivation is the encouragement that comes from a person to do something and does not require external stimulation. According to Sereliciouz (2020), intrinsic motivation is the motivation that comes from the student themselves to learn. Thus, according to Tri (2024), intrinsic motivation is the impulse to learn that comes from ourselves. For an individual's self-motivation to be effective, he or she needs to be encouraged to make progress in their mental, physical and emotional development while learning (Ximenes, 2024). Intrinsic motivation is motivation that is included in the learning situation and meets the needs and goals of students (Herwati et al., 2024). In the learning process, a student needs to have self-motivation to be willing, interested, happy, or satisfied with the subject studied, think independently, and be self-stimulated rather than needing encouragement from others.

Extrinsic motivation is the encouragement received from an individual, which drives our interest in learning. According to Sereliciouz (2020), extrinsic motivation is motivation that comes from outside. Thus, Tri (2024) said extrinsic motivation is motivation that comes from external factors, such as rewards and favourable values. Extrinsic motivation is motivation that is influenced by other individuals' encouragement, in which they can achieve worthwhile learning. Extrinsic motivations are active motives that function due to external stimuli. Extrinsic motivation is motivation caused by factors from outside the learning situation, such as credit points, diplomas, award levels, medals, conflict, and negative competition, which are sarcasm, ridicule, and punishment (Herwati et al., 2024).

Critical Thinking Relation with Mathematical Operations

Critical thinking in mathematical learning refers to the student's ability to analyse the structure of the problem, elaborate hypotheses, select appropriate solution strategies, and evaluate the validity of the results. Critical thinking is oriented to finding a fair answer and involves the ability to understand the logic or rationality of that answer (Bártolo and Ximenes, 2025). Students who have critical thinking will be open to analysis because the answer is fair and relevant to the context of the problem (Brookhart, 2010). In this process, students cannot just absorb information but need to use reflective and argumentative thinking to justify mathematical solutions.

An empirical study by Şahin (2015) found that stimuli for analytical activities in mathematics, such as discussion of reflective work, procedural debate, and validation of results, can have a direct impact on critical thinking capacity. Students who engage in this way will show high numerical performance and evidence of logical thinking in problem-solving (Ximenes, 2025c). Analytical competencies, such as analysing procedures, justifying calculations, and evaluating solutions, are strong indicators of critical thinking in the domain of mathematical operations. The evidence shows that critical thinking is not a secondary aspect in mathematics but an essential factor in achieving academic success and autonomy in problem-solving.

Benefits of Critical Thinking Skills

According to Elsabrina, Hangara, & Sancaya (2022), critical thinking is the mental process of analysing or evaluating information. It involves the ability to analyse, evaluate, and interpret information using logic and fundamental arguments. According to Facione (2011), critical thinking should be based on evidence, systematic reasoning, and independent decision-making. The dimensions of critical thinking include clarity, accuracy, relevance, and logic. In education, critical thinking contributes to student autonomy in the problem-solving process. The concept of critical thinking is directly related to the ability to solve problems, because students need to acquire the ability to analyse situations, make inferences, and propose viable solutions. Factors that can stimulate critical thinking include interrogative stimuli, open discussion, and opportunities to reflect on content. In mathematics, critical thinking helps students analyse the structure of numerical problems and determine fair solution methods (Susandi, 2021).

Critical thinking skills are beneficial not only in academic contexts but also in everyday life. When an individual develops critical thinking, he or she can gain the ability to face problems with perception, which can help achieve goals and make decisions that are justified by logical arguments. According to Elsabrina et al. (2022), critical thinking also contributes to the capacity to examine and evaluate the thoughts of others as a form of clarifying their argumentative basis and forming ideas logically. This process encourages the individual not to accept something through repetition but rather to seek proof, evidence, and validation before acting. The benefits of critical thinking also have a transformative impact on the individual's way of thinking, because it fosters an exploratory and creative mentality (Susandi, 2021). An individual who must make important decisions in politics, economics, or social relations can use the principles of critical thinking to prevent prejudice, harassment, or manipulation. This data shows that critical thinking is the foundation of intellectual autonomy.

Relationship Between Motivation and Critical Thinking

In the teaching-learning process, motivation and critical thinking are fundamental psycho-pedagogical aspects that ensure deep, sustainable, and meaningful learning. Learning motivation acts as an internal or external force that encourages students to engage seriously in learning activities and think critically, opening them to analysis, reflection, and rational decision-making. According to Cahyono et al. (2022), learning motivation can arise from the self (intrinsic) or external (extrinsic) factors, but each form will stimulate thought,

enthusiasm, intellectual contribution, and direction toward goal attainment. Here, motivation not only stimulates students to respond or repeat content but also acts as an important point for constructive mental investigation.

The relationship between motivation and critical thinking needs to be understood as an interdependent dynamic. Strongly motivated students usually tend to seek clarity, analyse content quickly, and reject unwarranted information. Thus, motivation can improve critical thinking capacity, because it can make students become analysts, reflective and sensitive to educational problems (Susandi, 2021). Students' level of motivation to learn can determine how well they perform in school; therefore, creating a motivating learning environment can be key to developing students' critical thinking skills at all levels of education (Fitria & Sari, 2024). On the other hand, if motivation is not there, then the critical thinking process will not develop efficiently. Critical thinking needs an internal basis as motivation to seek, examine and evaluate information. To unlock this potential, the education system needs to provide an environment that stimulates motivation for learning, with strategies that promote critical thinking as an essential capacity for students' academic progress (Ximenes, 2024).

METHODOLOGY

Type of Research

This study used quantitative research represents a systematic methodological approach that emphasises the use of numerical data to analyse relationships between variables. This approach enables the researcher to conduct objective observations, measurements/tests, and hypothesis testing. Quantitative research involves a population or sample with quantitative instruments such as questionnaires, scales, and statistical software to address and interpret data (Fischer, Boone, & Neumann, 2023). The methodology establishes a robust framework for examining causality and statistical correlations between independent and dependent variables. Data collected through quantitative research can be converted into reliable scientific inferences to underpin policy decisions, educational interventions, and empirical validation. This approach makes a relevant contribution to the scientific field because it emphasises objectivity, reproducibility, and standardisation. Quantitative methodology provides the possibility to test theories with a structured and systematic empirical basis, which contributes to strengthening scientific validity (Fischer et al., 2023). Therefore, it should be considered that methodological limitations are sensitive to qualitative aspects such as socio-cultural context and subjective interpretation.

Sampling Method and Research Site

The researchers employed random sampling, which involves selecting sample members from a population at random without regard to the population's strata (Sarker & AL-Muaalemi, 2022). This technique involves probability sampling, which is a method used by the researcher to ensure that each member of the population has an equal chance of being selected as part of the sample. The total population is 63 students from EBFC Mary Wilson Aubaca Baucau, specifically those in grades 7 and 8 (24 male and 39 female). The

population for the data validity test consisted of students from EBC, Saint António Teulale, who were in grades 7 to 9, totalling 455 students (213 males and 242 females). This sample was used to examine the relationship between learning motivation and students' critical thinking skills in mathematics lessons. In this research, the primary subjects for the main data are the students from EBFC Mary Wilson Aubaca Baucau, while the primary subjects for the data validity test are the students from EBC St António Teulale Baucau.

A sample is a portion of a population that possesses the necessary characteristics to serve as a research object (Sarker & AL-Muaalemi, 2022). Therefore, sampling is necessary because the researcher faces limitations in conducting research related to time, energy, funds, and the size of the population. Therefore, the sample for this research consists of students from EBFC schools. Mary Wilson Aubaca conducted the research with a total of 63 samples, which constitute the main data for this study. Therefore, the sample that the researcher took for the main data is 63 participants. The study focuses on learning motivation and students' critical thinking skills in operations management.

Data Collection Techniques

Data collection techniques are a way to help researchers obtain useful data results. The data collection technique is the most important step in this research, because the main purpose of the research is to obtain data. The technique used by the researcher to collect data is a questionnaire survey, which contains several written questions with answers provided, and respondents will complete this questionnaire independently (Kurzhals, 2021). The questionnaire survey technique is very important in quantitative research because it is efficient for collecting data from samples, it allows respondents to honestly choose their answers, and the collected data is easy to analyse statistically. This technique is appropriate for measuring and collecting data on the relationship between two variables. The researcher used the Likert scale to measure the relationship between the variables, from scale 1, strongly disagree, to scale 4, strongly agree (Jebb, Ng, & Tay, 2021). The researchers prepared a questionnaire to distribute to respondents, ensuring they provide credible answers that align with the research objectives.

Questionnaire Survey

The researcher used the questionnaire survey technique because it is appropriate to measure and collect data on the relationship between learning motivation and students' critical thinking skills in mathematics education. A questionnaire is a data collection technique through statements related to the research problem, then a systematic response to the problem. S questionnaire is a data collection technique that is conducted by giving a set of questions or written statements to respondents for them to answer (Kurzhals, 2021). The researchers employed the Likert scale model to select the sample and measure the respondents' attitudes.

A Likert scale is used to measure the attitudes, opinions, and perceptions of a person or group of people regarding social phenomena. The Likert scale is a valuable tool in research and surveys, measuring respondents' attitudes, opinions, and perceptions about social phenomena (Jebb, Ng, & Tay, 2021). Therefore, the researcher used the Likert scale to measure the variables and describe their indicators, which were then used as a basis to compile the instrument items in the form of statements or questions. The answers to the instrument items utilise the Likert scale to collect responses in the form of questions, allowing respondents to provide either a positive or negative answer simply by checking the alternative option presented. The list of questions in the questionnaire given to the respondents totalled 23 items, and for each answer to each item, there was a score.

Data Analysis Techniques

In this study, the researcher employed inferential statistical analysis techniques to comprehend the correlation between one variable and another. Inferential statistical data analysis techniques emphasise the process of generalisation to a large population, where conclusions will be drawn based on research results in a sample of a large population (Abdullah et al., 2021). The SPSS program (Statistical Package for Social Sciences) facilitated the use of the product-moment correlation to analyse the relationship between learning motivation and critical thinking skills.

A validity test is a test used to show the extent to which the measurement tool used measures what is being measured (Adeyemi, 2024). Validity testing was done before the main data collection at the research site. To determine whether an item is appropriate to use, a correlation coefficient significance test is usually performed at a significance level of 0.05, meaning an item is considered valid if it has a significant correlation with the total score (Adeyemi, 2024). Therefore, the questionnaire is considered valid if the significance value is less than 0.05; if the significance value exceeds 0.05, it is considered invalid. The r-table is then declared valid, but if the r-count value < r-table, then it is declared invalid (Adeyemi, 2024).

Thus, a reliability test is a tool to measure a questionnaire that is an indicator of a variable. The reliability test in this research used Cronbach's Alpha and was conducted using the SPSS program. Thus, according to Gavidia & Mariño (2021), “cronbach’s alpha” is a reference used to describe the correlation between the created scale and all existing variable scales. The instrument used in the variable is said to be reliable if it has a Cronbach's alpha of more than 0.60. The criteria for the reliability test are: if the Cronbach Alpha value is > 0.60, then the instrument is reliable, but if the Cronbach Alpha value is < 0.60, then the instrument is not reliable (Adeyemi, 2024).

The normality test is used to assess the normality of the researched variables, whether the data are normally distributed or not (Noel et al., 2021). In this research, the normality test was conducted using the Kolmogorov-Smirnov test technique, with the help of SPSS. To determine the normal distribution of data, a criterion is used that if the significance value is > 0.05, it means that the data is normally distributed, and if the significance value is < 0.05, it means the

distribution of data is not normal (Noel et al., 2021; Wara et al., 2025). Performing normality testing is a crucial part of analysing accurate and reliable research data. The assumption of normality is crucial because many parametric statistics, such as mean and standard deviation, depend on the distribution of the data.

Correlation Analysis

Correlation analysis is a statistical method used in this research to determine the relationship between students' motivation to learn and their ability to think critically in mathematics education. The correlation coefficient (R) shows the degree of correlation between the independent variable and the dependent variable (Changjun, & Xiaowen, 2025). The correlation coefficient must fall within the range of -1 to +1 ($-1 < r \leq +1$). This figure indicates that a positive sign signifies a positive correlation between the variables (Sugiyono, 2021).

Similarly, if a negative sign indicates a negative correlation between the variables, it means that as every X value increase, the Y value can decrease, and vice versa (Changjun, & Xiaowen, 2025). If r = -1 or is approaching -1, then it shows a negative influence, and the correlation of the variables proves to have a weak relationship. If r = 0 or is close to 0, then it shows a weaker or no correlation at all between the variables examined and tested (Sugiyono, 2021). Therefore, the researchers used the Pearson correlational method in the SPSS 21 program to determine the relationship between variables, based on the criteria reported in the following table.

Table 1. Coefficient Correlation

Interval coefficient	Coefficient Correlation
0.00 - 0.199	Very weak
0,20 – 0,399	Weak
0,40 - 0,599	Sufficient
0,60 - 0,799	Strong
0,80 - 1,000	Very strong

The hypothesis test in this research used the criterion: if the significance value is greater than the probability value of 0.05, then H0 is accepted, which means no relationship, and H1 is automatically rejected. If the significance value < probability value 0.05, H1 is accepted; it means there is a relationship between the variables, and automatically H0 is rejected. Therefore, the hypotheses of this research are: H1: learning motivation is related to students' critical thinking skills for operations in mathematics lessons.

Ethical Considerations

The researchers also received a research letter reported by the Catholic Institute for Teacher Training, Baucau, stating that they had received permission from the ICFP to conduct research. The purpose of this letter is to prevent any potential misunderstandings during the research process. The researchers delivered this letter to the school authorities to secure their permission before conducting the research. There were some important points in research ethics: the researcher needs to show a favourable attitude and conduct the right research

so as not to violate human dignity during the research (Åkerfeldt & Boistrup, 2021).

RESULT

Validity Test Results

The validity test results of the research instrument from the 68 samples are reported in the following table. The following table shows the results from the test using the SPSS 21 program.

Table 2. Validity Test Results

Variable	Test method	r-count	r-table	Decision
X1	Pearson Correlation	0.397	0.248	Valid
	Sig. (2-tailed)	0.001	0.05	
	N	68		
X2	Pearson Correlation	0.662	0.248	Valid
	Sig. (2-tailed)	0.001	0.05	
	N	68		
X3	Pearson Correlation	0.323	0.248	Valid
	Sig. (2-tailed)	0.007	0.05	
	N	68		
X4	Pearson Correlation	0.229	0.248	Invalid
	Sig. (2-tailed)	0.061	0.05	
	N	68		
X5	Pearson Correlation	0.628	0.248	Valid
	Sig. (2-tailed)	0.001	0.05	
	N	68		
X6	Pearson Correlation	0.470	0.248	Valid
	Sig. (2-tailed)	0.001	0.05	
	N	68		
X7	Pearson Correlation	0.541	0.248	Valid
	Sig. (2-tailed)	0.001	0.05	
	N	68		
X8	Pearson Correlation	0.506	0.248	Valid
	Sig. (2-tailed)	0.001	00.05	

	N	68		
X9	Pearson Correlation	0.369	00.248	Valid
	Sig. (2-tailed)	0.002	0.05	
	N	68		
X10	Pearson Correlation	0.564	0.248	Valid
	Sig. (2-tailed)	0.001	0.05	
	N	68		
X11	Pearson Correlation	0.687	0.248	Valid
	Sig. (2-tailed)	0.001	0.05	
	N	68		
Y1	Pearson Correlation	0.634	0.248	Valid
	Sig. (2-tailed)	0.001	0.05	
	N	68		
Y2	Pearson Correlation	0.406	0.248	Valid
	Sig. (2-tailed)	0.001	0.05	
	N	68		
Y3	Pearson Correlation	0.558	0.248	Valid
	Sig. (2-tailed)	0.001	0.05	
	N	68		
Y4	Pearson Correlation	0.333	0.248	Valid
	Sig. (2-tailed)	0.006	0.05	
	N	68		
Y5	Pearson Correlation	0.653	0.248	Valid
	Sig. (2-tailed)	0.001	0.05	
	N	68		
Y6	Pearson Correlation	0.638	0.248	Valid
	Sig. (2-tailed)	0.001	0.05	
	N	68		
Y7	Pearson Correlation	0.545	0.248	Valid
	Sig. (2-tailed)	0.001	0.05	
	N	68		
Y8	Pearson Correlation	0.637	0.248	Valid

	Sig. (2-tailed)	0.001	0.05	
	N	68		
Y9	Pearson Correlation	0.549	0.248	Valid
	Sig. (2-tailed)	0.001	0.05	
	N	68		
Y10	Pearson Correlation	0.297	0.248	Valid
	Sig. (2-tailed)	0.014	0.05	
	N	68		
Y11	Pearson Correlation	0.476	0.248	Valid
	Sig. (2-tailed)	0.001	0.05	
	N	68		
Y12	Pearson Correlation	0.541	0.248	Valid
	Sig. (2-tailed)	0.001	0.05	
	N	68		

The results of the validity test in this table with the SPSS program indicate that one item (X4) is invalid. The table indicates that the r-count value for item X4 is 0.229, which is less than the r-table value of 0.248. Then, the significance value of 0.061 is greater than 0.05, confirming that the item is invalid. The item is part of variable X (learner motivation). While all other items were considered valid because their r-count value > r-table or significance value < 0.05. Thus, some of the valid items are from the independent variable X (learning motivation), and all others are from the dependent variable Y (critical thinking ability). Therefore, 22 items remained valid because their r-count value was >0.248 or the significance value was <0.05, and the questionnaire was ready to be used for the main test.

Reliability Test Results

The reliability test results of Cronbach's alpha with the SPSS program are reported in the following table.

Table 3. Reliability Test Results

Reliability Statistics			
Cronbach's Alpha	N of Items	Significance value	Decision
0.870	23	0.60	Reliable

This table shows the results of the reliability test with Cronbach's alpha method, revealing a value of 0.870 for both the dependent (Y) and independent (X) variables. This result indicates that the questionnaire items are reliable, as the Cronbach's Alpha value of 0.870 exceeds the threshold of 0.60. Therefore, the

questionnaire was defined with items that reported credibility and consistency to collect the main data.

Normality Test Results

The results of the normality test of the one-sample Kolmogorov-Smirnov test with SPSS in this table describe the significance value of the residual value, where the value of the independent variable (X) and the dependent variable (Y) are analysed together, which is reported in the following table:

Table 4. Normality Test Results

One-Sample Kolmogorov-Smirnov Test			
Test method	Unstandardized Residual	Significance value	Decision
Kolmogorov-Smirnov Z	0.435	0.05	Normal

Therefore, the table above shows the results of the analysis with the one-sample Kolmogorov-Smirnov test. This table describes the residual value of 0.435 and the probability value of 0.05. Thus, the significance value of 0.435, which is greater than 0.05, indicates that the data have a normal distribution. The results of the one-sample Kolmogorov-Smirnov test indicated that the items were prepared and reported in the questionnaire, ensuring the normality of the distribution and collecting the main data.

Correlation Analysis Results

The results of correlation analysis between variable X and variable Y of bivariate correlation with the SPSS program are reported in the following table:

Table 5. Correlational Analysis Results

Correlations		
	Learning motivation	Critical thinking ability
Pearson Correlation	1	0.602
Sig. (2-tailed)		0.001
N	63	63
Pearson Correlation	0.602	1
Sig. (2-tailed)	0.001	
N	63	63

Based on this correlation analysis table, the value of Pearson correlation in the variables (X) learning motivation and (Y) critical thinking skills is 0.602. Then, the correlation in the test results showed a value between 0.60 and 0.799. Therefore, according to the criterion, a value of 0.602 indicates that the correlation is close to the maximum possible value (R) ®. Thus, a decision can be made that the results of correlation analysis reveal a strong relationship between learning motivation and students' critical thinking skills in mathematics learning content. Therefore, the result of the hypothesis test in this research is that H0 is rejected and H1 is accepted, which means that learning motivation has a strong

relationship with students' critical thinking skills for operations in mathematics lessons.

DISCUSSION

Learning motivation refers to the internal and external encouragement that an individual has to engage in learning activities, fostering enthusiasm to learn and explore new knowledge through critical and logical thinking. According to Cahyono et al. (2022), learning motivation is the encouragement that arises within the learners themselves and from the outside, which causes enthusiasm for learning and gives direction to learning activities to achieve goals. The results of this research also align with the results of the literature, which show a strong relationship between learning motivation and students' critical thinking skills in mathematics lessons.

This type of learning motivation is a force that encourages students to achieve goals in the learning process. The findings of this study show that the teacher's approach can encourage students with both internal and external motivation to develop a strong desire to learn effectively, according to this research. These findings aligned with those of Fitria & Sari (2024) found that intrinsic motivation is a drive that operates independently of external stimuli, asserting that each individual inherently possesses an impulse to act. In contrast, extrinsic motivation is defined as a drive that is activated by external stimulation. Therefore, students need to be motivated to learn to develop their critical thinking skills in the learning process. Thus, the results of this research strengthen the theoretical foundation that learning motivation is related to students' critical thinking skills and, through stimulation and guidance from teachers and themselves, can increase a student's ability to think critically and logically.

In addition, the strong correlation found in this research is similar to Elsabrina et al. (2022); critical thinking also contributes to the ability to examine and evaluate thoughts as a way to clarify their argumentative basis and form ideas logically. This is the process through which students learn to evaluate, interpret, and conclude mathematical problems. According to Brookhart (2010), students who have critical thinking will be open to analysis because the answer is fair and relevant to the context of the problem. In this process, students cannot just absorb information but need to use reflective and argumentative thinking to justify mathematical solutions. The results of this research also correspond to the ideas emphasised by the literature that students who develop their critical thinking skills can contribute to the ability to examine, evaluate, interpret, and conclude the results and can respond fairly and relevantly to the context of the problem.

The results of this research show that when students receive internal and external motivation, it can arouse their interest and ability to develop critical thinking skills to solve problems in mathematics. Integrating motivation and critical thinking skills into students can ensure their study success, particularly in mathematics learning. Learning motivation can transform students' critical thinking skills to solve problems and validate the outcomes of problem analysis.

CONCLUSIONS AND RECOMMENDATIONS

Learning motivation is a fundamental factor in the educational process, as it is an internal and external force that encourages students to engage enthusiastically in learning activities. When a student is intrinsically motivated, they take the initiative to learn, explore, and analyse mathematical problems. When students receive extrinsic motivation, such as stimuli from the teacher or the teaching environment, they can focus on learning activities, consistency, and determination to achieve academic goals. The results of this research prove that there is a significant and strong relationship between learning motivation and the critical thinking skills of students in mathematical operations, with a Pearson correlation coefficient of $r = 0.602$ ($p < 0.05$). This evidence shows that learning motivation can make a direct contribution to the development of students' critical thinking.

The research results have also answered the research question, which demonstrates that there is a relationship between learning motivation and students' critical thinking skills in mathematical operations. This relationship is a strong category, because motivation, as a psychological force, can stimulate students to use reflective, argumentative and logical thinking to solve problems. Learning motivation can transform students from passively absorbing information to being active in interpretation, justification and rational decision-making.

The pedagogical implication of this research is that teachers need to develop interactive, creative, and stimulating teaching strategies that allow students to develop interest, participation, and critical thinking skills. When the teaching environment is favourable and motivating, students not only increase their mathematical knowledge but also achieve academic success and develop competencies relevant to real-world life. Thus, this research provides a theoretical and practical contribution to reinforce that learning motivation plays an essential role in the development of critical thinking skills and is an important foundation for the improvement of mathematics learning in Timor-Leste.

Recommendation

Based on the results of the research, we recommend that the competent authorities contribute to the development of teaching methods that stimulate student motivation.

1. Mathematics teachers at EBFC Mary Wilson Aubaca Baucau can continue to create a favourable and motivated environment to stimulate them to be more interested and willing to learn all lessons, especially mathematics lessons, to show positive and academic results in the future.
2. ICFP continues to provide opportunities for future teachers to qualify themselves as more professional in the area of mathematical studies so as to use varied and motivated teaching methods to help students learn more enthusiastically in the future.
3. Teachers and future teachers need to create a favourable and motivated learning environment that can help students develop critical thinking skills for all lessons.

4. Students in schools, as the future of the beloved land of Timor-Leste, must strive to study diligently and motivate themselves to be able to make changes for the development of the beloved land of Timor-Leste in the future.
5. The Ministry of Education needs to improve the quality of education by creating various teaching methods in all lessons, especially in mathematics lessons.

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