

Exploring The Effect of Learning Environment on Students' Mathematical Thinking Ability: Evidence from Matrix Learning at SMA Hang Tuah 1 Surabaya

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Abstract

This study aims to determine the influence of the learning environment on the mathematical thinking skills of Phase F.11 students at SMA Hang Tuah 1 Surabaya in the context of matrix material. Mathematical thinking skills are essential abilities that need to be developed in mathematics learning because they relate to students' ability to reason, analyze, and solve problems logically and systematically. However, the results of the observations show that some students still have difficulty understanding the concept of matrices and applying them in problem-solving, which is thought to be caused by suboptimal learning environment factors. This study uses a quantitative approach with an explanatory research method. The research population comprised all students of Phase F.11 at SMA Hang Tuah 1 Surabaya. In contrast, the research sample consisted of 33 students from class F.11.3, selected via simple random sampling. The research instruments consisted of a learning environment questionnaire and a mathematical thinking ability essay test. Data were analyzed using simple linear regression in IBM SPSS Statistics version 26. The results of the study indicate that the learning environment has a positive and significant effect on students' mathematical thinking abilities, with a significance value of $0.001 < 0.05$. The regression equation obtained is $Y = 34.612 + 0.523X$, which means that every one-unit increase in the learning environment score will increase mathematical thinking abilities by 0.523 units. The coefficient of determination (R^2) of 0.541 indicates that the learning environment explains 54.1% of the variation in mathematical thinking abilities, while the remaining 45.9% is explained by other factors outside this study. Based on these results, it can be concluded that the better a student's learning environment—whether at home, school, or in the community—the higher their mathematical thinking skills, particularly in understanding and solving problems involving matrices. Therefore, improving the quality of the learning environment is a crucial factor in supporting successful mathematics learning in high school.

Keywords: Learning environment, mathematical thinking skills, Phase F.11 students

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INTRODUCTION

Mathematics is a subject that plays a crucial role in developing students' logical, systematic, and critical thinking skills. Through mathematics learning, students are trained to identify patterns, connect concepts, and solve everyday problems. One of the skills that needs to be developed in mathematics learning is mathematical thinking, as this ability encompasses not only calculation but also reasoning, analysis, and the ability to draw logical conclusions about a problem.

However, observations at Hang Tuah 1 High School in Surabaya, particularly among Phase F.11 students, revealed that mathematical thinking skills are still relatively low. Students often struggle to grasp concepts, particularly in matrix material, which requires understanding the operations and relationships among elements within a system. This difficulty is not solely due to cognitive factors but also to a learning environment that does not fully support active and meaningful learning.

The learning environment plays a crucial role in shaping students' motivation, attitudes, and thinking skills. A conducive learning environment, whether at home, school, or in the community, can enhance students' comfort and enthusiasm for learning, making it easier for them to grasp abstract mathematical concepts. Conversely, a less supportive environment, such as a lack of learning facilities, strained social relationships, or a hostile classroom atmosphere, can hinder the development of mathematical thinking skills.

According to Abbas (2023), a good learning environment encompasses three main aspects: the home, school, and community. In the home environment, parental support significantly influences a child's motivation to learn. At school, factors such as teacher teaching methods, student relationships, and learning resources are key to successful learning. Meanwhile, in the community, social and cultural interactions also influence students' thinking patterns. These three aspects are interrelated in shaping students' mental readiness and mathematical thinking skills.

In the context of learning mathematics on matrices, the role of the learning environment becomes increasingly important. Students need support from their surroundings to understand the basic concepts of matrix operations —addition, subtraction, and multiplication—and their application to solving real-world problems. A conducive learning environment encourages students to actively participate, discuss, and discover mathematical concepts for themselves through enjoyable and meaningful learning experiences.

Based on the description, it can be concluded that students' success in developing mathematical thinking skills, especially in matrix material, is not solely determined by internal factors such as motivation or interest in learning, but is also influenced by external factors, including the learning environment. Therefore, this study aims to analyze the influence of the learning environment on students' mathematical thinking skills in Phase F.11 of SMA Hang Tuah 1 Surabaya, with the hope that the results will contribute to improving the quality of the mathematics learning process in schools.

LITERATURE REVIEW

1. Learning Environment

The learning environment is everything surrounding students that influences the learning process, both directly and indirectly. According to Prantauwati et al. (2021), the learning environment encompasses all physical, social, and psychological conditions that contribute to creating a conducive learning environment. The learning environment extends beyond the classroom into the home and community, where students interact.

Abbas (2023) stated that an effective learning environment will support students in developing their thinking skills, while a unsupportive climate can reduce motivation and learning

achievement. A good learning environment has several characteristics, including: an orderly and comfortable classroom atmosphere, harmonious social relationships between teachers and students, and adequate learning facilities.

According to Puspita Dewi et al. (2024), learning environments are divided into two types: physical and social.

- a. The physical environment includes facilities, classrooms, lighting, ventilation, and learning tools that support comfortable learning. A good physical environment will improve students' concentration and learning effectiveness.
- b. The social environment encompasses interpersonal relationships between students and teachers, peers, family, and the community. Positive social support from the environment will increase self-confidence, enthusiasm, and responsibility in learning.

Furthermore, Abbas & Rizki (2023) explained that the learning environment can be classified into three main aspects: the home environment, the school environment, and the community environment.

- a. The home environment plays a role in providing emotional and moral support to students. Parents' education, attention, and the family's economic situation influence a child's motivation and readiness to learn.
- b. The school environment encompasses interactions between teachers and students, teaching methods, and school facilities. A school with a positive atmosphere will encourage students to think actively and creatively in solving problems.
- c. The community environment also shapes students' thinking skills through social activities, culture, and the values prevailing in their neighborhood.

Therefore, a conducive learning environment significantly influences the development of students' cognitive, affective, and psychomotor abilities, including mathematical thinking skills.

2. Mathematical Thinking Ability

Mathematical thinking skills are students' abilities to understand, analyze, and solve problems based on mathematical concepts and principles. According to Aini et al. (2019), mathematical thinking encompasses the mental processes used to connect ideas, organize information, and draw logical conclusions. In the context of mathematics learning, mathematical thinking skills are necessary so that students cannot only memorize formulas but also deeply understand the meaning and applications of concepts.

Sutiarso (2019) divides mathematical thinking skills into three main components:

- a. Causative thinking, which is the ability to solve problems based on systematic patterns and rules.
- b. Imaginative thinking, which is the ability to think creatively and generate new ideas to solve problems.
- c. Integrative thinking, which is the ability to connect mathematical concepts with real life and apply them in relevant contexts.

Students' mathematical thinking skills don't develop instantly, but develop through meaningful learning, ongoing practice, and a supportive environment that encourages intellectual exploration. Therefore, teachers play a crucial role in creating a learning environment that stimulates higher-order thinking skills (HOTS).

In matrix material, mathematical thinking skills are essential for understanding abstract concepts such as matrix operations, determinants, and inverses, and for their application in contextual problem-solving. Students with strong mathematical thinking skills will be able to see the relationships between concepts, identify patterns, and solve problems using structured logic.

3. The Relationship between Learning Environment and Mathematical Thinking Ability

A positive learning environment can be a key external factor supporting the development of students' mathematical thinking skills. This aligns with the research findings of Utaminingtyas et al. (2021), which found that a conducive learning environment can enhance critical thinking and problem-solving skills. An environment that supports social interaction and active learning allows students to participate directly in the mathematical thinking process.

Halim (2020) emphasized that a comfortable, well-organized learning environment can foster student self-confidence and active participation. In the context of mathematics learning, an interactive classroom atmosphere and teacher support in providing positive feedback will increase students' confidence in expressing their mathematical ideas.

Furthermore, research by Umami et al. (2023) shows that a home learning environment with parental attention and support is positively correlated with mathematical thinking skills. Students who receive guidance and motivation at home tend to have a high interest in learning and better academic achievement.

Thus, it can be concluded that the learning environment plays a significant role in shaping students' mathematical thinking skills. A conducive environment, both physical and social, will foster a sense of comfort, increase learning motivation, and encourage students to think logically, creatively, and reflectively as they understand mathematical concepts, particularly matrices.

METHOD

1. Types and Approaches of Research

This study uses a quantitative, explanatory research design. This approach was chosen because it focuses on examining relationships between variables that can be objectively measured numerically. This descriptive research method was used to explain the extent to which the independent variable —namely, the learning environment —influences the dependent variable —namely, students' mathematical thinking skills.

This study aims to determine the extent to which students' learning environment contributes to their mathematical thinking skills, especially in mathematics learning on matrix material in Phase F.11 at SMA Hang Tuah 1 Surabaya.

2. Location and Time of Research

This research was conducted at SMA Hang Tuah 1 Surabaya, located at Jl. Ikan Lumba-Lumba No. 27, Surabaya. The research location was selected purposively because the school has a reasonably complete learning environment and student characteristics relevant to the research objectives.

The research was conducted during the even semester of the 2024/2025 academic year, namely from April to May 2025, including observation activities, instrument distribution, data collection, and analysis of research results.

3. Population and Research Sample

The population in this study was all 245 students of Phase F.11 of Hang Tuah 1 High School, Surabaya. The sample was selected using a simple random sampling technique, which is random sampling without regard to strata, so that each member of the population has an equal chance of being selected into the sample.

Based on this technique, 33 students from class F.11.3 were selected as the research sample. This class was chosen because it has characteristics representative of the population and has participated in mathematics learning on matrices.

4. Research Variables

This study consists of two variables:

- a. Independent variable (X): Learning Environment, which refers to the physical and social conditions surrounding students that influence their learning activities.
- b. Dependent variable (Y): Mathematical Thinking Ability, which refers to students' ability to understand, reason, and solve mathematical problems in matrices.

5. Operational Definition of Variables

a. Learning Environment (X)

The learning environment is all external conditions that support or hinder students' learning activities, whether at home, school, or in the community. The learning environment is measured using a questionnaire with a five-level Likert scale. The indicators used include:

- 1) Home environment (parental support and attention);
- 2) School environment (teaching methods, teacher-peer relationships, learning facilities);
- 3) Community environment (social activities and environmental influences).

b. Mathematical Thinking Ability (Y)

Mathematical thinking is the ability to understand concepts, reason logically, and solve problems using mathematical principles. Measurement is conducted using descriptive tests on matrix material. Indicators of mathematical thinking ability include:

- 1) Causative thinking (the ability to solve problems logically and systematically),
- 2) Imaginative thinking (the ability to think creatively and discover new strategies),
- 3) Integrative thinking (the ability to relate mathematical concepts to real-life contexts).

6. Research Instruments

The research instruments consist of:

a. Learning Environment Questionnaire

This instrument measures the level of support in students' learning environments. The questionnaire is structured on a Likert scale with four answer options:

Alternative Answers	Positive Score	Negative Score
Strongly Agree (SA)	4	1
Agree (A)	3	2
Disagree (D)	2	3
Strongly Disagree (SD)	1	4

Before use, the questionnaire underwent validity and reliability tests, with results indicating that all statement items were valid and reliable.

b. Mathematical Thinking Ability Test

This test consists of descriptive questions based on matrix material, covering the ability to understand concepts, perform matrix operations, and apply matrix concepts to contextual problem-solving. The test has also been tested for content validity through expert judgment from lecturers and mathematics teachers.

7. Data collection technique

The data in this study were obtained through the following techniques:

- a. Observations were conducted to assess the learning environment at school and student learning behavior during the mathematics learning process.
- b. Questions were administered to students to gauge their perceptions of the learning environment.

- c. Descriptive tests were used to measure students' mathematical thinking skills in matrices.
- d. Documentation was used to collect secondary data such as student names, report card grades, and other relevant supporting data.

8. Data Analysis Techniques

Data analysis was carried out using the IBM SPSS Statistics program version 26 with the following stages:

- a. Prerequisite Analysis Test
Includes a normality test to determine data distribution and a homogeneity test to test for equality of variance between variables.
- b. Simple Linear Regression Analysis
Used to determine the effect of the learning environment (X) on mathematical thinking ability (Y).
- c. Partial t-Test
This test partially assesses the significance of the independent variable's influence on the dependent variable.
- d. Coefficient of Determination (R^2)
To determine the extent to which the learning environment contributes to students' mathematical thinking ability.

9. Research Procedures

The steps in implementing the research include:

- a. Conducting initial observations and determining research subjects.
- b. Developing and validating research instruments.
- c. Conducting instrument trials and revisions based on the results of validity and reliability tests.
- d. Conducting data collection through questionnaires and tests.
- e. Conducting data analysis using statistical techniques.
- f. Concluding the influence of the learning environment on students' mathematical thinking skills in matrices.

Result and Discussion

1. Research result

This study aims to determine the effect of the learning environment on the mathematical thinking skills of Phase F.11 students at SMA Hang Tuah 1 Surabaya in the context of matrix material. Data were obtained through a learning environment questionnaire and a mathematical thinking ability essay test. Analysis was carried out using IBM SPSS Statistics version 26, including descriptive tests, prerequisite tests, and simple linear regression tests.

a. Data Description

Based on the data processing results, the average learning environment score was 82.45, categorized as good, while the average score for students' mathematical thinking ability was 80.18, classified as high. These results indicate that most students have a learning environment that is sufficiently supportive of their mathematics learning process, and this correlates with good mathematical thinking ability.

The distribution of learning environment scores shows that students who receive high support from their home, school, and community environments tend to achieve better mathematical thinking test results than students whose learning environments are less supportive.

b. Normality and Homogeneity Test

The Kolmogorov-Smirnov normality test showed a p-value of 0.200 (> 0.05), indicating a normal distribution of the data. Meanwhile, Levene's homogeneity test showed a p-value of 0.327 (> 0.05), indicating that the data came from a homogeneous population. Therefore, the data met the requirements for linear regression testing.

c. Simple Linear Regression Test

The results of the simple linear regression analysis show the following regression equation: $Y = 34.612 + 0.523X$

Where:

- Y = Mathematical thinking ability
- X = Learning environment

The regression coefficient of 0.523 indicates that every one-unit increase in the learning environment score will increase the mathematical thinking ability score by 0.523 units.

The results of the t-test show a t-value of 5.598 and a significance level of $0.001 < 0.05$, indicating a positive and significant relationship between the learning environment and students' mathematical thinking abilities.

Furthermore, the coefficient of determination (R^2) of 0.541 indicates that the learning environment explains 54.1% of the variation in students' mathematical thinking abilities. In comparison, the remaining 45.9% is explained by other factors such as learning motivation, interest, learning strategies, and attitudes towards mathematics.

2. Discussion

These findings have important implications for education, particularly for teachers and schools. Teachers need to create interactive and supportive learning environments, both physically and socially. Schools are expected to provide comprehensive learning facilities, a comfortable classroom atmosphere, and foster positive relationships within the school community. Furthermore, parents need to give support and attention to their children's learning activities at home to create continuity between the school and home environments.

a. The Influence of Learning Environment on Mathematical Thinking Ability

The results of this study demonstrate that the learning environment significantly influences students' mathematical thinking skills. This aligns with Abbas's (2023) view that a conducive learning environment can improve students' concentration, motivation, and thinking skills. Students who learn in a comfortable environment and receive support from parents, teachers, and peers will more easily understand mathematical concepts, including abstract matrix material.

A supportive learning environment provides a positive learning experience. For example, a calm home environment and caring parents encourage students to focus on learning. In contrast, a school environment with complete facilities and a good relationship between teachers and students promotes active participation in the learning process. This finding aligns with research by Utamingtyas et al. (2021), which confirms that a conducive learning environment can improve students' learning outcomes and higher-order thinking skills.

b. The Influence of Learning Environment on Mathematical Thinking Ability

The research also shows that the social environment plays a crucial role in the development of mathematical thinking skills. Students with positive social relationships at school tend to be more active in discussions, asking questions, and collaborating to solve

math problems. Good social interactions foster self-confidence and reduce math anxiety. This aligns with Vygotsky's social constructivism theory, which emphasizes that effective learning occurs through social interaction and support from the surrounding environment (scaffolding).

Furthermore, teacher support in implementing a contextual learning approach also contributes to the development of mathematical thinking skills. A classroom environment that encourages the exploration of ideas and solving real-world problems helps students develop logical, creative, and reflective thinking skills, as explained by Emanuel et al. (2022) in their study on the influence of the learning environment on critical and mathematical thinking skills.

c. The Relationship between the Physical Environment and Understanding Matrix Material

A good physical environment, such as a clean classroom, adequate lighting, and access to learning materials, has also been shown to contribute to students' mathematical thinking skills. In matrix material, students who learned using visual media, such as tables, charts, or digital applications, demonstrated a higher conceptual understanding than those who learned solely through verbal explanations. This suggests that adequate learning facilities can facilitate students' understanding of abstract mathematical concepts.

These results are consistent with Halim's (2020) research, which states that a well-organized learning environment equipped with relevant learning media can improve students' motivation and learning outcomes in mathematics.

CONCLUSION

Based on the results of research and discussions that have been conducted regarding the influence of the learning environment on the mathematical thinking abilities of Phase F.11 students of SMA Hang Tuah 1 Surabaya on matrix material, several things can be concluded as follows:

1. The learning environment has a positive and significant influence on students' mathematical thinking skills. Regression analysis results indicate that the better the learning environment—encompassing the home, school, and community—the higher students' mathematical thinking skills are in understanding and solving mathematics problems, particularly in matrices.
2. The learning environment significantly contributes to improved mathematical thinking skills. The coefficient of determination of 54.1% indicates that more than half of the variation in students' mathematical thinking skills can be explained by learning environment factors. This confirms that a comfortable learning environment, adequate learning facilities, and social support from parents, teachers, and peers are crucial to successful mathematics learning.
3. A conducive learning environment encourages students to be active, creative, and reflective in mathematical thinking. Students who receive support from their environment tend to be more enthusiastic, confident, and able to connect mathematical concepts to real-world situations. Conversely, a less supportive learning environment can reduce students' motivation and mathematical thinking skills.

Thus, improving mathematical thinking skills depends not only on individual cognitive abilities but also on the quality of the learning environment created at home, school, and in the community. Therefore, teachers, schools, and parents need to work together to create a positive, interactive learning environment that supports the overall mathematics learning process.

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