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CRITICAL THINKING ABILITY OF JUNIOR HIGH SCHOOL STUDENTS IN GAME-BASED LEARNING USING GEMAS GAME

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Abstract

Games-based learning is a learning model that integrates material into games so that it can motivate students to think critically when solving problems. This study aims to review the critical thinking skills of junior high school students in learning mathematics that applies a game-based learning model using GEMAS game. This research uses the descriptive analysis method. The research was conducted at Tahfidz Quran Al-Fath Islamic Middle School with 29 students in class IX as research subjects; 2 subjects were taken to be interviewed about the results of their answers to the critical thinking ability test. Subjects were selected based on specific considerations, namely, students with high mathematical abilities and those with low mathematical abilities. Data collection was carried out using test and interview methods. Based on the analysis results, it was found that the percentage of students who could meet critical thinking according to FRISCO (Focus, Reason, Inference, Situasion, Clarity, dan Overview) criteria increased after game-based learning. There is an increase in critical thinking skills, both students with high mathematical abilities and those with low mathematical abilities. Students with high mathematical abilities have achieved better critical thinking criteria than students who have low mathematical abilities.

Keywords: Critical Thinking; FRISCO; Game Based Learning.

Abstrak

Pembelajaran berbasis games merupakan model pembelajaran yang mengintegrasikan materi ke dalam permainan (games) sehingga mampu memotivasi siswa untuk berpikir kritis dalam menyelesaikan masalah. Penelitian ini bertujuan untuk meninjau kemampuan berpikir kritis siswa SMP pada pembelajaran matematika yang menerapkan model pembelajaran berbasis game menggunakan game GEMAS. Penelitian ini menggunakan metode analisis deskriptif. Penelitian dilakasanakan di SMP Islam Tahfidz Quran Al-Fath dengan subjek penelitian 29 siswa kelas IX, yang diambil 2 subjek untuk diwawancara mengenai hasil jawabannya terhadap tes kemampuan berpikir kritis. Subjek dipilih berdasarkan pertimbangan tertentu, yakni siswa yang memiliki kemampuan matematika tinggi dan siswa yang memiliki kemmapuan matematika kurang. Pengumpulan data dilakukan dengan metode tes dan wawancara. Berdasarkan pada hasil analisis, diperoleh persentase siswa yang mampu memenuhi kriteria berpikir kritis FRISCO (Focus, Reason, Inference, Situasion, Clarity, dan *Overview) meningkat setelah pembelajaran berbasis game. Terdapat peningkatan kemampuan berpikir kritis, baik siswa dengan kemampuan matematika tinggi maupun siswa yang memiliki kemampuan matematika rendah. Siswa dengan kemampuan matematika tinggi memiliki ketercapaian kriteria berpikir kritis yang lebih baik dari siswa yang memiliki kemampuan matematika rendah..*

***Kata kunci**: Berpikir Kritis; FRISCO; Pembelajaran Berbasis Game*.

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INTRODUCTION

Critical thinking is one of the 21st-century skills that must be possessed (Habibi & Suparman, 2020; Ruqoyyah et al., 2020). Everyone needs to have the ability to think critically to participate fully in the economy and society and to achieve social justice (Furness et al., 2017). Critical thinking is needed for students to solve the problems given, especially for solving story problems or everyday life (Syafruddin & Pujiastuti, 2020).

Critical thinking is one's attempt to check the truth of information using evidence, logic and awareness of bias (Larsson, 2017). Critical thinking is a process for expressing goals with clear reasons about an activity (Ennis, 1996). Other opinions reveal that critical thinking is a cognitive process in analyzing problems clearly and sequentially, sorting out problems wholly and accurately, and identifying and analyzing information needed to plan problem-solving strategies (Fitriya et al., 2022). In learning mathematics through mathematical critical thinking, students will be able to organize and collaborate on mathematical thinking through communication, communicate their mathematical thinking clearly and coherently, analyze and evaluate critical thinking strategies, and use the language of mathematics to express mathematical ideas correctly (Maulidah et al., 2020).

There are several indicators to measure critical thinking skills. Facione (2020) reveals indicators of critical thinking skills, including interpretation, analysis, evaluation, inference, explanation, and self-regulation. Meanwhile, according to Ennis (1996), the criteria for measuring critical thinking skills are focus, reason, inference, situation, clarity, and overview, shortened to FRISCO.

Students need to have critical thinking skills. However, students' critical thinking skills in Indonesia still need to be improved. (Anita, 2021; Lestari & Roesdiana, 2021; Rosmalinda et al., 2021). That is in line with the results of Indonesia's PISA, ranked at the bottom, where PISA also measures critical thinking skills (Ajrina Mujarwati et al., 2018). One of the factors causing the low ability to think critically lies in the learning process because critical thinking can develop through the learning process (Andreou et al., 2014). The teacher's approach to learning has a role in improving students' critical thinking skills (Pratama et al., 2019). Therefore, choosing a learning model to develop critical thinking skills is necessary.

One way to develop student's critical thinking skills is by applying a game-based learning model (Carolyn Yang & Chang, 2013; Cicchino, 2015). In game-based learning, a game is deliberately designed for educational purposes to support learning media because it is considered more interesting (Dewi & Listiowarni, 2019). Mathematics education game effective to use in learning (Abdullah & Yunianta, 2018). The game-based learning model is valuable because it can hone critical thinking skills, group communication, and appropriate decisions (Wibawa et al., 2021). Several research results show that students who learn with the help of games show better critical thinking tendencies (Chang et al., 2020; Fitriyadi & Wuryandani, 2021; Urazaeva, 2018).

Most game-based learning techniques rely on computers or laptops, handheld devices or smartphones, and online applications (Hartt et al., 2020). In this study, the game that will be used is the GEMAS application, a junior high

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school math educational game containing math questions and material. The GEMAS application is chosen because The GEMAS application was chosen because the research results show that GEMAS is suitable for use and is able to improve critical thinking skills (Lukman et al., 2023). The problems in GEMAS presented are contextually based, which directs students to think critically to solve them, whereas contextual learning can improve students' critical thinking skills (Kurniati et al., 2015). This game is also enough to use an Android-based smartphone, as many students like to use smartphones for learning (Murphy et al., 2014). In addition, using a smartphone can improve students' learning process (Yamamoto, 2015). As previously stated, the learning process develops critical thinking skills (Andreou et al., 2014).

Based on this explanation, this research will be carried out to examine how critical thinking abilities of junior high school students are in game-based learning models using the GEMAS game. This research is intended as an innovation from learning mathematics on critical thinking skills and can be used as a reference for planning learning to improve critical thinking skills.

METHODS

The research design used is descriptive analysis. Descriptive research describes a variable, symptom, or condition as it is (Arikunto, 2016). Descriptive research aims to get an in-depth description and detailed information about critical thinking skills. The subjects of this study were 9th-grade junior high school students, consisting of 29 students, who previously carried out the learning process using Game Based Learning (GBL). The game used in the learning process is a game application called GEMAS (Junior High School Mathematics Educational Game), one of which is designed for material on a system of two-variable linear equations (SPLDV).

Data collection techniques used in this study are test and interview. The test questions consist of 4 questions related to a validated two-variable linear equation system (SPLDV) (Lukman et al., 2023). The data obtained in this study are student answer sheets. Student answer sheets will be used to analyze critical thinking skills. The results of student answers will be analyzed using Ennis' critical thinking stages, namely FRISCO (focus, reason, inference, situasion, clarity, dan overview). “Focus” means identifying and understanding the problem. “Reason” means providing reasons based on facts or evidence relevant to the problem given. “Inference” means choosing the right reasons to support conclusions. “Situation” means using all the information on the problem to solve it. “Clarity” means using a more detailed explanation of the solution being made. “Overview” means carrying out a thorough check (Lukman, Setiani, et al., 2023). The use of the FRISCO criteria in this study is because the criteria presented fulfill all aspects of critical thinking ability (Mahardiningrum & Ratu, 2018).

Furthermore, from 29 students, two students were selected to be interviewed regarding the results of their answers to the critical thinking ability test. The subjects chosen were students with high mathematical abilities and students with low mathematical abilities. The selection of these subjects considered seeing differences in developing critical thinking skills. The interviews in this research were guided by students' answers in

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completing test questions to explore data verbally. This is intended so that the results of the interview can clarify, strengthen and deepen students' answers in solving test questions. A series of activities carried out in analyzing data, namely data reduction, data presentation, and drawing conclusions to describe critical thinking skills after receiving game-based learning.

RESULTS AND DISCUSSION

Before analyzing students' critical thinking skills, learning was carried out using the Game-Based Learning (GBL) model using the GEMAS application (Junior High School Mathematics Education Game). GEMAS consists of two games, one related to One Variable Linear Equations (PLSV) and one related to a System of Two Variable Linear Equations (SPLDV). Each game in the GEMAS game consists of four levels. Level 1 displays several problems to direct students to understand PLSV or SPLDV. Level 2 consists of learning videos to help students understand and reinforce students understanding of PLSV or SPLDV material. Level 3 consists of PLSV or SPLDV problems related to daily life. Level 4 consists of PLSV or SPLDV problems related to other mathematical material.

The GEMAS application can only be accessed via Android-based devices, so the learning process in class requires students to use Android-based smartphones. At the beginning of learning, students are grouped into 3-4 study groups, then given an explanation of the game's rules and how to use the GEMAS application. Before entering SPLDV material, students are directed to recall PLSV material by playing PLSV games on the GAMES application.

Furthermore, students are given time to solve SPLDV problems in the application sequentially. As long as students solve problems in the GEMAS application, the teacher observes and gives instructions if there are students who experience problems. At the end of the allotted time, the teacher gives a signal to stop the game, and students report the results of their game. Finally, the teacher gives conclusions and evaluates students. The results of students' critical thinking based on FRISCO criteria before and after learning with the Game-Based Learning (GBL) model in Figure 1.

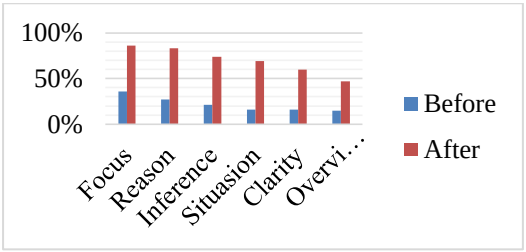

Figure 1. Critical Thinking Before and After using GEMAS

Table 1. Percentage of students' critical thinking ability based on FRISCO criteria before game-based learning

Criteria	Question Number				Ave
	1	2	3	4	rage
Focus	69%	59%	10%	7%	36%
Reason	62%	41%	0%	3%	27%
Inference	55%	28%	0%	0%	21%
Situasion	48%	17%	0%	0%	16%
Clarity	48%	17%	0%	0%	16%
Overview	41%	17%	0%	0%	15%

Table 2. Percentage of students' critical thinking ability based on FRISCO criteria after game-based learning

Criteria	Question Number				Ave
	1	2	3	4	rage
Focus	86%	86%	86%	86%	86%
Reason	79%	83%	86%	83%	83%
Inference	67%	67%	86%	76%	74%
Situasion	66%	55%	83%	72%	69%
Clarity	55%	41%	76%	69%	60%
Overview	48%	38%	72%	31%	47%

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Tables 1 and 2 show that the percentages of the criteria Focus, Reason, Inference, Situation, Clarity, and Overview have continued to decline. That is because the criteria for one another are inseparable, connected (Wasahua, 2021). That means that if the last criterion is met, the criteria are met from the start. Vice versa, if from the beginning the criteria are not met, then until the end, they will not be fulfilled.

As for the overall results, students' critical thinking skills are developed before and after game-based learning. Before game-based learning, the average percentage of each critical thinking criterion was 22%, which then increased to 70%. In addition, game-based learning shows better critical thinking tendencies (Chang et al., 2020; Fitriyadi & Wuryandani, 2021; Gatti et al., 2019; Urazaeva, 2018).

Based on the results of the answers of students with low mathematical abilities (SK) and students with high mathematical abilities (ST), it is known that there are differences in the achievement of criteria for critical thinking skills before and after game-based learning at Table 3.

Table 3. Differences in achievement criteria for critical thinking ability before and after game-based learning (GBL)

Subject	Question Number	Indicator Achievement Before GBL						Indicator Achievement After GBL					
		F	R	I	S	C	O	F	R	I	S	C	O
ST	1	✓	✓	×	×	×	×	✓	✓	✓	✓	✓	✓
	2	✓	✓	×	×	×	×	✓	✓	✓	✓	×	×
	3	×	×	×	×	×	×	✓	✓	✓	✓	✓	×
	4	×	×	×	×	×	×	✓	✓	✓	✓	✓	✓
SK	1	✓	✓	×	×	×	×	✓	✓	✓	✓	✓	×
	2	✓	×	×	×	×	×	✓	×	×	×	×	×
	3	×	×	×	×	×	×	✓	✓	✓	✓	✓	✓
	4	×	×	×	×	×	×	✓	×	×	×	×	×

Based on Table 3, critical thinking skills are developed in the two subjects after game-based learning. However, there are differences in the achievement of critical thinking criteria. In subjects with high mathematical ability (ST), out of 4 questions, two questions fulfill all indicators, one item does not meet the clarity and overview criteria, and one item does not meet the overview. Whereas subjects with low mathematical ability (SK) could only meet the criteria for critical thinking on two questions, one question did not meet the overview criteria, one only met the focus and reason criteria, and one more question only met the focus stage. That can happen because students' mathematics achievement positively correlates with their critical thinking skills (Alcantara & Bacsa, 2017). That is, a person with high mathematical abilities will have high critical thinking skills. Conversely, a person with low mathematical ability will have low critical thinking skills. The discussion of each criterion of critical thinking is as follows.

Focus

The results of the data analysis showed that the average percentage of students who met the focus criteria increased from 36% to 86%. That

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shows that students who meet focus criteria or identify and understand problems increase by around 50%. In addition, subjects with high mathematical abilities (ST) and subjects with low mathematical abilities (SK) could fulfill the focus criteria better than before game-based learning. The following is an example of ST and SK answers before and after game-based learning.

Table 4. ST and SK answers before and after game-based learning

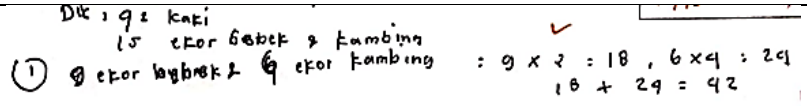
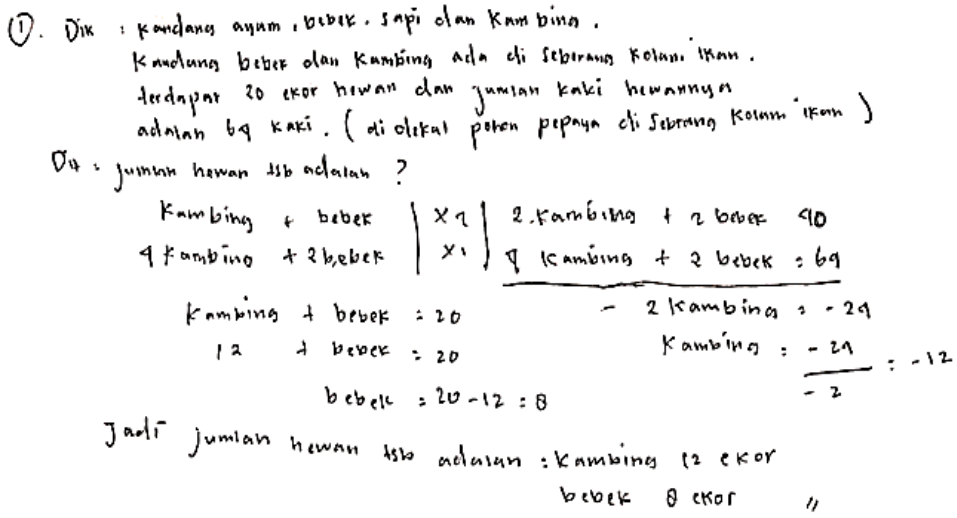
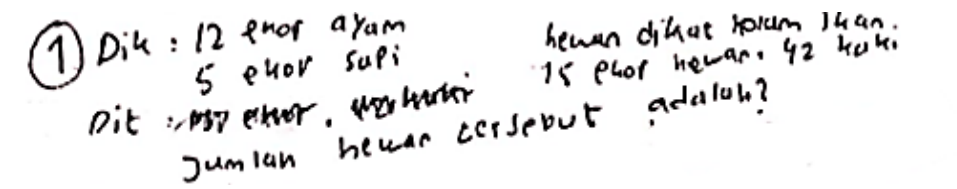
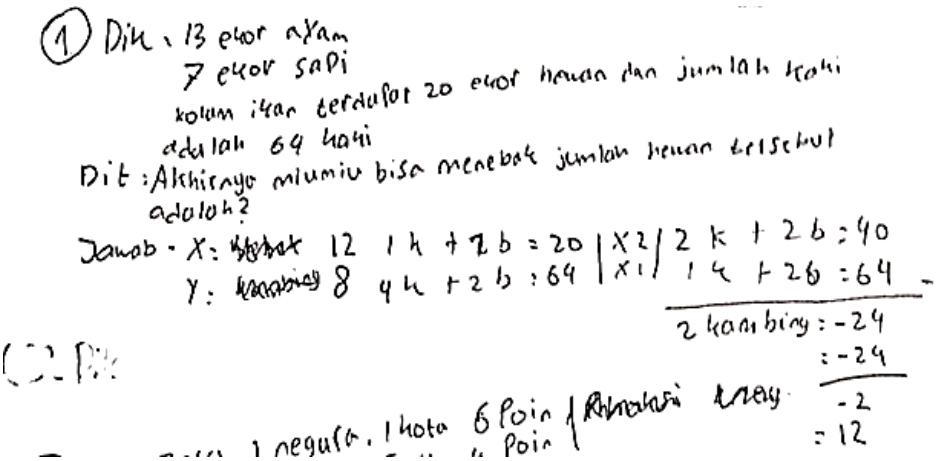
Subject	ST and SK Answers Before and After Game-Based Learning
ST before GBL	
ST after GBL	
SK before GBL	
SK after GBL	

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Table 4 shows that the answers before the game-based learning of the two subjects only wrote down the information contained in the problem without completing it. However, after game-based learning, the two subjects could understand the problem marked by solving the problem. This stage can be appropriately skipped because students are used to solving similar problems. The GEMAS application requires students to identify and understand problems to solve them. In line with the results of previous research that game-based learning can improve the ability to understand problems (Ke, 2019; Risnawati et al., 2018; Urazaeva, 2018).

Reason

Tables 1 and 2 show that the average percentage of students who can meet the reasoning criteria has increased from 27% to 83%. That shows that students who can give reasons based on facts or evidence relevant to a given problem increase by 56%. In addition, based on Table 3, subjects with high mathematical ability (ST) and subjects with low mathematical ability (SK) could fulfill the reasoning criteria better than before game-based learning. Even so, SK could not plan to solve the problem for questions 2 and 4. Based on the results of interviews with subject SK, SK understood the intent of the questions, but SK did not know how to solve them. That happened because ST's mathematical ability was indeed better than SK, so ST could pass this stage better than SK's, in line with the statement that mathematics achievement positively correlates with critical thinking skills (Alcantara & Bacsa, 2017).

Reasoning criteria or giving reasons based on facts means that students must be able to plan for solving the problem based on the information obtained. This stage can be appropriately skipped because the GEMAS application requires students to sort out information to plan for solving the problem. Games that require students to plan for solving the problem can improve planning skills in solving problems (K.-E. Chang et al., 2012).

Inference

In the inference criterion, there was an increase in students who could fulfill it from 21% to 74%. Students who meet the inference criteria can choose the right reasons to support conclusions or can choose the right strategy according to the plans that have been designed. That means that game-based learning can improve students' inference abilities because games with clear goals can improve the ability to develop strategies (Aprilianto & Mariana, 2018).

ST and SK could fulfill these criteria better than before game-based learning in the same inference criteria as the reasoning stage. However, SK could not fulfill the inference criterion for questions 2 and 4 because the reason criterion was not met. For questions 2 and 4, SK only understood the question's meaning but could not solve it. Based on the results of the interviews, SK preferred learning using games but still needed help to solve some of the problems given. That can happen because learning using games can increase motivation and enjoyment of learning, but it does not necessarily improve student learning outcomes (Cliburn, 2006).

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Situasion

In situation criteria, students must be able to use all the information on the problem to solve it. That means that students must be able to determine the adequacy of information, eliminate unnecessary information, and plan answers, then try to solve them. Tables 1 and 2 show an increase from this criterion, which was previously 16% to 69%. As with the inference and reason criteria, ST and SK could go through the situation criteria better than before game-based learning. It is just that, on the situational criteria, SK could not meet the situation criteria for questions 2 and 4.

This stage can be passed better, partly because the problems in the GEMAS application require students to sort out the appropriate information to solve the problem. Wheames are designed so students can sort information in advance, improving students' ability to solve problems (Chang et al., 2012).

Clarity

Clarity criteria increased from 16% of students who fulfilled it to 60%. Students can use a more detailed explanation of the solutions made on this criterion. Students can perform calculations correctly and successfully interpret the results of solving the problems they have made. That is because the GEMAS application fosters students' bias in doing calculations. That aligns with several research results showing that math educational games can improve numeracy skills (Lathifah & Maryanti, 2021; Singh et al., 2021).

As in the criteria of inference, reason, and situation, ST and SK could pass the clarity stage better than before game-based learning. It is just that SK could not meet the clarity criteria for questions number 2 and 4, while ST did not meet the clarity criteria for question number 2. Unlike SK, which could not solve the problems given from the start, ST did not meet this criterion because it did not perform any calculations correctly, so it could not give meaning to the results. After being confirmed, it turned out that ST needed to be more timely in interpreting and accurate calculations. In line with the results of the study, errors in solving math problems can occur due to doubts, inaccuracies, not doing calculations, not being able to understand the information in the problem correctly, being in a hurry to interpret the problem without interpreting it (Ratnaningsih & Hidayat, 2021).

Overview

Like the other criteria, the overview criteria also increased from 15% to 47%. In this criterion, several students, including ST and SK, have been able to do a thorough check. Because when playing, students have to reconfirm their answers, so they cannot earn points if they choose or write down the wrong answer. That is in line with the fact that learning with games allows students to re-examine the solution to the problems posed (Chang et al., 2012).

ST and SK could better meet the overview criteria than before game-based learning. SK could not meet the overview criteria for questions 2 and 4, while ST did not meet the overview criteria for questions 2 and 3. SK did not conduct a thorough check because it did not solve the problem, so it could not check. Meanwhile, ST did not meet the overview criteria because he already felt the answer was correct, so he no longer double-checked. That can happen because when students are

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confident, they usually will not answer questions seriously (Nuhfer, 2015).

Based on the results, it was found that through game-based learning, in this case using the GEMAS game, it was able to motivate students to think critically. It could be seen that both subjects with high and low mathematical abilities were able to think critically to solve problems better after game-based learning.

CONCLUSION AND SUGGESTION

Based on the explanation from the result and discussion, it could be concluded that students' critical thinking skills were better after game-based learning using the GEMAS game. Students with high and low ability levels increase their critical thinking skills after game-based learning. Educational games designed for mathematics learning can facilitate students to develop critical thinking skills. Through game-based learning, students can improve the criteria for critical thinking skills, namely, focus, reason, inference, situation, clarity, and overview.

This research has limitations, only examining students' critical thinking abilities in game-based learning. Therefore, studying other abilities towards game-based learning is advisable by paying attention to the factors that influence it. In addition, the games used in this study can only be based on Android, so it is advisable to develop or use games that a wider variety of devices can use.

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