



Implementation of Logix Games-Based STEAM Learning to Improve Students' Critical Thinking Skills

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Abstract: This study aims to describe the application of STEAM learning based on Logix games to improve students' critical thinking skills in science (Physics) material at SMP Negeri 8 Ambon. This study uses quantitative and qualitative research methods, a quasi-experimental type of research involving an experimental group and a control group. The sampling method is carried out randomly. The sample in this study consisted of 46 students. The design used was a pre-test post-test control group design. The research design was Quasi-Experimental. Data analysis in this study was conducted using quantitative descriptive analysis to describe the data as it is in the form of percentages and explain the data or events with explanatory sentences qualitatively and also used differential statistical analysis. The data analysis techniques used include: independent t-test and N-Gain test for test results and qualitative descriptive response test. The results of the N-Gain test found that in the control class using the conventional model, most students did not experience an increase in critical thinking skills with a percentage increase in the low category of 82.35% and a medium category of 17.65%, while for the experimental class it was found that the experimental class using the STEAM approach based on games logic on critical thinking skills experienced an increase in cognitive critical thinking skills with a percentage in the high category of 13.04%, medium of 78.26%, and low of 8.7%, this is supported by the value of the independent t-test with a 2-tailed sign value of less than 0.05 at the assumed equal variances value, there is a significant difference between the control and experimental classes where the treatment of the experimental class affects the student's grades, causing the grades to be higher than the value of the control class that was not given any treatment, so in general it can be concluded that the application of the STEAM approach based on games logic in science learning provides significant opportunities for students to develop critical thinking skills.

Keywords: STEAM Approach; Games Logix; Critical Thinking Skills.

Introduction

Society 5.0 is a future technological era that requires every individual to continually update and improve their skills. Technology plays a crucial role in providing solutions to social problems, improving the quality of life, and positively impacting society (Farid, 2023). This presents both a challenge and an opportunity to play an active role in determining the direction of future development. We are not only expected to be technology users but also to participate in creating solutions to

various social problems through technology (Parwati et al., 2021). Current technological advances clearly have great potential to broaden horizons and education, which in turn can influence behavior, character, and ways of thinking.

According to Chapter 1, paragraph 1 of the National Education System Law, education is an effort to create a learning process and environment that optimizes students' potential. The goal is for students to actively develop their potential, including spiritual or religious abilities, personality, self-control, intelligence,

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and noble character, as well as the skills necessary for life as individuals and members of society, the nation, and the state. The learning paradigm must change to accommodate modern needs (Fitriyah et al., 2021). However, the learning process needs to evolve and undergo a paradigm shift to align with current needs, known as 21st-century learning.

21st-century learning emphasizes students' 4C skills, including communication, collaboration, critical thinking, and creativity (Tang et al., 2020). Therefore, critical thinking is crucial for students' development. According to Yanwar and Fadila (2019), critical thinking emphasizes problem-solving and evaluation skills, as well as the validity of the solutions. According to Anggraini et al. (2022), critical thinking indicators include understanding information about a problem, identifying it, developing strategies, and drawing conclusions. Maximizing critical thinking skills is crucial at all levels of education and in all subjects. One approach to enhancing critical thinking skills is science (physics). This aligns with the goal of science (physics) learning, which is to enhance students' ability to reason logically, critically, creatively, and appropriately to help them solve problems (Santosa et al., 2020). As a result, the capacity for critical and mathematical thinking is mutually reinforcing (Mariani et al., 2021).

In Indonesia, students' critical thinking skills are still lacking (Wahyuni et al., 2023). Field conditions demonstrate how students' critical thinking skills only reach the level of knowing (Rokhimah & Rejeki, 2018). The results of the TIMSS survey, which is a study using cognitive tasks to assess students' critical thinking skills, revealed that Indonesian students often scored as low as 44 out of 49 countries in 2015 (Hadi & Novaliyosi, 2019). The Ministry of Education, Culture, Research, and Technology (2023) stated that the results of the 2022 PISA science test showed Indonesia's average score was 383, below the global average of 384. However, Indonesia's ranking rose 6 positions compared to 2018, from 71st to 65th. This improvement was largely due to educational programs implemented during the COVID-19 pandemic.

One factor contributing to low critical thinking skills is the dominance of teacher-centered learning models/approaches. In this model/approach, the teacher is the center of information, while students are more passive recipients of information. This type of learning tends to limit students' freedom to think critically and independently (Rusman, 2022). However, in the context of the Independent Curriculum implemented in Indonesia, there is a greater emphasis on active, participatory learning that can develop higher-order thinking skills (Ministry of Education, Culture, and Research, 2022). This curriculum aims to

strengthen the profile of Pancasila students, one of which is critical reasoning skills.

As a solution to this problem, the STEAM approach can be implemented. The STEAM (Science, Technology, Engineering, Art, and Mathematics) approach offers an integration of various disciplines that not only prioritizes logical thinking skills but also students' creativity in solving problems innovatively (Land, 2013). Previous research has shown that the STEAM approach is effective in improving students' critical thinking skills because it integrates various aspects of science that can enrich their thinking and problem-solving (Julianto E. & Kurniawan, 2021; Lee Hyonyong, 2019). Thus, students become not only consumers of knowledge but also creators and critical reasoners of their learning experiences. However, to make STEAM learning more effective and enjoyable, interactive and engaging learning media are needed for students, one of which is logic games (Muktyas et al., 2022)

Logic games are a type of game that requires players to use analytical, reasoning, strategic, and problem-solving skills. Examples of logic games include puzzles, sudoku, riddles, and digital-based simulations. These games can encourage collaboration and healthy competition among students, which can increase their motivation and engagement in the learning process (Lestari & Priyanto, 2023). Furthermore, games can provide a unique appeal thanks to the diverse and engaging content they present (Januar, 2023). By integrating logic games into the STEAM approach, it is hoped that students will experience a more enjoyable, challenging, and cognitively meaningful learning experience. In the context of critical thinking, activities in logic games train students to evaluate information, select alternative solutions, and make logic-based decisions.

However, observations at SMPN 8 Ambon revealed obstacles in developing students' critical thinking skills. Approximately 70% of seventh-grade students struggled with questions that tested higher-order thinking skills (HOTS), particularly in categories C4 (analyzing), C5 (assessing), and C6 (creating). Most students found it easier to solve questions that only tested memory or comprehension (C1-C3), while they struggled with questions that required analysis or synthesis of information. In class discussions, many students appeared passive and less able to express opinions or explain their thinking processes in solving problems. This indicates that students' critical thinking skills are still very low, and this poses a challenge in science learning in junior high schools. Furthermore, learning remains largely conventional and has not yet fully adopted the STEAM approach or digital media optimally. Therefore, learning innovations that combine

the STEAM approach and logic games media are relevant and urgent to implement.

This study aims to describe the application of STEAM learning based on Logix games to improve students' critical thinking skills at SMP Negeri 8 Ambon. The results of this study are expected to provide theoretical and practical contributions in the development of innovative STEAM-based learning models that encourage students to think critically, as well as serve as a reference for the development of 21st-century education policies at the secondary school level.

Method

This study used quantitative and qualitative research methods, a quasi-experimental type of research involving an experimental group and a control group. Experimental research uses a manipulation of at least one variable, controls other relevant variables, and observes the effect or influence on one or more dependent variables (Rukajat, 2018). This study compared the group given the Logix game treatment on critical thinking skills with the group given conventional treatment. The design used was a pre-test post-test control group design. The research design is presented in tabular form and can be seen in Table 1.

Table 1. Quasi-Experimental Design

Group	Pretest	Treatment	Posttest
Experiment	Q1	X	Q2
Control	Q3	-	Q4

Participants

The sample in this study consisted of 46 students at SMP Negeri 8 Ambon, with 23 students in the control class and 23 students in the experimental class. The sampling was random.

Research Instruments

The instruments in this study include; (1) tests, to assess knowledge of critical thinking skills, (2) Student response questionnaire sheets, to see student responses regarding STEAM-based learning and critical thinking skills.

Data analysis

Data analysis in this study was conducted using quantitative descriptive analysis to describe the data as it is in the form of percentages and explain the data or events with qualitative explanatory sentences and inferential statistical analysis (normal data using Shapiro Wilk greater than 0.05 and homogeneous). Data analysis techniques used include: independent t-test and N-Gain test for test results and response tests in a qualitative descriptive manner.



Figure 1. Research Flow

Results and Discussion

This study used two classes: the first as a control class and the second as an experimental class. The control class used a conventional model, while the experimental class used Games Logix-based STEAM for critical thinking skills. The results of the improvement (N-gain) obtained from this study are presented in Figures 2 and 3.

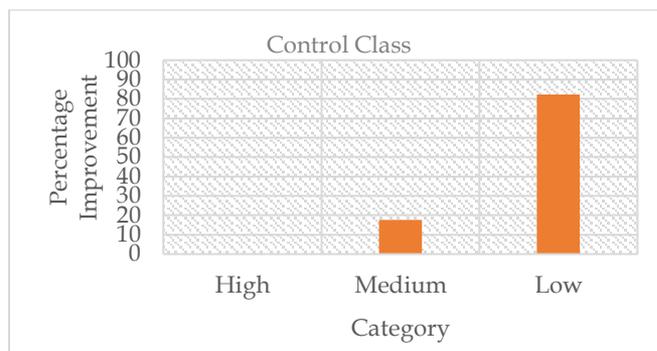


Figure 2. Improvement in Learning Outcomes of the Control Class

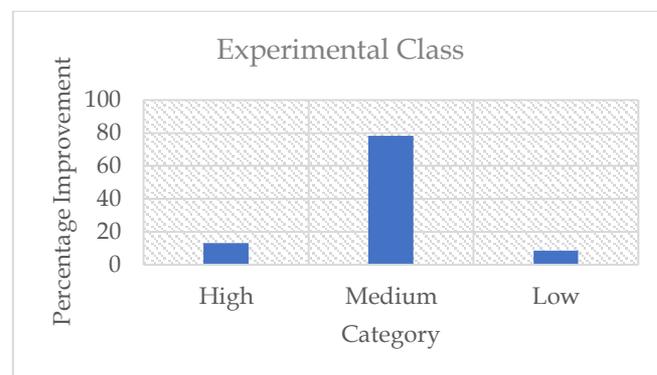


Figure 3. Improvement in Learning Outcomes of the Experimental Class

Based on Figure 2, it was found that in the control class using the conventional model, most students did not experience an increase in learning outcomes with the percentage of increased learning outcomes in the low category of 82.35% and the medium category of 17.65%, this is because conventional learning emphasizes active teachers in delivering lesson materials and little student participation in the learning process so that students become passive which has an impact on students becoming less independent and less participation in thinking so that the lack of knowledge gained during the learning process. The problem of students' lack of activity in the learning process has an impact on students' low ability to think that requires high-level reasoning. High-level thinking skills are identical to critical, creative and innovative thinking abilities. This hinders the development of education and hinders students' ability to develop higher-order thinking skills (Anware et al., 2023). As a result, students are accustomed to simply receiving information and lack the space to argue, analyze, evaluate, and solve problems. Another major cause is the lack of variety and innovation in the selection of learning media. Students in the science (physics) learning process are expected to be active, frequently doing practice questions, discussing, and asking questions, and teachers also play an active role as facilitators in group work, class discussions, and experimental activities (Hastuti et al., 2023).

Based on Figure 3, it was found that the experimental class that used the STEAM approach based on Logix games for critical thinking skills experienced an increase in learning outcomes with a percentage in the high category of 13.04%, medium of 78.26%, and low of 8.7%. So it can be said that most students experienced an increase in learning outcomes. This is because students were very enthusiastic about Logix games at the beginning of learning to train student focus and the STEAM approach requires students to be active in class

and able to think at a higher level, one of which is critical thinking. The integration of STEAM in learning is believed to be able to develop students' higher-order thinking skills (HOTS), including critical thinking. In practice, the STEAM approach encourages students to observe phenomena, ask questions, design solutions, and reflect on the results and learning process. (After Emilidha & Waluya, 2024). Based on the opinion expressed by (Kurniawati et al., 2022), STEAM is one strategy in stimulating sensitivity to what is happening around them. Thus, it further enhances students' exploration power in learning new things. Thus, students become not only consumers of knowledge, but also creators and critical reasoners of their learning experiences. However, to make STEAM learning more effective and enjoyable, interactive and engaging learning media are needed for students, one of which is the Logix game. (Muktyas et al., 2022).

Game-based learning has great potential to increase student interest and motivation. By presenting learning materials in a fun and challenging format, students are more likely to be actively engaged in the learning process. Complex science concepts can be presented through games that stimulate curiosity and exploration, helping students understand the content more deeply (Fatihah, 2023). In line with this, some argue that well-designed games can connect theory and practice and provide a realistic context for students to apply their knowledge. This is particularly important in science education, where students often struggle to grasp abstract concepts (Pakpahan, 2022). The results obtained when integrating Logix games into the STEAM approach provide students with a more enjoyable, challenging, and cognitively meaningful learning experience. In the context of critical thinking, activities in Logix games also train students to evaluate information, select alternative solutions, and make logic-based decisions. The results of the Logix games are presented in Figure 4.

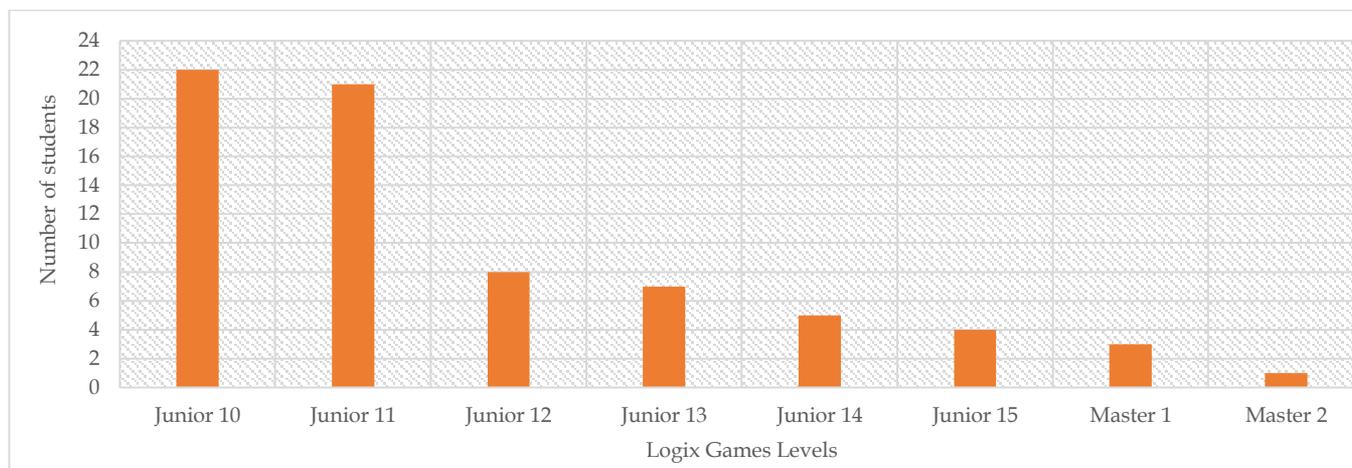


Figure 4. Results of the Experimental Class Logix Games

Based on Figure 4 above, it is found that the higher the level of logic games, the fewer students are able to play them because these games require critical thinking and it was found that only 3 students were able to answer the master 1 level and only 1 student was able to answer the master 2 level. Logic games are a type of game that requires players to use analytical, reasoning, strategy, and problem-solving skills. Examples of logic games include puzzles, sudoku, puzzle games, and digital-based simulations. Students who learn using game-based learning tend to be more motivated and enthusiastic about learning compared to those who learn using conventional methods. This is because game-based learning provides challenges that stimulate students' curiosity and creativity (Kaldarova et al., 2023). In addition, students can learn through direct experiences simulated in games, which in turn can

improve their understanding of the material being taught (Juhari & Abu Bakar, 2020). Thus, game-based science learning not only enriches the learning process but also opens up new opportunities to improve the quality of education by integrating innovative technology and engaging approaches for students in this digital era (Hayati, 2021). This result is in line with the results of the independent t-test on the post-test of the control class and the experimental class. The 2-tailed sig value (0.000) was found to be less than 0.05 at the assumed equal variances value, so there was a significant difference between the control and experimental classes where the treatment of the experimental class affected the students' grades, causing their grades to be higher than the grades of the control class which did not receive any treatment.

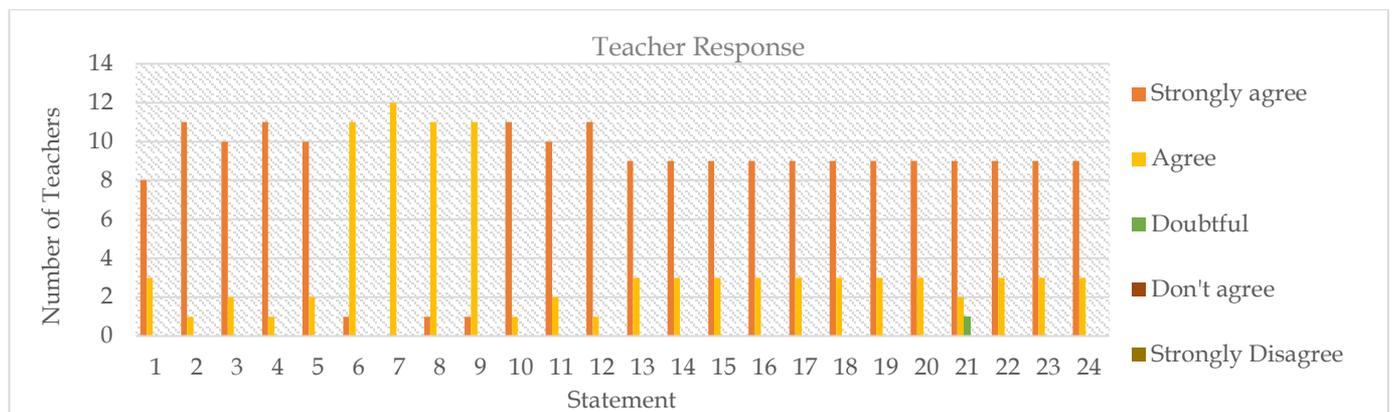


Figure 5. Teacher Questionnaire Regarding STEAM-based Logix Games and Critical Thinking Skills.

Based on Figure 5, it can be seen that most of the teachers at SMP Negeri 8 Ambon answered strongly agree and agree with all statements related to STEAM based on Games Logix and critical thinking skills,

which means that the teachers already know about STEAM and Games Logix based learning and critical thinking skills, but they have not yet implemented them.

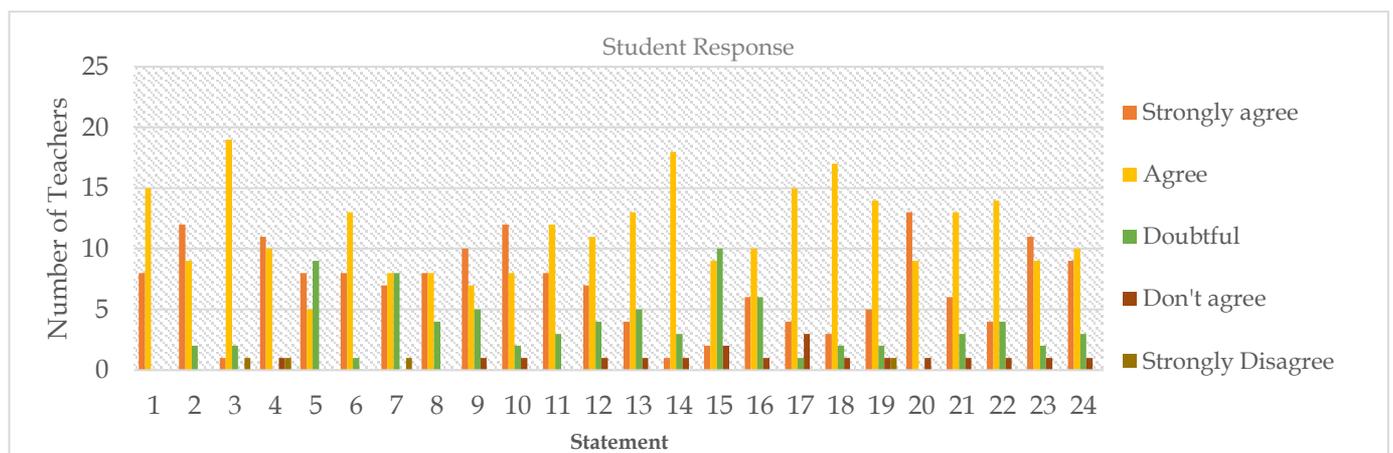


Figure 6. Student Responses Regarding STEAM-based Logix Games and Critical Thinking Skills.

Based on Figure 6, it was found that most students answered agree and strongly agree with most of the

statements so that it can be said that students are able to enrich their knowledge and are able to think critically

with the implementation of STEAM-based learning with the help of logic games and critical thinking skills. According to (Elisa et al., 2023) science subjects (biology, physics, and chemistry) are materials that not only teach students science concepts but also help them acquire realistic skills and values. This science learning ability is called "The heart of science learning activities or activities". This ability also involves several abstract thinking skills and is related to mental processes, such as the ability to think more broadly and generate new ideas, its relationship with the STEAM approach where in its application it can provide opportunities for students to generate science and technology-based ideas through the process of thinking and exploration in solving problems, this shows that the application of the STEAM approach based on logic games in science learning (IPA) can improve students' critical thinking skills.

Conclusion

The application of the STEAM approach based on Logix games in science learning provides significant opportunities for students to develop critical thinking skills. Judging from the N-Gain results of the experimental and control classes of science learning using the STEAM approach based on Logix games, the experimental class had a higher percentage than the control class. This indicates that the application of the STEAM approach based on Logix games in science learning has been proven to significantly improve students' critical thinking skills.

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Author Contributions

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Conflicts of Interest

The author declares no conflict of interest.

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