EDUCARE Journal of Primary Education
ISSN 2716-1021 (p) 2716-1013 (e)
OPEN ACCESS
https://educare.uinkhas.ac.id/index.php/jie

The Effect of Problem Based-Learning Based on Science Edutainment on Students' Logical Thinking

Reza Ariefka[1], Sasmita Sari [2]
[1,2]STKIP Muhammadiyah OKU Timur, Sumatera Selatan, Indonesia

rezaariefka@gmail.com

Article Information:
Received 2023-03-15
Revised 2024-04-23
Published 2023-06-27

Keywords: Logical Thinking; Problem Based Learning; Scince Edutainment.

ABSTRACT
The problem-based learning model based on science edutainment, presents a problem in each concept of game-based material. The main characteristic of the learning model used in this study is using games to help students understand problem-based material in an entertaining way. This study aimed to examine the effect of the problem based-learning based on science edutainment in scientific content on students' logical thinking. The type of research used in this research is quantitative research. This study had conducted in class IV of 45 students at SD Negeri Buay Pemaca. Data collection techniques included interviews, observation, documentation, and tests. Based on statistical tests, the independent sample t-test showed a significant value of 0.000 > 0.05, meaning that the science edutainment problem based-learning model had influenced students' logical thinking. The conclusion of this study is that the problem-based learning model based on science edutainment in science lessons has an effect on the logical thinking abilities of fourth grade elementary school students.

INTRODUCTION

Elementary school education has a major role as the foundation or basis of scientific knowledge and understanding (Kier & Lee, 2017). In the 21st century, the quality of the nation's life is determined by knowledge and skills (Sulaiman & Ismail, 2020). Learning using the Problem Based Learning model can provide direct experience to students, because the Problem Based Learning model facilitates students to experiment, collaborate, and solve problems (Yew & Goh, 2016; Chang et al., 2017; Afiyati et al., 2020). The Problem Based Learning model does not occur without the teacher developing a classroom environment that allows for an open exchange of ideas (Ramadhani et al., 2019). The learning process is often boring, learning will be more meaningful when the process is enjoyable while acquiring knowledge at the same time (Winarti et al., 2021). Science edutaiment can be used for fun learning so as to create a better mood for both students and teachers (Chasanah & Dewi, 2015). This science edutainment-based Problem Based Learning model combines the concepts of education and entertainment in harmony to create fun learning. It is intended that the material taught is easily understood by students.

Science edutainment is an innovative approach in learning that combines education and entertainment, specifically designed to make science learning more engaging for students. According to Taufiq et al. (2014), this method encourages students to participate in learning activities through educational games, creating a more enjoyable learning experience. The concept of science edutainment does not only focus on entertainment but ensures that the learning objectives are still met, as emphasized by Feiyue (2022). In fact, it introduces a way of learning that is fun and engaging while staying aligned with educational goals. The idea of making education enjoyable is becoming increasingly relevant, especially for students who often feel pressured in traditional learning environments. Yanuardianto (2020) supports this by highlighting how fun education has become a popular theme in discussions about student engagement and motivation. Ardianti et al. (2017) add that with activities that incorporate entertainment, students are expected to apply their learning more

How to cite	Ariefka, R., & Sari, S. (2023). The Effect of Problem Based-Learning Based on Science Edutainment on Students' Logical Thinking. *EDUCARE: Journal of Primary Education*, 4(1), 55–66. https://doi.org/10.35719/educare.v4i1.199

effectively in a stress-free atmosphere. This method not only enhances understanding but also motivates students to learn by making the process more enjoyable and interactive.

Logical thinking is a crucial aspect of the learning process, as it enables students to solve daily problems in a structured and correct manner. Beyond just making learning enjoyable, fostering logical thinking helps students analyze situations and develop reasoned conclusions. Octaria (2017) defines logical thinking as the ability to draw accurate conclusions based on established logical principles. This cognitive skill plays a significant role in students' intellectual development, especially in applying their learning to real-world situations. At the elementary school level, logical thinking can be seen in activities where students are required to make conclusions and verify their correctness. For example, Sumartini (2015) notes that students draw from their prior knowledge and experiences to prove whether their conclusions align with what they have learned previously. This reflective process strengthens their reasoning abilities and reinforces the connection between knowledge and practice. Moreover, logical thinking does not develop in isolation—it is nurtured through experience. Goldie (2016) emphasizes that students' logical reasoning builds upon the knowledge they have gained from their own experiences. Therefore, the teacher's role becomes vital in this process. Teachers must actively motivate students, guide them in applying their knowledge, and provide opportunities for them to practice their logical reasoning skills. Candrawati and Hidayati (2017) further argue that students who are able to enhance their logical thinking skills are more likely to succeed academically, as these skills enable them to approach learning in a more structured, analytical manner. Thus, developing logical thinking not only benefits students in their academic pursuits but also in their overall problem-solving abilities.

Students' logical thinking skills need to be trained so that students are accustomed to using these abilities. The ability to think logically is also influenced by the conditions/atmosphere of group discussion activities that have been cultivated so far. Fios said that the ability to think logically requires problem-investigation activities, by the opinion above. Problem-Based Learning is learning with problem-based activities, this stimulates students' logical thinking skills. Based on the interview results of the midterm test, students are still under the KKM. SD Negeri Buay Pemaca, the percentage level that reached the KKM was only 49% of the 23 students. This fact proves that students' thinking skills are still lacking. Providing material information and the learning process is influenced by the teacher. Teachers can prevent learning boredom by using fun learning or developing varied learning models so that learning is not boring. Based on this fact, it is necessary to propose alternative solutions using fun learning models that can improve logical thinking skills. Therefore, innovation can be applied using a problem-based learning model based on science edutainment. Problem based learning can trigger problem solving skills in everyday life and will encourage the emergence of logical thinking skills in students. Meanwhile, science edutainment makes science learning activities fun. This is in accordance with the characteristics of the SD Negeri Buay Pemaca area which characterizes the area with natural conditions that are in accordance with the water cycle material for learning science.

The implementation of a Problem-Based Learning model based on science edutainment will significantly improve students' logical thinking skills and problem-solving abilities at SD Negeri Buay Pemaca compared to conventional learning models. This hypothesis is formulated based on the idea that Problem-Based Learning (PBL) encourages students to engage in problem-solving activities that stimulate their logical thinking. By integrating science edutainment, which introduces fun and engaging learning activities, the learning process becomes more enjoyable and relevant to real-world applications. Thus, it is expected that students will not only find the learning process more enjoyable but also enhance their cognitive abilities, particularly in logical reasoning and problem-solving. Consequently, the use of this innovative model will likely lead to improved academic outcomes and overall student engagement in the learning process, particularly in natural science topics like the water cycle that align with the local environmental context of SD Negeri Buay Pemaca.

RESEARCH METHODS

The research method employed in this study was quantitative, specifically using a quasi-experimental design. According to Creswell (2014), quasi-experimental research is suitable when random assignment is not feasible, allowing researchers to study the impact of an intervention in real-world educational settings. The design used in this study was the Nonequivalent Control Group Design, where participants were not randomly assigned to groups, thus ensuring the research aligns with the natural class arrangement (Gay et al., 2011). This study involved two class groups: the experimental group and the control group. The experimental group was treated using the Problem-Based Learning (PBL) model based on science edutainment, while the control group used the traditional PBL model without the science edutainment element. As stated by Yew and Goh (2016), PBL enhances problem-solving skills, while integrating science edutainment introduces a fun learning environment that can further enhance student engagement and outcomes (Chang et al., 2017).

The data analysis technique used in this study involved several statistical tests conducted with SPSS 16 software to ensure accurate and valid results. First, the normality test was performed using the Kolmogorov-Smirnov test to check whether the data followed a normal distribution. If the data were normally distributed, this would validate the use of parametric tests, as suggested by Field (2013). Next, the Levene's Test for Equality of Variances was conducted to determine whether the variances between the experimental and control groups were equal, a key assumption for the subsequent independent samples t-test (Levine, 2006). Finally, the independent samples t-test was used to test the hypothesis by comparing the mean scores of the two groups. This test assessed whether there was a statistically significant difference in the learning outcomes between students taught with the science edutainment-based PBL model and those taught using the conventional PBL model (Fraenkel & Wallen, 2012). A p-value of less than 0.05 would indicate a significant difference, supporting the hypothesis that the innovative PBL model is more effective in improving students' logical thinking and problem-solving skills.

RESULTS AND DISCUSSION

a. Normality Test

This normality test had performed to verify that the experimental class and control class had a normal data distribution. The normality testing used the Kolmogorov-Smirnov test using SPSS 16.0 for windows. The results of the normality analysis test of students' logical thinking had presented in the table below.

Table 1. Results of the Logical Thinking Normality Test

	Class	N	Kolmogorov- Smirnof Test	Asymp Sig.	Level of Significance	Annotation (Sig>0,05)
Initial	Experimental	23	0.123	0.200	0.05	Normal
	Control	25	0.133	0.200	0.05	Normal
Final	Experimental	23	0.148	0.200	0.05	Normal
	Control	25	0.149	0.200	0.05	Normal

Based on the results presented in Table 1, it was found that the Asymp. Sig. value in the initial experimental class was 0.200, while the Asymp. Sig. value in the control class was also 0.200. These results indicate that the Asymp. Sig. value in both classes was greater than 0.05, which means that the data on the students' initial critical thinking ability followed a normal distribution. Similarly, the Asymp. Sig. value in the final experimental class was 0.200, and the Asymp. Sig. value in the final control class was also 0.200. Since the Asymp. Sig. values in both classes were greater than 0.05, it can be concluded that the data on students' final logical thinking abilities also followed a normal distribution. Therefore, the data in both the experimental and control groups, for both the initial and final measurements, showed a normal distribution.

b. Homogeneity Test

The homogeneity test had performed to verify whether the data obtained from the pre-test and post-test results in the experimental and control classes had the same variants or homogeneous data. The homogeneity test in this study used the Levene Statistical test using SPSS 16.0 for windows. The results of the analysis of the homogeneity test students' logical thinking ability had presented in the table below.

Table 2. Results of Logical Thinking Homogeneity Test

	Class	Lavene Statistic	df1	df2	Sig.	Level of Significance	Annotation (Sig>0.05)
Initial	Experimental and Control	0.426	1	45	0.524	0.05	Homogenous
Final	Experimental and Control	0.273	1	45	0.643	0.05	Homogenous

Based on the results presented in Table 2, it was found that the Sig. value in the initial experimental and control classes was 0.524. This result indicates that the significance value was greater than 0.05, which means that the data variance for the students' initial critical thinking ability in both classes was the same or homogeneous. Furthermore, the Sig. value in the final experimental and control classes was 0.643. This result also shows that the significance value was greater than 0.05, indicating that the data variance for the students' final logical thinking ability in both classes was the same or homologous. Therefore, it can be concluded that both the initial and final data in the experimental and control classes showed equal or homogeneous variance.

c. The Results of the Effect Problem-Based Learning Model Based on Science Edutainment in Improving Logical Thinking Ability

The aim of testing the logical thinking ability hypothesis was to determine whether there was an influence of the Problem-Based Learning Model supported by Science Edutainment in improving students' logical thinking ability. After conducting the prerequisite tests, including the normality and homogeneity tests, the hypothesis was tested using the Independent Sample T-test with SPSS 16.0 for Windows. The results of the logical thinking hypothesis test for both the experimental and control classes are presented in the table below. Further explanation: by using the Independent Sample T-test, the researcher aimed to assess whether there was a significant difference in logical thinking ability between the two groups (the experimental and control classes) after applying the Problem-Based Learning model integrated with a science edutainment approach. If a significant difference is found, it would indicate that the implementation of this learning model positively influenced the improvement of students' logical thinking ability in the experimental class compared to the control class. The results of this analysis serve as the basis for concluding whether the method is effective in enhancing students' logical thinking abilities.

Table 3. Results of Independent Sample T-test Logical Thinking

		Levene`s Test for Equalitty of Variances		**t-test for Equality of Means**						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error	95% Confidence Interval of the Difference	
									Lower	Upper
Logical Thinking	Equal variances assumed	.422	.516	4.431	46	.000	19.110	4.324	10.406	27.813
	Equal variances not assumed			4.510	42.359	.000	19.110	4.256	10.524	27.696

It was found that the significance value of the final students' logical thinking ability was 0.000. These results indicate that the significance value was less than 0.05, meaning that Ho (null hypothesis) is rejected, and Ha (alternative hypothesis) is accepted. This means that the Problem-Based Learning model supported by Science Edutainment has a significant influence on students' logical thinking ability. Further explanation: A significance value (p-value) lower than 0.05

suggests a statistically significant difference between the experimental and control groups. Rejecting the null hypothesis implies that the change in students' logical thinking abilities is not due to random chance but is instead a result of the instructional approach applied in the experimental group. Therefore, the findings confirm that integrating the Problem-Based Learning model with Science Edutainment effectively enhances students' logical thinking skills. This method encourages students to engage in deeper reasoning, critical analysis, and problem-solving, which are essential components of logical thinking.

The results showed a clear improvement in students' logical thinking abilities. Specifically, the difference in test results before and after the application of the Problem-Based Learning model integrated with Science Edutainment demonstrated a notable increase. The pretest scores, which assess students' initial logical thinking ability, revealed an average score of 40.93, whereas the posttest scores, after implementing the learning model, showed a significant increase with an average score of 75.10. This increase was further analyzed using the N-Gain formula, which calculates the level of improvement between the pretest and posttest scores. The N-Gain value obtained was 0.67, indicating that the improvement falls within the moderate category. Further explanation: This moderate increase suggests that the Science Edutainment-based Problem-Based Learning model effectively enhanced students' logical thinking abilities. While the improvement was not categorized as high, the result still signifies meaningful progress, as the students moved from a lower baseline to a significantly improved understanding of logical thinking. This outcome highlights the effectiveness of engaging students with problem-solving strategies and interactive learning tools, such as those provided by Science Edutainment, to foster cognitive development and critical thinking skills in a practical learning environment.

Discussion of Findings

The findings of the study show a notable increase in students' logical thinking abilities, which can be evaluated through several key aspects. These include the students' ability to grasp the essential concepts of a subject, make informed decisions, and apply reasoning to draw conclusions. Throughout the learning process, particularly during discussion activities, students were engaged in identifying and analyzing problems. This approach requires students to use logical thinking in evaluating and reasoning through the problem-solving process (Hmelo-Silver, 2004; Tofade et al., 2013; Wale & Bishaw, 2020). The success of the Problem-Based Learning (PBL) model, supported by Science Edutainment, is evident in how it encourages students to think more critically and logically. The activities designed under this model prompted students to identify core issues, analyze information systematically, and reason through potential solutions. This process not only improves their problem-solving skills but also fosters a deeper understanding of the subject matter by requiring active engagement and logical thought.

The paragraph underscores the crucial role that activities such as decision-making, drawing conclusions, and problem-solving play in developing students' logical thinking skills (Octaria, 2017). These activities are essential not only in academic contexts, such as solving mathematics problems, but also in addressing real-life challenges. Engaging students in such tasks encourages them to think critically and apply reasoning to come up with practical solutions. At the primary school level, logical thinking involves specific features like the ability to draw conclusions and validate those conclusions based on prior experiences, as pointed out by Widyastuti & Pujiastuti (2014). This ability to reflect on past knowledge and experiences is key to building sound reasoning skills. Additionally, Rohman et al. (2018) identify three core indicators of logical thinking: (1) understanding concepts, (2) making informed decisions, and (3) applying reasoning. These components are interconnected and essential for effective problem-solving. Understanding concepts enables students to comprehend the issues they are tackling, making decisions involves choosing the best course of action based on available data, and reasoning helps them justify their conclusions and decisions logically. Together, these indicators form the foundation for developing strong critical thinking and analytical skills. By nurturing these abilities early on, students are better equipped to handle more complex problems in higher levels of education and in real-world scenarios (Yue et al., 2017; Thornhill-Miller et al., 2023).

Thus, fostering logical thinking through practical activities helps students build a skill set that is essential for lifelong learning and adaptability.

a. Students' logical thinking ability on concept indicator

The increase in students' logical thinking ability on the concept indicator, from 53% in the pretest to 85% in the posttest, with an index increase of 32%, clearly demonstrates the effectiveness of the Problem-Based Learning (PBL) model supported by Science Edutainment. This improvement reflects that students are not only able to provide relevant concepts but also articulate ideas more effectively when solving problems. The ability to present concepts simply and logically is enhanced through this innovative learning model, which encourages students to actively engage in the learning process (Flores et al., 2012).

By using Problem-Based Learning, students are encouraged to approach problems by generating creative and original concepts. This method nurtures their logical thinking skills by placing them in scenarios where they must analyze situations, identify the core issues, and propose viable solutions. The incorporation of Science Edutainment makes this process more engaging and accessible, allowing students to understand complex concepts in a more interactive and enjoyable manner. Moreover, this learning model fosters collaboration and discussion among students, further reinforcing their ability to communicate and refine their ideas logically and effectively. Ultimately, the PBL model not only enhances their logical thinking but also equips students with the skills to approach problem-solving creatively and systematically, a crucial skill set for academic and real-world success (Morreira et al., 2020; Taylor et al., 2021).

b. Students' logical thinking ability on the decision indicator

The significant increase in students' logical thinking ability on the decision-making indicator, from a pretest score of 46% to a posttest score of 80%, with an index increase of 34%, highlights the effectiveness of providing students with opportunities to develop their decision-making skills. This improvement demonstrates that students are now better equipped to identify and determine the appropriate steps for solving problems. Through the implementation of the Problem-Based Learning (PBL) model, students are actively involved in the problem-solving process. They are encouraged to explore various aspects of the problem and engage in observation to gather relevant information. This exploratory process allows students to evaluate different approaches, critically analyze the available data, and make informed decisions about how to tackle the problem. The collaborative nature of working in groups further enhances this ability, as students can exchange ideas, assess potential solutions, and ultimately choose the best course of action based on logical reasoning and collective input (Graesser et al., 2018; Amelkin et al., 2018). By fostering a learning environment where students are responsible for determining problem-solving steps, the PBL model helps them develop autonomy in their decision-making processes. This skill is essential not only for academic success but also for real-world applications, where individuals must make strategic decisions based on analysis and evidence. Overall, this increase in decision-making ability reflects a deeper understanding of the problem-solving process, encouraging students to think critically and logically in order to achieve effective solutions (Adler & Heckscher, 2018; Zawacki-Richter et al., 2019).

c. Students' logical thinking skills on the reasoning indicator

The significant improvement in students' logical thinking skills on the reasoning indicator, with a pretest score of 37% and a posttest score of 73%, resulting in a 36% increase, demonstrates a notable enhancement in their ability to draw logical conclusions. This growth highlights the effectiveness of the Problem-Based Learning (PBL) model supported by Science Edutainment in fostering reasoning skills. By utilizing this learning model, students are given opportunities to actively engage in the problem-solving process, which involves not only identifying solutions but also reasoning through the steps required to reach those solutions. The PBL model emphasizes hands-on experiences, where students are tasked with analyzing information, connecting various concepts, and ultimately drawing well-reasoned conclusions. This approach encourages them to think critically about the information at hand and systematically apply logical reasoning to come

to a decision. Furthermore, the integration of Science Edutainment makes the learning process more enjoyable and engaging, which in turn enhances students' focus and participation. The fun and interactive elements of this approach help reduce the cognitive load, allowing students to process information more effectively and develop stronger reasoning skills. As students are required to conclude their activities during discussions, the continuous practice of reasoning and concluding during classroom tasks reinforces their ability to articulate well-thought-out solutions. Overall, this improvement in reasoning ability reflects the power of combining Problem-Based Learning with Science Edutainment to create a dynamic, enjoyable, and intellectually stimulating learning environment. The model not only supports students in drawing conclusions but also strengthens their overall critical thinking and logical reasoning abilities, preparing them for more complex problem-solving scenarios in the future.

Based on the results of this study, the Science Edutainment-based Problem-Based Learning (PBL) model has demonstrated a substantial impact on enhancing students' logical thinking abilities. This is evidenced by the notable increase in the average N-Gain between the experimental class, which utilized the PBL model, and the control class. The N-Gain score of 0.67, categorized as moderate, indicates that the Science Edutainment-supported PBL approach in science learning effectively strengthens students' logical thinking skills. This finding underscores the critical role of logical thinking in the learning process. As thinking skills are directly linked to the learner's ability to absorb and process information, improve learning speed, and enhance overall learning effectiveness, developing these skills becomes paramount in educational settings. Logical thinking, in particular, enables students to analyze problems, evaluate solutions, and make informed decisions, which are essential competencies in both academic and real-world contexts. Learners who are trained to think critically and logically show a positive trajectory in their educational development (Liu et al., 2015; Almulla, 2020; Dwyer, 2023). The ability to think is not merely a cognitive exercise but a transformative process that fosters deeper understanding and long-term retention of knowledge. The PBL model’s effectiveness lies in its grounding in real-life problems and events, which resonate with the learner's environment. By connecting academic content with practical, everyday scenarios, the model helps bridge the gap between theoretical knowledge and real-world application, further enhancing students' problem-solving skills. Moreover, the integration of Science Edutainment within this model adds an engaging and interactive dimension to the learning experience (Von Esch & Kavanagh, 2018; Tsybulsky & Muchnik-Rozanov, 2019). This approach not only makes learning more enjoyable but also facilitates a more profound engagement with complex scientific concepts, helping students to better internalize and apply what they learn. The PBL model's focus on student-driven inquiry, combined with the immersive nature of Science Edutainment, cultivates an environment where learners actively participate in their learning journey, leading to more meaningful cognitive development (Schutz et al., 2019).

The ability to think critically and logically plays a pivotal role in enhancing a student’s learning ability, speed, and overall effectiveness in absorbing new information. Thinking skills are essential because they form the cognitive foundation that enables students to analyze, evaluate, and synthesize knowledge. This connection between thinking skills and learning underscores the importance of cultivating these skills early on in a student’s educational journey. As Lutfianasari et al. (2018) suggest, students who are systematically trained to think critically tend to demonstrate marked improvements in their educational outcomes, as their development is positively influenced by their enhanced cognitive abilities. Developing students’ logical thinking skills should start as early as possible, as these skills serve as crucial preconditions for advanced cognitive processes. Ratna (2015) emphasizes that logical thinking skills are not isolated but rather interconnected within a broader cognitive framework. This structural connection implies that the various components of logical thinking—such as reasoning, problem-solving, and decision-making—are inherently linked to one another and to the way students process information. Logical thinking requires students to validate cognitive conclusions, meaning they must engage in a structured process of evaluating the information at hand and drawing sound, reasoned conclusions. Moreover, the form and process of

logical thinking share a deep structural relationship, where each step in reasoning and problem-solving builds upon the previous one. This continuous and iterative process strengthens cognitive functions, as students learn not just to memorize facts but to engage in deeper analysis and validation of ideas. By fostering these skills early, educators can help students build a solid foundation for lifelong learning, enabling them to approach complex challenges with confidence and clarity.

Based on the explanation above, it can be concluded that the use of the Problem-Based Learning (PBL) model integrated with Science Edutainment makes a significant contribution to enhancing students' logical thinking skills (Prafitasari et al., 2021; Ye & Zhou, 2022). This approach is highly effective because the PBL model, combined with the engaging nature of Science Edutainment, provides structured learning steps that are designed to facilitate problem-solving and cognitive development in students. The key strength of this model lies in its ability to encourage students to actively engage with problems presented during the learning process. By simulating real-life challenges or complex academic questions, the PBL model pushes students to think logically and critically to find solutions (Allison & Pan, 2011; Daungcharone & Thongkoo, 2022). Science Edutainment adds another layer of engagement, making the learning experience more interactive and enjoyable, which helps sustain students' attention and interest in problem-solving tasks.

The structured steps in the PBL model guide students through the process of identifying the problem, analyzing it, gathering relevant information, and applying logical reasoning to propose solutions. This method ensures that students are not passive recipients of information, but active participants in their learning journey. They are required to think logically at every stage, from understanding the problem to formulating and defending their conclusions. Moreover, by fostering an environment where problem-solving is central to learning, this approach promotes the development of higher-order thinking skills. Logical reasoning, critical analysis, and decision-making are all crucial aspects of solving the problems presented by the teacher. The iterative process of working through problems helps solidify students' ability to think logically, as they must constantly evaluate information, make connections, and justify their solutions based on evidence and reasoning.

In conclusion, the Problem-Based Learning model, enhanced by Science Edutainment, offers a comprehensive framework that not only makes learning more engaging but also strengthens students' logical thinking abilities. By encouraging active participation, critical reflection, and hands-on problem-solving, this model ensures that students are better equipped to think logically and systematically about complex issues, both inside and outside the classroom.

CONCLUSIONS

Based on the results, it can be concluded that the Problem-Based Learning (PBL) Model integrated with Science Edutainment significantly enhances students' logical thinking skills in science education. Statistical analysis using the independent sample t-test showed a significance value of 0.000 ($p < 0.05$), indicating a meaningful difference between the experimental and control groups. The PBL model fosters active learning and problem-solving, while Science Edutainment makes learning more interactive and engaging, promoting deeper cognitive processing. Overall, this approach improves both academic performance and critical thinking, essential for future success in academic and real-world problem-solving.

The findings of this study have both theoretical and practical implications for education. Theoretically, they support constructivist learning theory by demonstrating that integrating Problem-Based Learning (PBL) with Science Edutainment enhances students' logical thinking and cognitive development through active and engaging learning. This aligns with theories emphasizing the importance of real-world problem-solving and multisensory learning in fostering higher-order thinking skills. Practically, the results suggest that educators should adopt this approach in their teaching strategies, particularly in science education, to improve students' critical thinking and problem-solving abilities. By utilizing real-life scenarios and interactive content, teachers can create more engaging and effective learning experiences. This approach can also guide curriculum design,

ensuring that students develop essential cognitive skills for academic success and real-world challenges.

For future research, it is recommended to explore the long-term effects of integrating the Problem-Based Learning (PBL) model with Science Edutainment on students' logical thinking and problem-solving abilities. Researchers could expand the study across different subject areas and educational levels to determine the generalizability of the findings. Additionally, investigating the impact of this model on other cognitive skills, such as creativity and critical thinking, would provide a broader understanding of its benefits. Future studies could also compare the effectiveness of PBL with other interactive learning models to assess which methods yield the most significant improvement in student outcomes. Finally, incorporating qualitative data, such as student feedback and teacher observations, could provide deeper insights into the learning process and identify areas for improvement in implementing these innovative teaching approaches.

ACKNOWLEDGEMENT

We extend our deepest gratitude to the informants for their invaluable support and cooperation throughout this research. The willingness of the institutions to provide access to resources, students, and faculty greatly contributed to the success of this research. We appreciate the commitment and active participation of all parties involved, which made this research possible and helped us achieve meaningful results. Contributions have been instrumental in advancing our understanding of the educational approaches explored, and we look forward to continuing to collaborate in future endeavors.

BIBLIOGRAPHY

Adler, P.S. and Heckscher, C. (2018). Collaboration as an Organization Design for Shared Purpose, Toward Permeable Boundaries of Organizations? (Research in the Sociology of Organizations, Vol. 57), *Emerald Publishing Limited, Leeds*, pp. 81-111. https://doi.org/10.1108/S0733-558X20180000057004

Afiyati, Y., Warniasih, K., & Utami, N. W. (2020). Problem-solving with guided inquiry learning: An analysis of studentâ€™s problem-solving ability. *Journal of Physics: Conference Series*, 1581(1), 012035. https://doi.org/10.1088/1742-6596/1581/1/012035

Allison, J., & Pan, W. (2011). Implementing and Evaluating the Integration of Critical Thinking into Problem Based Learning in Environmental Building. *Journal for Education in the Built Environment*, 6(2), 93–115. https://doi.org/10.11120/jebe.2011.06020093

Almulla, M. A. (2020). The Effectiveness of the Project-Based Learning (PBL) Approach as a Way to Engage Students in Learning. *Sage Open*, 10(3). https://doi.org/10.1177/2158244020938702

Amelkin, V., Askarisichani, O., Kim, Y. J., Malone, T.W., & Singh, A. K. (2018) Dynamics of collective performance in collaboration networks. *PLoS ONE* 13(10): e0204547. https://doi.org/10.1371/journal.pone.0204547

Ardianti, S. D., Pratiwi, I. A., & Kanzunnudin, M. (2017). Implementasi Project Based Learning (PjBL) Berpendekatan Science Edutainment Terhadap Kreativitas Peserta Didik. *Jurnal Refleksi Edukatika, 7*(2), 145–150. https://doi.org/10.24176/re.v7i2.1225

Candrawati, N., & Hidayati, N. A. (2017). The Relationship Among Learning Independence, the Logically Thinking Ability and Learning Environment At Home With Mathematics Learning Outcomes of Students Grade XI of Audio Video Mechanical Deparment in SMK Negeri 1 Pundong Bantul Yogyakarta. *AdMathEduSt: Jurnal Ilmiah Mahasiswa Pendidikan Matematika, 4*(1), 23–28. https://doi.org/10.12928/admathedust.v4i2.13363

Chang, C. J., Chang, M. H., Chiu, B. C., Liu, C. C., Chiang, S. F., Wen, C. T., Hwang, F. K., Wu, Y. T., Chao, P. Y., Lai, C. H., Wu, S. W., Chang, C. K., & Chen, W. (2017). An Analysis Of Student

Collaborative Problem Solving Activities Mediated By Collaborative Simulations. *Computers & Education*, 114, 222-235. https://doi.org/10.1016/j.compedu.2017.07.008

Chasanah, L., & Dewi, N. R. (2015). Pengembangan Sciencepoly Game Berbasis Kontekstual Sebagai Media Science-Edutainment Pada Materi Kalor dan Perpindahannya Untuk Siswa Kelas VII SMP. *Unnes Science Education*, *4*(2), 873–880. https://doi.org/10.15294/usej.v4i2.7937

Creswell, J. W. (2014). *Research Design: Qualitative, Quantitative, And Mixed Methods Approaches* (4th ed.). Sage Publications.

Daungcharone, K., & Thongkoo, K. (2022). The effects of thinking process model technique on logical thinking skills influencing programming achievement. *In 2022 Joint International Conference on Digital Arts, Media and Technology with ECTI Northern Section Conference on Electrical, Electronics, Computer and Telecommunications Engineering (ECTI DAMT & NCON)* (pp. 134-138). IEEE. https://doi.org/10.1109/ECTIDAMTNCON53731.2022.9720360

Dwyer, C. P. (2023). An Evaluative Review of Barriers to Critical Thinking in Educational and Real-World Settings. *Journal of Intelligence*, 11(6), 105. https://doi.org/10.3390/jintelligence11060105

Feiyue, Z. (2022). Edutainment Methods in the Learning Process: Quickly, Fun and Satisfying. *International Journal of Environment, Engineering and Education*, *4*(1), 19–26. https://doi.org/10.55151/ijeedu.v4i1.41

Field, A. (2013). *Discovering statistics using IBM SPSS statistics* (4th ed.). Sage Publications.

Flores, K. L., Matkin, G. S., Burbach, M. E., Quinn, C. E., & Harding, H. (2012). Deficient Critical Thinking Skills among College Graduates: Implications for leadership. *Educational Philosophy and Theory*, 44(2), 212–230. https://doi.org/10.1111/j.1469-5812.2010.00672.x

Fraenkel, J. R., & Wallen, N. E. (2012). How to design and evaluate research in education (8th ed.). McGraw-Hill.

Gay, L. R., Mills, G. E., & Airasian, P. W. (2011). *Educational research: Competencies for analysis and applications* (10th ed.). Pearson.

Goldie, J. G. (2016). Connectivism: A knowledge learning theory for the digital age?. *Medical teacher*, 38(10), 1064–1069. https://doi.org/10.3109/0142159X.2016.1173661

Graesser, A. C., Fiore, S. M., Greiff, S., Andrews-Todd, J., Foltz, P. W., & Hesse, F. W. (2018). Advancing the Science of Collaborative Problem Solving. *Psychological Science in the Public Interest*, 19(2), 59-92. https://doi.org/10.1177/1529100618808244

Hmelo-Silver, C.E. (2004). Problem-Based Learning: What and How Do Students Learn?. *Educational Psychology Review* 16, 235–266. https://doi.org/10.1023/B:EDPR.0000034022.16470.f3

Kier, M. W., & Lee, T. D. (2017). Exploring The Role of Identity in Elementary Preservice Teachers Who Plan to Specialize in Science Teaching. *Teaching and Teacher Education, 61*, 199–210. https://doi.org/10.1016/j.tate.2016.10.016

Levine, M. A. (2006). *Testing Statistical Assumptions*. Sage Publications.

Liu, Z. K., He, J., & Li, B. (2015). Critical and Creative Thinking as Learning Processes at Top-Ranking Chinese Middle Schools: Possibilities and Required Improvements. *High Ability Studies*, *8139*(November). https://doi.org/10.1080/13598139.2015.1015501

Lutfianasari, U., Widodo, A. T., & Sumarti, S. S. (2018). Application of PBL Model Assisting the Chemo-Edutainment Based Worksheets for Increasing the Students' Activities and Critical

Thinking. *Journal of Innovative Science Education*, *7*(08), 1–9. https://doi.org/10.15294/JISE.V7I1.21230

Morreira, S., Luckett, K., Kumalo, S. H., & Ramgotra, M. (2020). Confronting the complexities of decolonising curricula and pedagogy in higher education. *Third World Thematics: A TWQ Journal*, 5(1–2), 1–18. https://doi.org/10.1080/23802014.2020.1798278

Octaria, D. (2017). Kemampuan Berpikir Logis Mahasiswa Pendidikan Matematika Universitas PGRI Palembang pada Mata Kuliah Geometri Analitik. *Jurnal Pendidikan Matematika RAFA*, *3*(2), 181–194. https://doi.org/10.19109/jpmrafa.v3i2.1740

Prafitasari, F., Sukarno, S., & Muzzazinah, M. (2021). Integration of Critical Thinking Skills in Science Learning Using Blended Learning System. *International Journal of Elementary Education*, 5(3), 434–445. https://doi.org/10.23887/ijee.v5i3.35788

Ramadhani, R., Huda, S., & Umam, R. (2019). Problem-Based Learning, Its Usability and Critical View as Educational Learning Tools. Journal of Gifted Education and Creativity, 6(3), 193-208.

Ratna, M. (2015). Pengaruh Metode CTL dan Kemampuan Berpikir Logis Terhadap Hasil Belajar IPA Siswa Kelas IV Sekolah Dasar Negeri 114 Palembang. *Jurnal Pendidikan Dasar*, *6*(2), 254–265. https://doi.org/10.21009/JPD.062.07

Rohman, A., Rukiyati, & Purwastuti, A. (2018). *Epistemologi & Logika Filsafat Untuk Pengembangan Pendidikan*. Yoyakarta: ASWAJA PRESSINDO.

Schutz, K., Danielson, K., & Cohen, J. (2019). Approximations in English language arts: Scaffolding a shared teaching practice. *Teaching and Teacher Education*, 81, 100–111. https://doi.org/10.1016/j.tate.2019.01.004

Sugiyono. (2016). *Metode Penelitian Pendidikan*. Bandung: Alfabeta.

Sulaiman, J., & Ismail, S. N. (2020). Teacher competence and 21st century skills in transformation schools 2025 (TS25). *Universal Journal of Educational Research*, *8*(8), 3536–3544. https://doi.org/10.13189/ujer.2020.080829

Sumartini, T. S. (2015). Peningkatan Kemampuan Penalaran Matematis Siswa Melalui Pembelajaran Berbasis Masalah. *Mosharafa: Jurnal Pendidikan Matematika*, *5*(1), 1–10. https://journal.institutpendidikan.ac.id/index.php/mosharafa/article/view/mv4n1_1/244

Taufiq, M., Dewi, N. R., & Widiyatmoko, A. (2014). Pengembangan Media Pembelajaran IPA Terpadu Berkarakter Peduli Lingkungan Tema "Konservasi" Berpendekatan Science-Edutainment. *Jurnal Pendidikan IPA Indonesia*, *3*(2), 140–145. https://dx.doi.org/10.15294/jpii.v3i2.3113

Taylor, M., Hung, J., Che, T. E., Akinbosede, D., Petherick, K. J., & Pranjol, M. Z. I. (2021). Laying the groundwork to investigate diversity of life sciences reading lists in higher education and its link to awarding gaps. *Education Sciences*, 11(7), 359. https://doi.org/10.3390/educsci11070359

Thornhill-Miller, B., Camarda, A., Mercier, M., Burkhardt, J. M., Morisseau, T., Bourgeois-Bougrine, S., Vinchon, F., El Hayek, S., Augereau-Landais, M., Mourey, F., Feybesse, C., Sundquist, D., & Lubart, T. (2023). Creativity, Critical Thinking, Communication, and Collaboration: Assessment, Certification, and Promotion of 21st Century Skills for the Future of Work and Education. *Journal of Intelligence*, 11(3), 54. https://doi.org/10.3390/jintelligence11030054

Tofade, T., Elsner, J., & Haines, S. T. (2013). Best practice strategies for effective use of questions as a teaching tool. *American journal of pharmaceutical education*, 77(7), 155. https://doi.org/10.5688/ajpe777155

Tsybulsky, D., & Muchnik-Rozanov, Y. (2019). The development of student-teachers' professional identity while team-teaching science classes using a project-based learning approach: A multi-level analysis. *Teaching and Teacher Education*, 79, 48-59. https://doi.org/10.1016/j.tate.2018.12.006

Von Esch, K. S., & Kavanagh, S. S. (2018). Preparing Mainstream Classroom Teachers of English Learner Students: Grounding Practice-Based Designs for Teacher Learning in Theories of Adaptive Expertise Development. *Journal of Teacher Education*, 69(3), 239-251. https://doi.org/10.1177/0022487117717467

Wale, B.D., & Bishaw, K.S. (2020). Effects of using inquiry-based learning on EFL students' critical thinking skills. *Asian. J. Second. Foreign. Lang. Educ*. 5, 9. https://doi.org/10.1186/s40862-020-00090-2

Widyastuti, N. S., & Pujiastuti, P. (2014). Pengaruh Pendidikan Matematika Realistik Indonesia (PMRI) terhadap Pemahaman Konsep dan Berpikir Logis Siswa. *Prima Edukasia*, *2*(2), 183–193. https://doi.org/10.21831/jpe.v2i2.2718

Winarti, W. T., Yuliani, H., Rohmadi, M., & Septiana, N. (2021). Pembelajaran Fisika Menggunakan Model Discovery Learning Berbasis Edutainment. *Jurnal Ilmiah Pendidikan Fisika*, *5*(1), 47–54.

Yanuardianto, E. (2020). Pembelajaran Edutainment Dalam Penanaman Karakter Cinta Tanah Air Pada Anak Usia Dini di Sekolah Dasar. In *EDUCARE: Journal of Primary Education 1*(3). https://dx.doi.org/10.35719/educare.v1i3.11

Ye, J., & Zhou, J. (2022). Exploring the relationship between learning sentiments and cognitive processing in online collaborative learning: A network analytic approach. *The Internet and Higher Education*, 55, 100875. https://doi.org/10.1016/j.iheduc.2022.100875

Yew, E. H. J., & Goh, K. (2016). Problem-Based Learning: An Overview of its Process and Impact on Learning. In *Health Professions Education* (Vol. 2, Issue 2, pp. 75–79). King Saud bin Abdulaziz University. https://doi.org/10.1016/j.hpe.2016.01.004

Yue, M., Zhang, M., Zhang, C., & Jin, C. (2017). The effectiveness of concept mapping on the development of critical thinking in nursing education: A systematic review and meta-analysis. *Nurse Education Today*, 52, 87-94. https://doi.org/10.1016/j.nedt.2017.02.018

Zawacki-Richter, O., Marín, V. I., Bond, M., & et al. (2019). Systematic review of research on artificial intelligence applications in higher education – Where are the educators? *International Journal of Educational Technology in Higher Education*, 16, 39. https://doi.org/10.1186/s41239-019-0171-0