



The Effect of Snakes and Ladders Game on Students' Science Literacy on Solar System Materials in Elementary School

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Abstract: The results of the 2022 PISA show a decline in Indonesian students' scientific literacy, necessitating innovation in learning media. This study aims to examine the effect of the Snakes and Ladders game on the scientific literacy of sixth-grade students at SDN 01 Tuguharum on the solar system. The Snakes and Ladders game was chosen because its visual, interactive, and rule-based nature is suitable for scientific concepts. The method used was quantitative with a Nonequivalent Control Group design. The sample consisted of 44 sixth-grade students divided into experimental and control groups. Data were collected through tests and documentation, then analyzed using instrument testing and hypothesis testing. The results showed that students in the experimental group scored higher than those in the control group ($t = 11.99$, $p < 0.05$), indicating that the Snakes and Ladders game media had a positive effect on students' scientific literacy. This finding contributes to improving students' ability to explain scientific phenomena. The implication is that Snakes and Ladders can serve as a practical and engaging alternative to science education in elementary schools.

Abstrak: Hasil PISA 2022 menunjukkan penurunan literasi sains siswa Indonesia, maka diperlukan inovasi media pembelajaran. Penelitian ini bertujuan menguji pengaruh media permainan ular tangga terhadap literasi sains siswa kelas VI SDN 01 Tuguharum materi tata surya. Permainan ular tangga dipilih karena sifat permainan yang visual, interaktif, dan berbasis aturan cocok untuk konsep-konsep sains. Metode yang digunakan adalah kuantitatif dengan desain Nonequivalent Control Group. Sampel terdiri dari 44 siswa kelas VI yang terbagi menjadi kelompok eksperimen dan kontrol. Data dikumpulkan melalui tes dan dokumentasi, lalu dianalisis menggunakan uji instrumen dan uji hipotesis. Hasil penelitian menunjukkan bahwa siswa dalam kelompok eksperimen memperoleh nilai lebih tinggi dibandingkan dengan kelompok kontrol ($t = 11,99$, $p < 0,05$), sehingga media permainan ular tangga berpengaruh positif terhadap literasi sains siswa. Temuan ini berkontribusi dalam meningkatkan kemampuan siswa terkait menjelaskan fenomena ilmiah. Implikasinya, ular tangga dapat diadopsi sebagai alternatif yang praktis dan menarik untuk pendidikan sains di sekolah dasar.

A. Introduction

Education is a deliberate, planned process that helps people reach their full potential, become responsible members of society, and acquire the skills they need independently. To put it simply, education is the human endeavor to develop one's intrinsic potential on a physical and spiritual level in conformity with cultural and societal ideals (Rahman et al., 2022). Furthermore, learning is the assistance that instructors provide students to help them build their own knowledge, master their abilities, and develop their attitudes and beliefs. Learning is thus a process that aids in children's successful learning (Pratiwi et al., 2019; Cashman et al., 2021; Lee, 2022; Schlatter et al., 2022; Kay & Buxton, 2023; Leonard et al., 2023).

In the modern world, technology is advancing rapidly and has an impact on many facets of human existence. The development of information and communication technology has altered how we communicate, collaborate, and educate ourselves. One way that human resources must assist the realization of an increasingly sophisticated education is by responding to it with scientific literacy (Irsan, 2021).

The capacity to comprehend, assess, and use scientific knowledge and data in decision-making is known as science literacy. The OECD defines scientific literacy as the capacity to recognize questions, learn new information, and make fact-based judgments. According to the definition, students who acquire science literacy can comprehend and assist in decision-making about the natural world and how humans interact with it by applying their scientific knowledge, recognizing questions, and drawing conclusions supported by data (Ardiyanti et al., 2019). It also entails knowing how science works in daily life and how it affects society.

The school literacy campaign began in March 2016 and has continued to this day (Muhammad, 2018). The goal of the school literacy movement is to raise students' literacy levels through formal education. According to numerous surveys and studies, Indonesians still have lower literacy levels than people in other nations (Liza et al., 2023). Understanding the changes driven by human activity and actively engaging with social and environmental concerns requires science literacy. An essential part of studying science is mastering science literacy, which is the capacity to comprehend, apply, and assess scientific knowledge in daily life (Riser et al., 2020; Canlas et al., 2024). According to Pertiwi et al (2018), science literacy is the capacity of individuals to use their knowledge to formulate questions, offer scientific explanations or understanding, gather or create new knowledge, and draw conclusions based on a variety of scientific evidence. It also includes the capacity to cultivate a hypothetical mindset in order to contribute to the resolution of various scientific concepts and problems.

In Indonesian education, scientific literacy is critical, particularly for equipping students to address the problems of the twenty-first century. One of the 21st-century skills students need to keep up with global trends is scientific literacy, though Indonesian students' proficiency in this area remains lacking (Yusmar & Fadhilah, 2023). In addition to

helping to solve social and environmental issues, science literacy enables students to comprehend and use scientific information in daily life.

Based on the PISA results in 2022, released on December 05, 2023, the reading score dropped from 371 to 359, and the science score dropped from 396 to 383. The PISA results show that Indonesia ranks low in science literacy, underscoring the need to improve the curriculum and teaching methods. Overall, the PISA 2022 results for science literacy are among the lowest, equivalent to those obtained in 2006. Indonesia ranked 68 out of 81 countries surveyed (OECD, 2023). The implementation and learning process at the primary school level remains theoretical and tedious, contributing to inadequate scientific literacy. Natural science is seen simply as a set of ideas to be learned, and professors continue to use traditional teaching strategies and media in the classroom, making learning dull and tedious for pupils. Teachers must be able to raise the quality of instruction in the existing educational system (Bachtiar, 2016; Nuryani & Handayani, 2020).

The goal of teaching natural science in primary school, according to Barus (2022), is to provide pupils with the opportunity to naturally be interested, to learn how to ask questions and seek evidence-based explanations of natural events, and to foster scientific thinking. Student learning success is strongly influenced by several key components: students, teachers, learning materials, techniques, and the tools or media used in the learning process. During this learning process, various obstacles often arise (Nugraha, 2018; Darman, 2020). Various obstacles in the learning process can be reduced through media, as they play a significant role in the learning process. Innovation is required to maintain the continuity of science education that may develop science literacy abilities, particularly the science process component in the indication of scientifically understanding phenomena, given the urgency and issues that exist. Innovation in learning activities, namely the use of alternative models that emphasise student engagement, is one such approach.

To promote or enhance students' scientific literacy in natural and social science courses, researchers have attempted to use snakes-and-ladders gaming media. With technological advancements shaping new learning media, such as the snakes-and-ladders game, good and optimal learning media are those that address the problems encountered and can be used as tools or intermediaries between educators and students to stimulate thought, process information, and convey messages. In this instance, the snakes-and-ladders game was evaluated for its ability to enhance scientific literacy; in the classroom, it may help students grasp concepts, boost memory, capture their interest, and connect them to real-world situations.

The Snakes and Ladders learning medium blends learning and gaming. To help students play and learn efficiently, this game includes questions relevant to the material. Surbakti (2023) claims that the snakes-and-ladders game is a learning tool based on classic games, created by modifying student characteristics to meet learning goals and serve as a means of delivering knowledge to students. According to the Snakes and Ladders learning resource, the game board is divided into tiny boxes, and many "ladders" or "snakes" are

shown linking the boxes. This game falls under the genre of "board games," which include Ludo, Monopoly, and others.

Despite the growing body of research on game-based learning and the use of traditional board games in science education, existing studies have largely focused on students' learning outcomes, motivation, or conceptual understanding, rather than on science literacy as a multidimensional competency. Moreover, previous studies tend to emphasize general achievement scores without explicitly examining core science literacy indicators, particularly students' ability to explain scientific phenomena, which represents a higher-order literacy skill in the PISA framework. In addition, empirical evidence on the effectiveness of simple, low-cost, and non-digital learning media remains limited, especially at the elementary school level and within specific science topics such as the solar system. As a result, there is a lack of rigorous quasi-experimental research that systematically compares traditional instruction with game-based media in terms of their impact on students' science literacy competencies.

To address this gap, this study offers a novel contribution by empirically investigating the use of the Snakes and Ladders game as a learning medium explicitly designed to foster science literacy, rather than merely improving academic achievement. Unlike prior studies, this research places a specific emphasis on students' ability to explain scientific phenomena, a key indicator of science literacy that integrates conceptual understanding, reasoning, and evidence-based explanation. Furthermore, this study adopts a quasi-experimental design to compare game-based learning with conventional teaching methods, thereby providing stronger empirical evidence regarding the instructional value of traditional, low-cost media. By situating the intervention within elementary science learning on solar system materials, this study also extends the application of game-based learning to a context that requires abstract scientific reasoning among young learners.

Based on the identified research gap and the proposed novelty, this study is guided by the following research question: Does the use of Snakes and Ladders game media significantly affect elementary students' science literacy compared to conventional learning methods? Accordingly, this research is important because it provides empirical evidence of how simple, low-cost, and enjoyable media can positively influence science learning, while also addressing the need for innovative learning strategies that align with students' cognitive, affective, and social characteristics at the elementary school level. The general objective of this research is to analyse the effect of Snakes and Ladders media on students' science literacy. Specifically, the research aims to compare the science literacy outcomes of students taught using Snakes and Ladders with those taught using conventional methods.

B. Method

This study employed a quantitative research methodology with a quasi-experimental design. This approach was selected because the research aimed to test the effect of a specific treatment, namely the use of the Snakes and Ladders game media, on students' science literacy. The design used was the Nonequivalent Control Group Design,

in which two groups were compared: one receiving the treatment (experimental group) and the other receiving conventional instruction (control group).

The subjects of this study were sixth-grade students at SDN 01 Tuguharum. Purposive sampling was used, resulting in 44 students divided into two groups: Class VIa (22 students) as the experimental group and Class VIb (22 students) as the control group. Purposive sampling was chosen to ensure participants were from the same grade level and had relatively comparable characteristics, even though it does not provide equal opportunity for all members of the population.

Ethical considerations were also taken into account in this research. Prior to data collection, permission was obtained from the school and the students' parents. Student participation was voluntary, and the confidentiality of personal data was guaranteed. The research ensured that no physical or psychological harm occurred to the participants, and the learning activities conducted were aligned with the curriculum so that students benefited from the intervention without disruption to their education.

Data were collected using tests and documentation. The test instruments were first validated through validity and reliability tests to ensure accuracy and consistency. Data analysis involved several stages: a normality test (to confirm that the data distribution followed a standard curve). Homogeneity test (to check whether the variance between groups was equal). Moreover, a t-test (to test the research hypothesis regarding group differences). In addition, effect size analysis was conducted to measure the magnitude of the treatment's impact on students' science literacy. The research flow is shown in Figure 1.

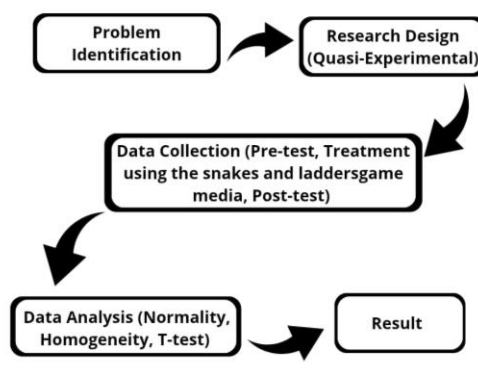


Figure 1. Research Flow in The Use of Snake and Ladders Game Media

Figure 1. Research Flow in the Use of Snakes and Ladders Game Media illustrates the systematic stages of this quasi-experimental study, beginning with the identification of research problems related to students' low science literacy. The process continues with the selection of research subjects and the division of participants into experimental and control groups using purposive sampling. Both groups were administered a pre-test to measure initial science literacy levels. Subsequently, the experimental group received instruction using the Snakes and Ladders game media, while the control group was taught using conventional learning methods. After the treatment phase, a post-test was administered to both groups to assess changes in students' science literacy. The collected data were then

analyzed through instrument validity and reliability testing, followed by normality, homogeneity, and hypothesis testing using a paired-sample t-test and effect size analysis. The research flow concludes with the interpretation of results and the formulation of conclusions regarding the effect of Snakes and Ladders game media on students' science literacy.

C. Result

Two classes, VIA as the experimental group and VIB as the control group, each with 22 students, participated in this research at SD Negeri 01 Tuguharum. Both classes took a pre-test consisting of 20 multiple-choice questions before treatment to assess students' baseline levels of scientific literacy comprehension. The findings from the normality and homogeneity tests, and the t-tests, indicate that the scientific learning capacities of students in grades VA and VB are similar. The table below displays the findings of the pre-test data analysis.

Table 1. Description of Pre-test Analysis Results

Description	Experiment VI A	Control VI B
Average Value	49,23	25,89
Standard Deviation	10,14	9,85
χ^2_{count}	1,11	1,11
χ^2_{table}	2,018	2,018

According to Table 1's data, the experimental class's average pre-test score is 49.23, whereas the control class's is 25.89. According to the homogeneity test, the data of the two classes exhibit a homogenous or statistically equivalent distribution because the χ^2_{count} is less than the χ^2_{table} ($1.11 < 2.018$). The following summarizes the test results of the experimental and control classes before they received therapy (treatment) after the completion of the investigation. Where the pre-test findings are used to produce data recapitulation. The data is as follows:

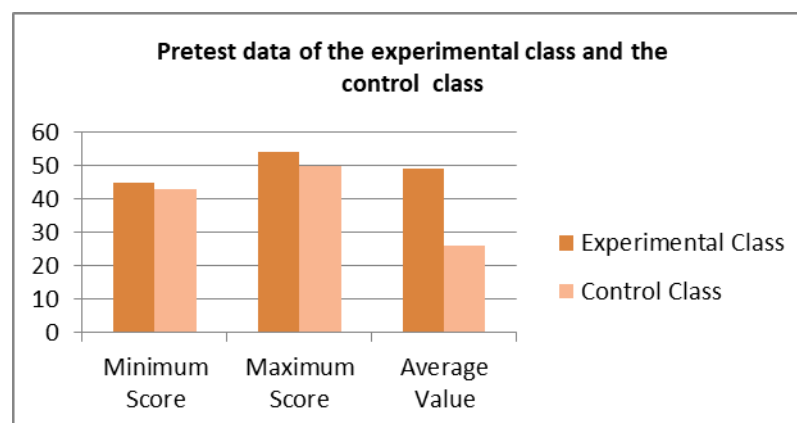


Figure 2. Recapitulation of Experimental and Control Class Pre-Test Data

Figure 2, depicting pre-test data, clearly indicates that the experimental and control classes started with comparable initial skills. In this case, the experimental class's average pre-test score was somewhat higher than that of the control group; specifically, the experimental group's average score was 49.23, while the control group's average score was 45.59. Moreover, instructors have failed to provide students with a comprehensive introduction to cultivating scientific literacy skills in basic education, leading to the expectation that pupils have struggled to grasp these skills.

The experimental class used snakes-and-ladders media after various learning treatments, while the control class used traditional techniques. To assess the effect of the therapy, all students were given a post-test once again. The following are the findings of the post-test data analysis for the experimental and control groups.

Table 2. Data from the Analysis of Students' Post-test Values

Description	Experimen Class	Control Class
Average Value	84,50	61,82
Highest Score	92	66
Lowest Score	77	59
Standard Deviation	9,85	10,68
χ^2_{count}	7,48	7,48
χ^2_{table}	2,018	2,018

Table 2 clearly indicates that the experimental class achieved an average post-test score of 84.50, with scores ranging from 66 to 92. The control group's mean score was 61.82, with a minimum of 59 and a maximum of 77. A summary of the test outcomes after treatment in both the experimental and control groups is shown below. According to the analysis, children who use Snakes and Ladders gaming media exhibit significantly different scientific literacy skills than those who do not.

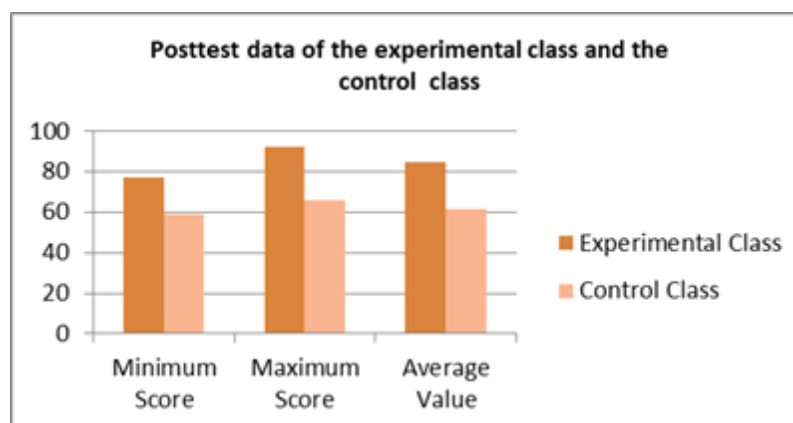


Figure 3. Recapitulation of Experimental and Control Class Pre-Test Data

From the results of the post-test or after treatment with learning exercises that used media from the snakes and ladders game in experimental courses and traditional instruction

in control classrooms. The experimental class had an average post-test score of 84.50, while the control class attained an average score of 61.82.

Researchers want to determine whether using snakes and ladders influences the science literacy skills of grade VI pupils at 01 Tuguharum State Elementary School by administering a pre-test and post-test. The following are the processes used to determine the hypothesis:

- a. Ho: There is no impact of utilizing snakes and ladders on the science literacy skills of grade VI students at 01 Tuguharum State Elementary School.
- b. Ha: There is an effect of using snakes and ladders on the science literacy skills of grade VI students at 01 Tuguharum State Elementary School.

After that, do a paired t-test. If the two-tailed p-value < 0.05 , Ho is rejected and Ha is accepted; if it is > 0.05 , Ho is accepted, and Ha is rejected. The paired t-test findings are shown in the table below.

Table 3. Data from the Analysis of Students' Post-test Values

		Paired Differences							
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		t	df	Sig. (2 Tailed)
					Lower	Upper			
Paired 1	Pre-test post-test	35,27	10,275	2,944	29,193	41,347	11,99	21	0.000

According to the study, students' pre-test and post-test average scores were 49.23 and 84.50, respectively. Following the learning therapy using the snakes-and-ladders gaming media, there was a noticeable increase in the average score. With a significance level of Sig. (2-tailed) = 0.000, the paired-samples t-test yielded a count of 11.99, which is significantly below the $\alpha = 0.05$ significance threshold. Consequently, it may be said that Ha is accepted and H0 is rejected. The use of Snakes and Ladders as a game medium significantly influences students' scientific literacy skills. Consequently, after receiving therapy, kids' scientific literacy scores rise. In this instance, pupils' scientific literacy in the study of the solar system is influenced by snakes-and-ladders media.

D. Discussion

Based on the pre-test data analysis in this study, students' basic science literacy skills remain relatively low. Various factors contribute to this initial weakness, including school-related factors such as the underutilization of learning materials aligned with children's developmental stages during instruction. Teachers' selection of teaching materials plays a crucial role in shaping students' science literacy. Conventional practices in teaching natural and social sciences, which pay little attention to reading and writing as fundamental

competencies, have also led to low levels of science literacy. According to Basuki (2019), three factors affect students' science literacy: Psychological factors (interest and motivation for learning), familial factors (parental guidance and educational background), institutional factors (teaching methodologies, facilities and infrastructure, and educational materials or media for natural science), and extracurricular learning activities. This study found that the use of snakes-and-ladders media might Influence students' scientific literacy.

Using the snakes-and-ladders game as a learning medium, students can enhance their scientific literacy skills, particularly in relation to the indicators of science literacy. In this study, the focus is placed on the indicator of scientifically explaining phenomena, which is considered the most comprehensive component of scientific literacy competence. According to the PISA framework, scientific literacy in the context of scientific processes encompasses the ability to identify scientific questions, explain phenomena scientifically, and apply scientific evidence. Among these components, the ability to explain phenomena scientifically involves the highest level of literacy competence, as it requires students to connect concepts, observations, and evidence in a coherent explanation. The Snakes and Ladders game supports this process by creating an engaging and interactive learning environment. As noted by Sanaky (as cited in Fadila et al., 2021), this medium can motivate students to participate in learning actively, create a more enjoyable and varied classroom atmosphere, and facilitate students' understanding of the material presented by the teacher. The game also helps present core information in a more easily comprehensible format, stimulates students' focus and analytical thinking, and supports the creation of conducive learning conditions. Consequently, students can grasp scientific concepts more quickly and meaningfully during the learning process.

In this instance, the use of snakes-and-ladders media enables students to acquire the three indicators of scientific literacy and enhance their science literacy skills. This study focuses on the capacity to comprehend and apply scientific ideas in daily life as a key aspect of science literacy. The scientific literacy skills indicators used in this research are based on those identified by Jufri (2017) and are shown in the table below.

In this study, students' science literacy was examined through three core competencies, namely the ability to identify scientific questions, explain scientific phenomena, and use scientific evidence. The ability to identify scientific questions reflects students' capacity to recognize scientific issues, understand key concepts, and identify relevant information within a given context. Explaining scientific phenomena represents a higher-level literacy skill, as it requires students to apply scientific knowledge, connect concepts, and provide logical explanations of observed events. Meanwhile, the use of scientific evidence refers to students' ability to interpret data, draw conclusions based on evidence, and communicate scientific reasoning in a meaningful way. These three competencies collectively illustrate students' capacity to understand, apply, and evaluate scientific knowledge in everyday life, which aligns with the conceptual framework of science literacy emphasized in contemporary science education.

Following treatment or therapy using snakes-and-ladders gaming media, all three scientific literacy indicators have improved. A checkered drawing board, dice, and images of snakes and ladders are used in the educational game Snakes and Ladders, which two or more players can play. Students are encouraged to actively engage in learning via this game. Students may enjoy learning through snakes-and-ladders activities, and they are more likely to want to participate in the process (Wati, 2021).

The findings of this study confirm that the snakes-and-ladders game, as a learning medium, significantly improves students' science literacy, particularly in understanding the solar system. This result is consistent with previous studies that demonstrate the effectiveness of game-based learning in enhancing student engagement and conceptual understanding. For instance, Hidayat et al (2020) found that board games in science learning could improve students' ability to connect concepts and increase their learning motivation. Similarly, Prastyo and Suryanti (2018) emphasized that the use of traditional games as instructional media could transform abstract scientific concepts into more tangible and meaningful learning experiences. These comparisons provide broader evidence that integrating play elements into the classroom is a practical approach to achieving educational goals.

The effectiveness of the Snakes and Ladders game can be explained by its combination of visual, interactive, and rule-based features. These elements encourage active participation, repeated exposure to content, and peer interaction, all of which are essential for strengthening memory and conceptual understanding. According to the Cognitive Theory of Multimedia Learning (Mayer, 2017), learning becomes more effective when information is presented through multiple modalities. In this context, the snakes-and-ladders game not only delivers content but also embeds it in a fun, motivating activity that stimulates both students' cognitive and affective domains. The competitive yet collaborative nature of the game sustains students' attention and creates a favorable emotional climate, which is crucial for deep learning (Ryan & Deci, 2020).

However, the limitations of this study include the relatively small sample size and its implementation in only one school, as well as the potential Influence of external factors such as teacher experience and classroom management. In practical terms, the snakes-and-ladders game can serve as an inexpensive, flexible, and relevant alternative learning medium to support science literacy in elementary schools, in line with the Merdeka Curriculum agenda. Moreover, this study reinforces the idea that integrating game-based media is not only pedagogically appropriate but also supports students' psychological needs.

E. Implication

The findings of this study suggest that the Snakes and Ladders game can serve as a practical, low-cost, and engaging instructional medium to enhance science literacy at the elementary level. By integrating visual, interactive, and rule-based play into learning, teachers can foster greater student participation and make complex concepts more

accessible. This approach aligns with student-centered learning principles and can be particularly valuable in resource-limited schools, offering an alternative to traditional lecture methods. At a broader level, the successful application of this medium underscores the potential for game-based learning to be incorporated into the science curriculum as a practical tool for enhancing cognitive understanding and student motivation.

F. Limitation and Suggestion for Further Research

This study has several limitations. The research was limited to a single school and had a small sample size, limiting the generalizability of the findings. Moreover, the intervention focused solely on the solar system, leaving its effectiveness in other science areas unclear. Data collection relied solely on tests and documentation, without qualitative insights into student experiences or classroom dynamics. Additionally, external factors such as teacher Influence and classroom environment were not controlled, and the study did not assess the long-term retention of knowledge gained.

Future studies should increase sample size across multiple schools to enhance generalizability and consider randomised experimental designs to minimise bias. It would also be beneficial to apply the Snakes and Ladders game to a broader range of science topics, including abstract or higher-order concepts, to evaluate its broader applicability. Combining quantitative and qualitative methods, such as student interviews, classroom observations, and attitude surveys, could yield richer insights into the learning process. Furthermore, longitudinal research should be conducted to examine the sustainability of students' science literacy gains and the potential of integrating such game-based learning into the regular curriculum.

G. Conclusion

This study shows that the use of snakes-and-ladders media can significantly improve the science literacy skills of sixth-grade students at Tuguharum 01 Public Elementary School. This can be seen in the post-test results of the experimental class, which received treatment with snakes-and-ladders media, and the control class, which used conventional methods. Based on the paired-samples *t*-test calculation, the *t*-value was 11.99, with a significance level of Sig. (2-tailed) = 0.000, which is much smaller than the significance level of $\alpha = 0.05$. Therefore, it can be concluded that using the snake-and-ladder game media has a positive effect on students' science literacy skills. Learning with the snake-and-ladder game medium enables students to explain phenomena scientifically and actively involves them in the learning process. Students who learn using the Snakes and Ladders medium show greater improvement than those who use conventional methods because the game is tailored to the learning material, motivating students to engage in the learning process. This finding aligns with other studies that show that the use of snake-and-ladder learning media in science education helps improve students' understanding, especially in mastering complex concepts. This method not only improves understanding but also attracts students' interest in learning through more varied and interactive learning media.

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