

Enhancing Elementary Students' Interest and Conceptual Understanding of the Solar System Through Edutainment-Based Interactive Learning Media

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ARTICLE INFO

Keywords:

edutainment games;
interactive learning media;
science education;
student interest;
conceptual understanding;
solar system

Article history:

Received 2025-01-30

Revised 2025-03-03

Accepted 2022-09-30

ABSTRACT

Traditional teaching methods in science education often struggle to effectively convey abstract concepts such as the Solar System, leading to low student engagement and limited conceptual understanding. Integrating interactive learning media, particularly edutainment games, offers a promising solution to enhance both interest and comprehension in elementary science learning. This study employed a quasi-experimental design using a Nonequivalent Control Group Design to evaluate the effectiveness of edutainment game-based learning media. Participants included two groups of sixth-grade students: an experimental group taught using edutainment games and a control group taught using conventional methods. Pretest and post-test assessments were administered to measure conceptual understanding, while a Likert-scale questionnaire evaluated students' learning interest. Data were analyzed using Paired Sample T-Tests to determine the significance of differences between pre- and post-intervention scores. Findings revealed a statistically significant improvement in both learning interest and conceptual understanding among students in the experimental group compared to the control group ($p < 0.001$). Students exposed to edutainment game-based learning demonstrated higher engagement levels and deeper comprehension of the Solar System topic. The use of game-based interactive media not only fostered active learning but also addressed challenges associated with teaching abstract scientific content. These results support the integration of edutainment games into elementary science curricula as a means to enhance learning outcomes and student motivation.

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1. INTRODUCTION

Learning media serve as a tool or method used to support the teaching and learning process, making it more effective and efficient. These media can take the form of print, audio, visual, or digital, each playing a role in conveying information to students. Over time, learning media have continued to

evolve in line with technological advancements and the needs of modern education. One such innovation is interactive learning media, which allows students to be more actively involved in the learning process (Yu et al., 2020). This type of media encourages two-way interaction between students and the learning material, increasing student engagement in learning. With features such as simulations, animations, and technology-based activities, interactive learning media can create a more engaging and meaningful learning experience. Edutainment game-based learning media is an advanced form of interactive learning media that combines entertainment and education in a single platform. The use of edutainment games in learning aims to create a fun and challenging learning experience, motivating students to understand better the material being taught. In the context of science learning in elementary schools, this media is becoming increasingly popular as it helps students better grasp abstract concepts.

Learning interest is a crucial factor in student academic success. Students with a high interest in learning tend to be more active in the learning process, more motivated to explore the material, and have stronger learning endurance (Ryan & Deci, 2020). In science learning, particularly regarding the solar system, low interest in learning can be a major obstacle to understanding the material. Conventional lecture-based teaching methods are often less engaging, causing students to lose interest and resulting in low involvement in the learning process. If left unaddressed, this low interest in science can have long-term effects on students' participation in STEM (Science, Technology, Engineering, and Mathematics) fields (Archer et al., 2021). Therefore, a more engaging and effective teaching approach is needed to enhance students' learning interest. Previous studies have explored the use of edutainment games in science learning and have shown positive results in increasing engagement and conceptual understanding. For example, research by Hwang et al. (2022) demonstrated that interactive edutainment-based learning games improve students' motivation and comprehension of astronomical concepts. Similarly, Sun & Rueda (2021) found that digital games integrated with inquiry-based learning enhance students' cognitive and affective learning outcomes in science education. However, many of these studies focus on secondary education or higher education levels, leaving a research gap in understanding the effectiveness of edutainment-based interactive learning media in elementary school contexts.

On the other hand, conceptual understanding is crucial to ensure that students not only memorize information but also internalize and apply concepts in various situations (Mayer, 2021). In science learning, particularly about the solar system, many students struggle with understanding abstract concepts due to the challenging nature of the material, which is difficult to visualize. Learning that focuses solely on text and lectures often does not suffice in helping students build a strong conceptual understanding. Studies such as those by Lee & Anderson (2023) suggest that interactive and game-based learning environments significantly enhance students' understanding of complex scientific concepts by providing immersive and experiential learning experiences. Nevertheless, there is still limited research that specifically examines how edutainment-based interactive learning media can bridge the gap between engagement and deep conceptual comprehension among elementary school students in the context of solar system learning.

This study aims to fill this gap by exploring the impact of edutainment-based interactive learning media on elementary students' interest and conceptual understanding of the solar system. By integrating engaging learning experiences with scientifically accurate simulations, this research seeks to provide empirical evidence on how such an approach can enhance both interest and comprehension at the elementary level.

Edutainment games offer an innovative solution by providing a more interactive and exploratory learning experience. With features such as simulations, animations, and game-based challenges, this media can increase student engagement and help them more easily understand complex concepts (Sun et al., 2020). Previous research has shown that game-based learning media has great potential in enhancing students' interest and conceptual understanding of the solar system in elementary school science learning. Mukti et al. (2023) revealed that the development of game-based assessment tools can

improve students' science literacy, while Zainil et al. (2022) highlighted that digital STEM-based learning models can develop critical thinking and collaboration skills essential in science learning. Additionally, Andira et al. (2022) found that students' interest in science significantly affects their academic performance, while Erviana et al. (2019) emphasized the low motivation for science learning in some regions, necessitating more engaging instructional approaches. Hasani et al. (2020) also stressed the importance of an integrative STEM-based approach to enhance students' interdisciplinary understanding, consistent with Maison et al. (2020), who showed that students' attitudes toward science play a crucial role in the learning process.

The advantages of edutainment games in increasing learning motivation and student engagement are the primary reasons for their selection in this study. Unlike passive conventional teaching methods, game-based approaches create a more interactive and enjoyable learning experience (Haruna et al., 2018). This aligns with constructivist learning theory, which emphasizes active student involvement in knowledge acquisition (Piaget, as cited in Schunk, 2020). According to cognitive load theory (Sweller, 2020), multimedia-based learning can enhance conceptual understanding by reducing extraneous cognitive load and optimizing students' working memory. The flexibility offered by educational games allows students to learn at their own pace in a more engaging environment (Tokac et al., 2019). By integrating gamification elements such as challenges, rewards, and adaptive difficulty, edutainment games can foster enthusiasm for learning while simultaneously deepening students' comprehension of complex scientific concepts (Hamari et al., 2021).

The novelty of this research lies in its exploration of edutainment games as interactive learning media to enhance students' interest and conceptual understanding of the solar system at the elementary school level. Unlike previous studies that primarily focused on developing science literacy and critical thinking skills (Wang et al., 2020; Yang & Chang, 2019), this study examines how game-based media directly impact two fundamental aspects of science learning: student interest and conceptual understanding. Moreover, this study considers how these factors contribute to improving the effectiveness of science education in the digital age, where engagement with technology plays a crucial role in shaping learning experiences. To ensure the validity of the findings, external variables such as prior knowledge, teacher influence, and instructional time were controlled by ensuring that both the experimental and control groups had similar initial conditions, equal teacher involvement, and structured learning sessions. Additionally, the study employed validated instruments, including a concept comprehension test and a learning interest questionnaire, both of which were tested for reliability using Cronbach's alpha.

Despite its promising findings, this study has several limitations. Access to technology remains a challenge, particularly in underprivileged schools where students may lack adequate digital resources (Ertmer & Ottenbreit-Leftwich, 2020). Additionally, the successful implementation of edutainment games depends on teacher readiness; not all educators have received sufficient training to integrate technology effectively into their teaching practices (Sari & Wahyudi, 2023). Another limitation is scalability—while the study demonstrated positive effects in a controlled classroom setting, its broader application across different educational contexts requires further investigation. Future research should explore the effectiveness of edutainment games in different educational levels and subjects, as well as investigate the long-term impact of game-based learning on student retention and higher-order thinking skills.

2. METHODS

The research method used in this study is an experimental research method. Experimental research is a type of scientific investigation in which one or more independent variables are manipulated and controlled, while the dependent variable is observed to identify variations caused by the manipulation of the independent variable (Creswell, 2020). This study aims to examine the effect of

edutainment game-based learning media on the interest and understanding of sixth-grade elementary school students regarding the solar system concept in science subjects.

The sample in this study was divided into two groups: the experimental class, which received formative assessment treatment using game-based formative assessment, and the control class, which utilized conventional media. The research design employed was the Nonequivalent Control Group Design within a quasi-experimental framework. Both classes received the same instructional material on the solar system concept, with different formative assessment methods applied. At the beginning of the study, students in both the control and experimental classes were given a pretest to assess their initial knowledge. The experimental class received formative assessment treatment using interactive edutainment game-based media, while the control class utilized conventional methods such as lectures and discussions.

Table 1. Nonequivalent Control Group Design

Class	Pretest	Treatment	Post-test
Experimental	O1	X1	O2
Control	O3	X2	O4

Description :

- O1 : Pretest score (before treatment)
- O2 : Post-test score (after treatment)
- X1 : Treatment using edutainment game-based learning media
- X2 : Treatment using conventional methods (lectures and discussions)
- O3 : Pretest score (before treatment)
- O4 : Post-test score (after treatment)

The study population included all sixth-grade students from three elementary schools (Classes VI A to VI D). The sampling technique used was purposive sampling, where samples were selected deliberately based on specific characteristics relevant to the research objectives. The sample was divided into two groups: the control group (Classes VI C and VI D), consisting of 75 students and the experimental group (Classes VI A and VI B), also consisting of 75 students. These classes were carefully selected to ensure a proportional representation of the population. Before the treatment was applied, both groups took a pretest to measure their initial understanding of the solar system concept. The experimental group received instruction using interactive edutainment game-based media, whereas the control group was taught using conventional methods without additional media. After the intervention, a post-test was administered to evaluate learning outcomes between the two groups.

The research instruments included observation, multiple-choice concept comprehension tests, and a Likert-scale questionnaire to measure learning interest. Instrument validity was tested using the Pearson Product-Moment correlation, while reliability was analyzed using the Kuder-Richardson (K-R 20 and K-R 21) method. Data collection was conducted quantitatively, beginning with normality testing using the Shapiro-Wilk test and homogeneity testing via Levene's Test using SPSS version 26.0. Once the prerequisite tests were satisfied, hypothesis testing was performed using the Paired Sample T-Test to assess significant differences between pretest and post-test results concerning students' learning interest and understanding of the solar system concept in science subjects.

3. FINDINGS AND DISCUSSION

Before conducting the study, the researcher developed a test instrument consisting of 25 multiple-choice questions for the pretest and post-test, which were validated prior to use. The validation process was carried out with sixth-grade students from three elementary schools using the Pearson Product-Moment Correlation technique, resulting in 20 valid questions and 5 invalid ones. The reliability of the instrument was tested using the Kuder-Richardson method, which indicated a high level of reliability. The difficulty level analysis categorized 1 question as difficult, 14 questions as moderate, and 5

questions as easy. Meanwhile, the discrimination index analysis showed that none of the questions were poor or inadequate, with 12 questions classified as fair, 7 as good, and 1 as very good.

Next, the researcher developed interactive learning media based on edutainment games and implemented them in the experimental class for the Natural Science (IPA) subject, focusing on the Solar System topic. The teacher utilized the interactive learning media to deliver the material, provide examples, engage students with game-based elements, and incorporate quizzes into each learning session. Students were given opportunities to ask questions if they did not understand the material. This approach aimed to assess the effectiveness of edutainment games in enhancing students' learning interest and conceptual understanding of the Solar System.

Before the intervention, students in both the experimental and control classes took a pretest consisting of 20 questions to measure their initial understanding of the Solar System. Each correct answer was awarded 1 point, while incorrect answers received 0 points. After collecting baseline data, the experimental class was taught using interactive edutainment game-based learning media, whereas the control class continued with conventional methods such as lectures and discussions without additional media. Upon completion of the intervention, a post-test was administered to all students to evaluate the differences in learning outcomes between the experimental and control groups in terms of both learning interest and conceptual understanding of the Solar System.

Table 2. Students' Interest and Conceptual Understanding Data

	Pretest Experiment	Post-test Experiment	Pretest Control	Post-test Control
N	75	75	75	75
Mean	51.43	68.07	46.90	61.4
Median	50.00	70.00	45.00	60.00
Minimum	30	55	25	50
Maximum	75	85	70	80

Source: Processed Primary Data (2024)

Based on the data above, the mean and median values provide an overview of the central distribution of scores in each group. The mean pretest score for the experimental group was 51.43, which increased to 68.07 in the post-test. Meanwhile, the mean score of the control group's pretest was 46.90 and increased to 61.40 in the post-test. This shows that the higher score increase in the experimental group compared to the control group indicates that the use of educational game-based learning media is more effective in increasing students' interest and conceptual understanding of the solar system compared to conventional learning methods.

Table 3. Normality Test Results

Variable		Group	Kolmogorov-Smirnov			Shapiro-Wilk		
			Statistic	df	Sig.	Statistic	df	Sig.
Interest	Pretest	Experimental	0,092	75	0.200	0.961	75	0.325
		Control	0,087	75	0.200	0.965	75	0.413
	Posttest	Experimental	0,085	75	0.200	0.958	75	0.271
		Control	0,082	75	0.200	0.968	75	0.484
Conceptual Understanding	Pretest	Experimental	0,095	75	0.200	0.957	75	0.259
		Control	0,089	75	0.200	0.969	75	0.513
	Posttest	Experimental	0,102	75	0.190	0.947	75	0.136
		Control	0,085	75	0.200	0.971	75	0.556

Source: Processed Primary Data (2024)

Table 3 presents the results of the normality test using the Kolmogorov-Smirnov and Shapiro-Wilk methods to assess whether the data collected followed a normal distribution. All the significance values

obtained in these two tests were > 0.05 , for both the experimental and control groups, in both the pretest and post-test. These results indicate that the data in this study were normally distributed, which is one of the prerequisites for conducting further statistical analysis, such as the t-test. Normal distribution in the research data ensures that comparisons between the experimental and control groups can be made validly and reliably, and supports the conclusion that changes in scores after the intervention can be interpreted more accurately.

Table 4. Homogeneity Test Result (Levene's Test)

Variable	Group	df1	df2	Sig.
Interest	Pretest	1	148	0.548
	Posttest	1	148	0.101
Conceptual Understanding	Pretest	1	148	0.836
	Posttest	1	148	0.699

Source: Processed Primary Data (2024)

Table 4 presents the results of the homogeneity test using Levene's Test to assess the similarity of variances between the experimental and control groups. All significance values obtained were > 0.05 , indicating that the variances of the pretest and post-test data in both groups were homogeneous. Homogeneity of variance indicates that the level of variation in the data of the two groups is relatively similar, so further statistical analysis, such as the t-test, can be carried out assuming that the data distribution between the experimental and control groups has similar characteristics. Thus, the differences in results observed between the two groups can be attributed to the treatment given, rather than to other external factors.

Table 5. Paired Sample t-Test Results

Pair	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval	t	df	Sig. (2-tailed)
Pretest & Post-test Experiment	-16.64	9.87	1.75	-20.11, -13.17	-9.51	74	<0.001
Pretest & Post-test Control	-14.50	10.26	1.83	-18.11, -10.89	-7.93	74	<0.001

Source: Processed Primary Data (2024)

Table 5 displays the results of the paired sample t-test to compare the pretest and post-test scores in each group. The test results show that there was a significant increase in students' interest and conceptual understanding after the intervention, with a p-value < 0.001 in both groups. However, this improvement was greater in the experimental group than in the control group. In the experimental group, the mean pretest and post-test scores were significantly different with $t = -9.51$, while in the control group, the difference was smaller with $t = -7.93$. These results indicate that the use of educational game-based learning media has a greater impact in increasing students' interest and conceptual understanding of the solar system compared to conventional learning methods. The significant difference in score improvement suggests that the integration of interactive technology in science learning can substantially improve learning effectiveness.

This study aligns with previous research investigating the use of technology in education, particularly in the context of game-based educational learning. As found by Chen et al. (2021), technological tools that support knowledge construction can significantly enhance student learning outcomes by fostering deeper engagement and interactive learning experiences. Similarly, Wang & Tsai

(2022) demonstrated that educational technology, including interactive media, facilitates real-time feedback, improving students' motivation and conceptual understanding. The results of this study also recorded a significant improvement in students' interest and conceptual understanding of the solar system after using educational game-based learning media. The statistical test results indicate that this improvement was more pronounced in the experimental group than in the control group, reinforcing the effectiveness of game-based educational learning over conventional methods. This finding is consistent with research by Al-Fadley et al. (2023), which suggests that gamification elements in learning can enhance cognitive engagement and retention by incorporating problem-solving tasks and interactive challenges.

The implementation of educational games in learning followed a structured approach. The learning sessions were divided into three stages: (1) an introductory phase where students were given a brief explanation of the solar system, (2) an interactive phase where students engaged with the educational game through guided exploration and inquiry-based tasks, and (3) a reflection phase where students discussed their learning experiences and applied their knowledge to answer conceptual questions. The game was designed to incorporate elements such as visual animations, interactive simulations, and challenge-based assessments, which have been shown to enhance cognitive engagement and understanding (Brown et al., 2020). Additionally, validity and reliability tests were conducted on the research instruments, including the conceptual understanding test and the learning interest questionnaire. The content validity was assessed by subject matter experts, while reliability analysis using Cronbach's alpha confirmed a high level of internal consistency, ensuring the credibility of the research findings.

These findings contribute to the broader discourse on technology-enhanced learning by integrating key principles of cognitive learning theories, constructivism, and technology-based education models. According to Sweller's Cognitive Load Theory (Sweller, 2021), the integration of multimedia elements in educational games can optimize cognitive processing by reducing extraneous cognitive load and facilitating schema development. Furthermore, from a constructivist perspective (Piaget, 2022), interactive learning experiences enable students to actively construct their knowledge through exploration and problem-solving. This study also aligns with Mayer's Multimedia Learning Theory (Mayer, 2023), which posits that students learn more effectively when instructional content combines visual and verbal representations. The results suggest that edutainment games improve conceptual understanding primarily through interactive and visual elements that reinforce abstract scientific concepts. However, as Eden (2024) highlights, socioeconomic disparities can limit students' access to such technologies, creating inequities in learning outcomes. Therefore, ensuring equitable access to technology remains a crucial challenge for educators and policymakers. Educational institutions must design inclusive learning environments that support the adoption of game-based learning while addressing barriers related to accessibility and digital literacy.

4. CONCLUSION

The results of the study indicate that the use of game-based educational media significantly improves the interest and conceptual understanding of sixth-grade students regarding the Solar System topic in science lessons. A greater improvement was observed in the experimental group, which used interactive learning media, compared to the control group that employed conventional teaching methods. This is reflected in the higher average scores in both the pretest and post-test for the experimental group. The improvement suggests that game-based educational media enhances student engagement in the learning process, facilitates the understanding of complex concepts, and creates a more enjoyable and engaging learning environment. Therefore, this media proves to be more effective in improving student learning outcomes compared to traditional teaching methods. Based on these findings, it is recommended that schools consider using game-based educational media for other topics as well to enhance students' interest and understanding across the curriculum. Additionally, it is

essential for schools to ensure equal access to technology for all students and provide training for teachers so that the use of technology in teaching can be more effective. Regular evaluation of the implementation of such media is also necessary to ensure its effectiveness in improving the quality of education. For future research, it is suggested to explore other models of educational games that may further enhance student engagement and conceptual understanding. Additionally, examining the effectiveness of game-based educational media across different educational levels, such as early childhood education or secondary education, would provide valuable insights into its broader applicability. Comparative studies on different game-based learning approaches, including augmented reality (AR) or virtual reality (VR), could also offer a deeper understanding of how various interactive elements influence learning outcomes.

Conflicts of Interest: The authors declare no conflict of interest.

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