

DEVELOPMENT OF A SOLAR SYSTEM PUZZLE GAME BOARD AS A SCIENCE LEARNING MEDIA IN ELEMENTARY SCHOOL

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Abstract: *The teaching of solar system material in elementary schools is still dominated by conventional methods that are ineffective in increasing student interest and understanding. This study aims to develop a solar system puzzle game board as an interactive science learning medium to increase students' learning motivation and cognitive abilities. The research method used is research and development through several stages, namely problem identification, data collection, product design, prototype creation, testing, evaluation, and revision. The results of the literature review and limited testing show that the puzzle game board media can increase student active engagement, facilitate understanding of the order and characteristics of the planets, and create a fun learning atmosphere. Thus, the solar system puzzle game board has the potential to be an innovative and effective alternative learning medium in science education in elementary schools.*

Keywords: *Learning Media, Puzzle, Board Game, Solar System, Science*

INTRODUCTION

Science education at the elementary level plays a crucial role in shaping students' fundamental understanding of natural phenomena. One important topic taught in elementary science is the solar system, which introduces students to planets, their order, and their characteristics. Despite its importance, solar system instruction is often delivered through conventional teaching methods, such as lectures and textbook-based explanations, which may reduce students' interest and learning motivation.

Several studies indicate that traditional learning methods are less effective in stimulating students' curiosity and active participation. Learning media that incorporate interactive and playful elements are considered more suitable for elementary students, as they align with their cognitive development and learning preferences. Game-based learning has been proven to increase student engagement, improve learning outcomes, and promote critical thinking skills.

Puzzle-based learning media offer significant advantages because they combine visual representation, kinesthetic activity, and problem-solving tasks. Through puzzle games, students can actively construct knowledge while enjoying the learning process. However, the application of puzzle media specifically for astronomy learning, particularly the solar system, remains limited. Therefore, this study focuses on developing a Solar System Puzzle Game Board as an innovative learning medium that facilitates meaningful and enjoyable learning experiences for elementary students.

LITERATURE REVIEW

Learning about the solar system is one of the fundamental topics in Natural Science (IPA) that is introduced at the elementary school level. This material aims to familiarize students with the structure, sequence, and characteristics of celestial bodies within the solar system. However, several studies indicate that solar system instruction in elementary schools is still dominated by conventional methods, such as lectures and textbook-based learning, which tend to be less effective in increasing students' interest and conceptual understanding (Nugroho et al., 2024).

Nugroho et al. (2024) emphasize that the use of game-based learning media, particularly board games, in teaching the solar system can enhance students' engagement and improve concept retention. This finding is consistent with the study conducted by Endang et al. (2023), which reported that puzzle-based media with a universe theme significantly improved the cognitive abilities of early childhood learners, especially in logical thinking and problem-solving skills. The use of games as learning media has been widely studied and has demonstrated positive outcomes. Santi and Astuti (2020) state that game-based learning models create a more active, effective, and enjoyable learning environment, leading to increased student motivation, learning outcomes, and participation. Similarly, Pamungkas et al. (2024) found that educational board games not only enhance conceptual understanding but also motivate students and reduce learning fatigue during classroom activities. Play is an essential activity in children's learning processes because it supports cognitive development, imagination, and creativity. According to Pamungkas et al. (2024), learning activities packaged in the form of games provide meaningful and enjoyable learning experiences. This is further supported by Pae (2021), who found that puzzle-solving activities have a significant influence on early childhood cognitive development.

Numerous empirical studies have also demonstrated the effectiveness of puzzle media in science learning. A study by Endang et al. (2023) revealed that the use of puzzle media in teaching the solar system to fourth-grade students significantly improved critical thinking skills, increasing from 50.66% in the pre-cycle to 81.33% in the second cycle. Similar findings were reported by Chamidah and Mintohari (2014), who observed an increase in learning mastery from 45.4% in the pre-cycle to 86.3% in the second cycle through the implementation of puzzle-based learning media. Puzzles are defined as games that involve assembling fragmented images or shapes into a complete form (Firdaus & Nugroho, 2016). This type of media is considered effective because it simultaneously engages visual, motor, and cognitive aspects of learners. Studies by Putra et al. (2019) and Yuda et al. (2020) also developed multimedia-based educational puzzle games and concluded that such media are feasible and effective for use in elementary school learning contexts.

Although research on the use of puzzles and educational games in learning has been extensively conducted, studies that specifically focus on developing puzzle board games for astronomy learning, particularly on the topic of the solar system, remain limited. Therefore, this study aims to develop a solar system puzzle board game as an alternative interactive learning medium that is enjoyable, memorable, and capable of enhancing elementary school students' cognitive abilities, creativity, and learning motivation.

METHOD

Educational media development in this study is grounded in the principle that effective learning tools must address not only cognitive outcomes but also learners' engagement, motivation, and long-term educational impact. Taking into account current and future economic, social, and environmental impacts, the development of learning media in this research considers present classroom needs as well as future learning sustainability. Based on this perspective, the study employed a Research and Development (R&D) approach aimed at producing an interactive and sustainable learning medium. Sustainability in this context refers to the media's ability to remain pedagogically relevant, reusable, and adaptable for continuous classroom use. To ensure a systematic and reflective development process, the ADDIE instructional design model was adopted, consisting of Analysis, Design, Development, Implementation, and Evaluation stages.

The analysis stage focused on identifying current instructional challenges in teaching the solar system at the elementary level, including low student engagement and limited use of interactive media. Observations and teacher consultations were conducted to understand learners' needs and classroom conditions. This stage also considered future learning demands by identifying competencies that students should develop, such as conceptual understanding, critical thinking, and active participation. During the design stage, the Solar System Puzzle Game Board was conceptually structured to balance educational content, visual clarity, and learner interaction. The design emphasized simplicity, durability, and usability to ensure that the media could be sustainably implemented across different learning contexts and over extended periods. The development stage involved creating a physical prototype of the puzzle game board using safe and durable materials suitable for elementary students. Planetary components were designed with distinct visual characteristics to support long-term usability and repeated learning activities. Content accuracy and visual quality were reviewed to ensure instructional reliability.

The implementation stage consisted of limited classroom trials in which students interacted directly with the puzzle game board. This stage examined how the media functioned in real learning situations, focusing on student engagement, ease of use, and learning interaction. Teacher facilitation and classroom dynamics were also observed to assess practical applicability. Finally, the evaluation stage assessed both the immediate and potential long-term effectiveness of the learning media. Evaluation criteria included student participation, accuracy in arranging planetary order, and teacher feedback regarding sustainability of use.

The results of the evaluation informed revisions to improve the instructional quality and durability of the media. Through this structured yet flexible methodological approach, the study ensures that the developed Solar System Puzzle Game Board not only addresses current learning challenges but also supports sustainable science learning practices in elementary education.

RESULT AND DISCUSSION

This questionnaire was designed to collect data on respondents' opinions and evaluations of the Solar System Puzzle Game Board learning media used at the elementary school level. The instrument aims to measure respondents' perceptions regarding the quality of the media, its level of attractiveness, and its effectiveness in supporting the learning process of solar system material.

The assessment of media quality includes aspects of design, clarity of the material, suitability to the characteristics of elementary school students, and ease of use. The attractiveness aspect focuses on visual appeal, game elements, and the media's ability to increase students' interest in learning. Meanwhile, the effectiveness aspect aims to determine the extent to which the Solar System Puzzle Game Board helps students understand solar system concepts, enhances active student engagement, and creates an enjoyable learning atmosphere.

The results of this questionnaire are expected to provide an objective overview of the strengths and weaknesses of the Solar System Puzzle Game Board learning media, so that they can be used as a basis for evaluation and further development of more optimal learning media in elementary school settings.

Tabel 1.

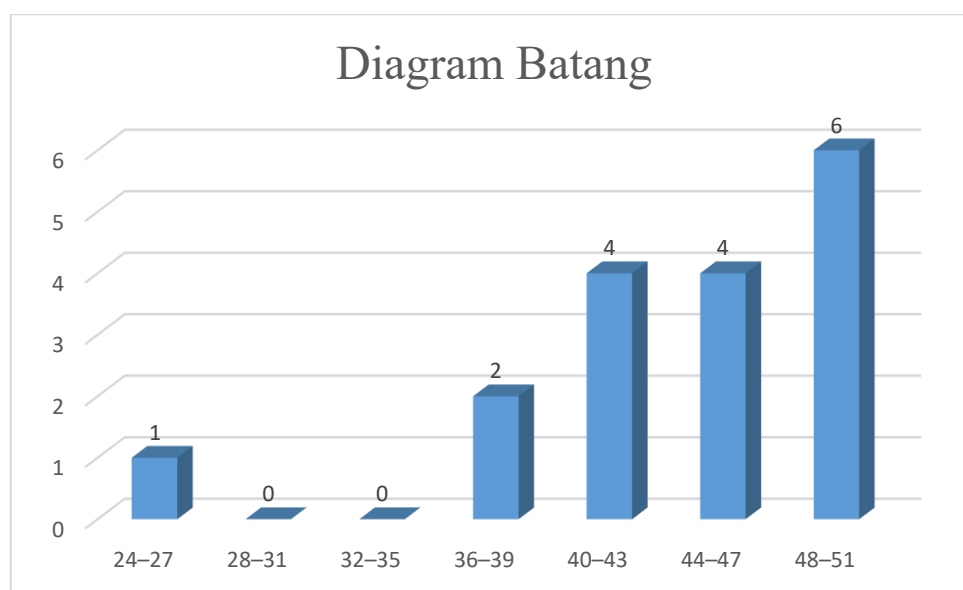
Nilai Data	Frekuensi (fi)	FR (%)	F.K (<)	F.K (>)
24–27	1	6%	0	17
28–31	0	0%	1	16
32–35	0	0%	1	16
36–39	2	12%	1	16
40–43	4	24%	3	14
44–47	4	24%	7	10
48–51	6	34%	11	6
JUMLAH	17	100%	17	0

Based on the results of processing the questionnaire data on the evaluation of the Solar System Puzzle Game Board learning media, data were obtained from 17 respondents, with a maximum score of 50 and a minimum score of 24, resulting in a range of 26. The data were then grouped into six class intervals with a class width of 4, in accordance with the rules for calculating frequency distributions.

The grouped data are presented in the form of a grouped frequency distribution table, which includes score intervals, frequency (fi), relative frequency (FR), as well as cumulative frequencies less than and greater than. The lowest score interval is 24–27, with a frequency of 1 respondent (6%), while no respondents provided evaluations in the 28–31 and 32–35 intervals. In the 36–39 interval, there were 2 respondents (12%), followed by an increase in the

40–43 and 44–47 intervals, each with 4 respondents (24%). The highest frequency occurred in the 48–51 interval, with 6 respondents (34%), indicating that the majority of respondents gave evaluations in the high score category.

Based on the cumulative frequency, it can be seen that most respondents provided evaluations above the midpoint of the distribution. This indicates that the Solar System Puzzle Game Board learning media is perceived as having good quality, being attractive, and being effective in supporting the learning process at the elementary school level. Thus, the frequency distribution table shows a dominant tendency of respondents' evaluations in the higher score intervals, supporting the conclusion that the developed learning media is feasible for use as an innovative and enjoyable learning medium.

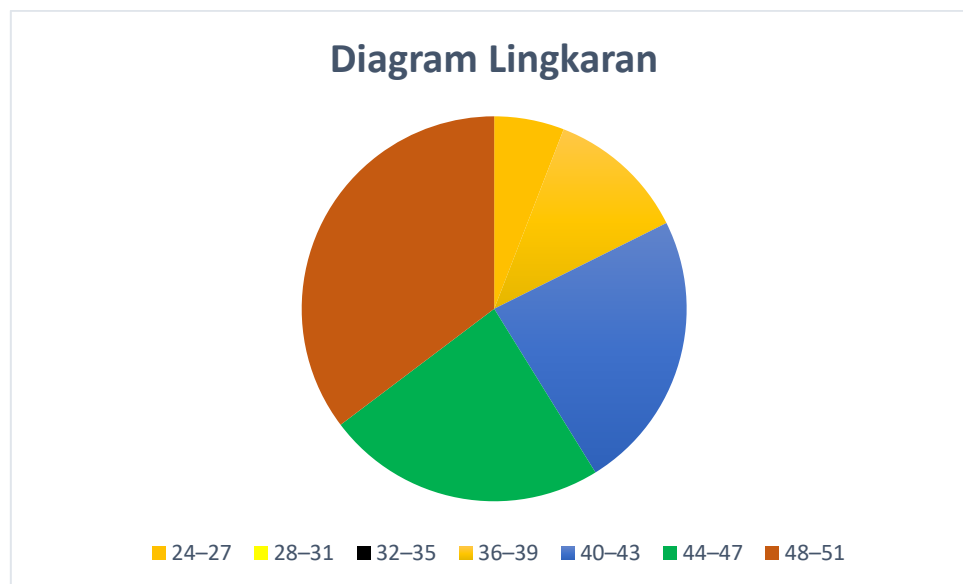


Gambar 1.

The bar chart is used to visually present the frequency distribution of respondents' evaluations of the Solar System Puzzle Game Board learning media. This chart illustrates the relationship between score intervals on the horizontal axis and the number of respondents (frequency) on the vertical axis, making it easier for readers to understand the data distribution pattern.

Based on the bar chart, it can be observed that the 48–51 score interval has the highest bar, with a frequency of 6 respondents, indicating that most respondents provided evaluations in the high score category. The 40–43 and 44–47 intervals also show relatively high frequencies, with 4 respondents each, suggesting a positive tendency in respondents' assessments of the learning media. Meanwhile, no respondents are found in the 28–31 and 32–35 score intervals, as indicated by the absence of bars in these categories. The 24–27 and 36–39 intervals have relatively low frequencies, with only 1 and 2 respondents, respectively, indicating that only a small number of respondents provided low evaluations of the learning media.

Overall, the bar chart shows that respondents' evaluations tend to be concentrated in the medium to high score intervals. This indicates that the Solar System Puzzle Game Board learning media is perceived as having good quality, being attractive, and being effective as a learning medium at the elementary school level.



Gambar 2.

The pie chart is used to illustrate the percentage proportions of respondents' evaluations of the Solar System Puzzle Game Board learning media based on the predetermined score intervals. Presenting the data in the form of a pie chart aims to facilitate readers' understanding of the comparative contribution of each score interval to the total number of respondents.

Based on the pie chart, the 48–51 score interval has the largest proportion, accounting for 34%, indicating that most respondents provided evaluations in the high score category. The 40–43 and 44–47 intervals each contribute 24% of the total respondents, suggesting that more than half of the respondents gave positive evaluations of the learning media. Meanwhile, the 36–39 interval accounts for 12%, and the 24–27 interval only 6%, indicating that only a small proportion of respondents provided low evaluations. No respondents are present in the 28–31 and 32–35 intervals; therefore, these intervals do not form sectors in the pie chart.

Overall, the pie chart shows that respondents' evaluations are dominated by medium to high score intervals. This indicates that the Solar System Puzzle Game Board learning media is perceived as having good quality, being attractive, and being effective for use in the elementary school learning process.

CONCLUSION

Based on the results of the research and data analysis, it can be concluded that the Solar System Puzzle Game Board is a feasible, attractive, and effective learning medium for science

education at the elementary school level. The development of this learning media responds to the limitations of conventional teaching methods, which tend to be less effective in increasing students' interest, engagement, and conceptual understanding of the solar system. The descriptive analysis of questionnaire data from 17 respondents shows that the distribution of responses is dominated by medium to high score intervals, with the highest frequency occurring in the 48–51 interval (34%). This indicates that most respondents provided positive evaluations of the media in terms of quality, attractiveness, and effectiveness. The absence of responses in several lower score intervals further suggests that the Solar System Puzzle Game Board received minimal negative assessments.

Visual representations through bar charts and pie charts reinforce these findings by clearly illustrating the concentration of responses in higher score categories. These results demonstrate that the puzzle game board successfully engages learners, facilitates understanding of the order and characteristics of planets, and creates an enjoyable learning atmosphere. The interactive and game-based nature of the media aligns well with the cognitive and developmental characteristics of elementary school students. Furthermore, the implementation of the ADDIE model ensured a systematic development process, from needs analysis to evaluation and revision, resulting in a learning medium that is not only pedagogically effective but also sustainable and reusable for long-term classroom use. Teacher feedback and classroom observations during limited trials also support the practicality and adaptability of the media.

In conclusion, the Solar System Puzzle Game Board has strong potential as an innovative alternative learning medium that enhances motivation, active participation, and conceptual understanding in elementary science learning. Therefore, this media is recommended for broader implementation and further development, particularly through wider-scale trials to strengthen its empirical effectiveness and educational impact.

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