

Developing an Android-Based Digital Snakes and Ladders Media on Life Cycles to Enhance Science Literacy in Fourth-Grade Elementary Students

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Article Info

Keywords:

Digital Snakes and Ladders media, Android, scientific literacy, IPAS, life cycle of living things.

ABSTRACT

This study was motivated by the relatively low scientific literacy of elementary school students, particularly in explaining scientific phenomena, interpreting information, and relating scientific concepts to everyday life. In addition, science and social studies (IPAS) instruction was still dominated by conventional teaching methods, while the use of Android-based digital learning media remained limited. This study aimed to develop Android-based digital Snakes and Ladders learning media on the topic of the life cycle of living things and to analyze its validity, practicality, and effectiveness in improving elementary school students' scientific literacy. The study employed a Research and Development (R&D) method using the 4D development model, consisting of Define, Design, Develop, and Disseminate stages, combined with a mixed-methods approach. The research subjects involved 47 fourth-grade students from SDN 17 Tilamuta, SDN 11 Tilamuta, and SDN 05 Tilamuta. The research instruments consisted of validation sheets for media, subject-matter, and learning experts, teacher and student response questionnaires, observation sheets, and scientific literacy tests administered as pretests and posttests. The data were analyzed using quantitative and qualitative descriptive techniques, while N-Gain analysis was employed to determine the improvement in students' scientific literacy. The results showed that the developed media obtained validity scores of 92.5% from the media expert, 92.5% from the subject-matter expert, and 89% from the learning expert, with an overall average of 91.33%, categorized as highly valid. The practicality assessment showed a student response score of 92.61% and a teacher response score of 97.22%, both categorized as highly practical. The effectiveness of the media was indicated by an increase in the mean scientific literacy score from 58.50 on the pretest to 89.80 on the posttest, with an N-Gain score of 0.75, categorized as high. Therefore, the developed Android-based digital Snakes and Ladders media was determined to be highly valid, highly practical, and effective in improving elementary school students' scientific literacy on the topic of the life cycle of living things.

Article Information

Keywords:

Media ular tangga digital, Android, literasi sains, IPAS, siklus hidup makhluk hidup.

ABSTRACT

Penelitian ini dilatarbelakangi oleh masih rendahnya kemampuan literasi sains peserta didik sekolah dasar, khususnya dalam menjelaskan fenomena ilmiah, menafsirkan informasi, dan mengaitkan konsep sains dengan kehidupan sehari-hari. Selain itu, pembelajaran IPAS masih didominasi oleh metode konvensional dan pemanfaatan media pembelajaran digital berbasis Android belum optimal. Penelitian ini bertujuan untuk mengembangkan media ular tangga digital berbasis Android pada materi siklus hidup makhluk hidup serta menganalisis validitas, kepraktisan, dan keefektifannya dalam meningkatkan literasi sains peserta didik sekolah dasar. Penelitian menggunakan metode Research and Development (R&D) dengan model pengembangan 4D yang terdiri atas tahap Define, Design, Develop, dan Disseminate, serta menggunakan pendekatan mixed methods. Subjek penelitian melibatkan 47 peserta didik kelas IV dari SDN 17 Tilamuta, SDN 11 Tilamuta, dan SDN 05 Tilamuta. Instrumen penelitian meliputi lembar validasi ahli media, ahli materi, dan ahli pembelajaran, angket respons guru dan peserta didik, lembar observasi, serta tes literasi sains berupa pretest dan posttest. Data dianalisis secara deskriptif kuantitatif dan kualitatif serta menggunakan analisis N-Gain untuk mengetahui peningkatan kemampuan literasi sains. Hasil penelitian menunjukkan bahwa media yang dikembangkan memperoleh persentase validasi ahli media sebesar 92,5%, ahli materi sebesar 92,5%, dan ahli pembelajaran sebesar 89%, dengan rata-rata 91,33% yang termasuk kategori sangat valid. Kepraktisan media berdasarkan respons peserta didik memperoleh persentase sebesar 92,61% dan respons guru sebesar 97,22%, keduanya termasuk kategori sangat praktis. Keefektifan media ditunjukkan oleh peningkatan nilai rata-rata literasi sains dari 58,50 pada pretest menjadi 89,80 pada posttest, dengan nilai N-Gain sebesar 0,75 yang termasuk kategori tinggi. Dengan demikian, media ular tangga digital berbasis Android yang dikembangkan dinyatakan sangat valid, sangat praktis, dan efektif dalam meningkatkan literasi sains peserta didik sekolah dasar pada materi siklus hidup makhluk hidup.

Article History

Received : 15/08/2026

Revised : 10/09/2026

Accepted : 21/10/2026

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1. Introduction

21st-century education demands that young people have critical, creative, collaborative thinking skills, and be technologically literate. The use of technology in learning is key to improving the quality of education. Android-based digital learning media is expected to support students' communication, collaboration, critical thinking, and creativity skills. Digital learning media utilizes technology to support material delivery, learning interactions, and evaluation through text, images, audio, video, animation, and other multimedia. The snakes and ladders game can be modified into a learning medium by incorporating materials, information, questions, and challenges into the game box so that player activities also involve learning activities. Sunarti, Amril, and Vebrianto (2020) showed that the snakes and ladders game can be developed as a science learning medium by combining elements of games, information, and challenges. Boalemo Regency continues to develop education through digitalization. In June 2025, the Boalemo Smart School program was launched, aiming to improve the quality of education through the use of digital technology, including the development of interactive learning media. In 2025, 28 schools were trialed, and it is estimated that by 2026, 190 schools will implement the program. The Boalemo Smart School program encourages schools and teachers to utilize technology in learning. One aspect that can be improved through digitalization is scientific literacy, which includes the ability to understand scientific concepts, apply knowledge to solve problems, and make evidence-based decisions (Bybee, 2020). According to the OECD (2019), scientific literacy encompasses an understanding of natural and social phenomena and the ability to relate them to everyday life. The 2022 PISA results show Indonesia's scientific literacy score at 383, a 13-point decrease from 2018. The 2025 Indonesian Education Report Card shows that the proportion of elementary school students/Islamic elementary school students/equivalent students achieving minimum literacy competencies increased from 52.04% in 2022 to 57.11% in 2023 and 59.04% in 2024, but approximately 40.96% still have not achieved minimum literacy competencies. In science learning, particularly on the life cycle of living things, students still often memorize stages without understanding biological processes logically. Therefore, learning innovations that utilize digitalization are needed. Based on data from the Boalemo Regency Statistics Agency (BPS) (2024), approximately 23.2% of the population is in the school-age range of 0–14 years out of a total of 152.1 thousand people, so there is a large potential for users of Android-based learning media. Initial observations at SDN 05, SDN 11, and SDN 17 Tilamuta show that science learning is still dominated by lecture methods and conventional media, while the use of Android-based digital media is still limited. The three schools were selected because they are located in the same geographic area and have relatively similar learning characteristics. All three also demonstrated issues such as limited use of digital media and the need to improve students' scientific literacy skills. Interviews with fourth-grade teachers revealed that most teachers had not yet used Android-based media due to limited training and the lack of digital media relevant to the

curriculum. Students' scientific literacy skills were also low, particularly in explaining natural phenomena and the concept of the life cycle of living things. Seventy-two percent of students stated that science lessons were boring due to the lack of interactive media, while 85 percent of teachers needed digital media that was easy to use and appropriate to the local context.

Educational games can integrate elements of entertainment and learning, creating interactive, enjoyable, and meaningful learning experiences. Snakes and Ladders has the potential to be developed as a learning medium because it allows students to learn concepts in a gradual, repetitive, and enjoyable manner. Previous research has shown that Snakes and Ladders media can increase motivation, engagement, and learning outcomes. However, most developments are still oriented towards learning outcomes or motivation, while scientific literacy skills have not been the main focus. Existing media also generally do not integrate scientific literacy indicators based on the PISA framework, such as explaining scientific phenomena, evaluating and designing scientific investigations, interpreting scientific data and evidence, and linking scientific concepts to everyday life. This condition indicates a research gap in the development of digital learning media that not only convey material but also develop scientific literacy skills comprehensively. Empirical conditions at SDN 05, SDN 11, and SDN 17 Tilamuta also show a gap between the digitalization policy of education through Boalemo Smart School and the implementation of learning in the classroom. Based on these conditions, the development of Android-based digital snakes and ladders media was carried out by integrating the principles of Game-Based Learning, scientific literacy indicators based on the OECD/PISA framework, material on the life cycle of living things according to the Independent Curriculum, and the contextual needs of elementary schools in Boalemo Regency. The media is equipped with animated visualizations, contextual questions, direct feedback, and recording of learning outcomes. The media is expected to facilitate students in explaining scientific phenomena, interpreting data, analyzing problems, and connecting scientific concepts with everyday life. Thus, the development of Android-based digital snakes and ladders media is expected to be an alternative solution to low scientific literacy skills while supporting the digitalization of learning through the Boalemo Smart School Program. This media is also expected to provide practical benefits for teachers and enrich the study of the development of digital learning media based on Game-Based Learning in science learning. Therefore, this research focuses on the development of Android-based digital snakes and ladders media to improve students' scientific literacy skills on the life cycle of living things material in elementary schools. The media development is expected to produce a product that meets the aspects of validity, practicality, and effectiveness as a learning medium to support improving the quality of science learning in elementary schools.

2. Method

A. Location and Research Subjects

The research was conducted at SDN 05 Tilamuta, SDN 11 Tilamuta, and SDN 17 Tilamuta in Boalemo Regency. The

selection of schools was based on characteristics that suited the research needs, efforts to improve the quality of learning through engaging and interactive media, and diverse student conditions. The research was planned to take place from September 2025 to December 2025 with research subjects in two stages, namely a limited trial and a wider trial. The limited trial involved 15 fourth-grade students of SDN 17 Tilamuta, while the wider trial involved 18 fourth-grade students of SDN 11 Tilamuta and 14 fourth-grade students of SDN 05 Tilamuta. The trial was conducted to determine the feasibility, practicality, and effectiveness of the Android-based Digital Snakes and Ladders media in improving scientific literacy.

B. Research Methods and Design

This research is a research and development (R&D) that aims to produce Android-based digital Snakes and Ladders media and test its feasibility, practicality, and effectiveness in improving elementary school students' scientific literacy. The development model used is the 4D (Four-D Models) from Thiagarajan, Semmel, & Semmel (1974), which consists of Define, Design, Develop, and Disseminate. The research also uses a mixed methods approach, namely quantitative data in the form of pretest-posttest results, validation, questionnaires, and effectiveness tests as well as qualitative data in the form of observations, interviews, and field notes. The effectiveness of the product was tested using a One Group Pretest-Posttest design, namely giving a pretest before learning using the media and a posttest after using the media. The improvement in scientific literacy skills was analyzed using Normalized Gain (N-Gain).

The development stages include: Define, Design, Develop and Disseminate

C. Population, Sample, and Research Subjects

D. Data Collection Techniques

Data collection techniques include: Expert validation, carried out by material experts, media experts, and education practitioners, Observation, used to assess the implementation and practicality of the media, Tests (pretest-posttest), used to measure the increase in students' scientific literacy, Questionnaires, used to assess students' and teachers' responses to the media Data Analysis Techniques

1. Instrument Validity Results

The instrument's content validity was assessed through expert judgment to determine its suitability for the measured aspects. Validation was conducted on instruments from subject matter experts, media experts, and learning experts. The validation results indicated that all aspects of the instrument were valid and suitable for use in research.

2. Media Validity Analysis

The media validation data were analyzed descriptively quantitatively based on the scores of the media expert validators, material experts, and learning experts using the formula:

$P = (\Sigma x / \Sigma xi) \times 100\%$. Where: P = percentage of validation results, Σx = total score obtained, Σxi = maximum score

The validator's comments and suggestions were analyzed descriptively as a basis for revising and improving the media.

3. Practicality Analysis

Practicality data was obtained through student and teacher

response questionnaires. Data were analyzed using percentages: $P = (\Sigma x / \Sigma xi) \times 100\%$

The results are used to determine responses to ease of use, attractiveness, and usefulness of media in learning.

4. Effectiveness Analysis

The effectiveness of the media was analyzed based on the increase in scientific literacy skills through pretest and posttest results using Normalized Gain (N-Gain): $N\text{-Gain} = (\text{Posttest score} - \text{Pretest score}) / (\text{Maximum score} - \text{Pretest score})$

N-Gain Classification: $0.70 \leq g \leq 1.00$ = High, $0.30 \leq g < 0.70$ = Medium, $0.00 \leq g < 0.30$ = Low

The N-Gain results are used to describe the level of improvement in students' scientific literacy skills after using Android-based Digital Snakes and Ladders media.

3. Results and Discussion

A. Research Results

The research was conducted in three elementary schools in Tilamuta District, Boalemo Regency: SDN 17 Tilamuta, SDN 11 Tilamuta, and SDN 05 Tilamuta. These three schools were selected because they are located in the same administrative area and have relatively similar learning characteristics, particularly in the use of the Merdeka Curriculum, fourth-grade science learning, and the need for Android-based digital learning media. The school facilities and infrastructure are adequate, with a stable electricity network and some students have access to smartphones. The research subjects were fourth-grade students. A limited trial involved 15 students from SDN 17 Tilamuta, while a broader trial involved 18 students from SDN 11 Tilamuta and 14 students from SDN 05 Tilamuta. Observation and interview results showed that science learning on the life cycle of living things was still dominated by lectures and textbooks. The use of Android-based digital media was not optimal, so students had difficulty understanding the stages of the life cycle sequentially and relating concepts to everyday life. Scientific literacy skills were also in the low to moderate category, and some students remained passive in discussions.

1. Objective Conditions of Learning as a Basis for Media Development

Science learning still uses lectures and textbooks as the primary sources. Android-based digital media has not been optimally utilized, resulting in less varied learning and less than optimal student engagement. Students still have difficulty understanding the stages of the life cycle sequentially, explaining scientific phenomena, interpreting simple information, and relating concepts to everyday life. Based on these conditions, visual, interactive, and easy-to-use media are needed, providing opportunities for students to read information, answer questions, discuss, and obtain feedback. The media developed integrates material on the life cycle of living things, scientific literacy-based questions, game activities, a scoring system, and feedback. The media is designed to be used via Android and in individual and group learning.

2. Product Development

The development of the Android-based digital Snakes and Ladders media uses the 4D model (Define, Design, Develop, and Disseminate). These stages are used to translate

learning conditions and student needs into a product design, which is then developed, validated, revised, and implemented in the learning process.

a. Define Stage

The Define stage was conducted to determine learning needs, student characteristics, learning materials, and scientific literacy skills. The results indicated that the media needed to present material visually and interactively, be usable via Android, integrate games with scientific literacy-based information and questions, and provide opportunities for students to read, answer questions, discuss, and obtain feedback.

b. Design Stage

In the Design stage, researchers developed an Android-based digital snakes and ladders game integrated with material on the life cycles of living things and scientific literacy indicators. The game is a modification of the traditional snakes and ladders game into an interactive digital format to support students' scientific literacy improvement. The game combines recreational, competitive, and educational elements. Students use virtual dice to move around the snakes and ladders board. Each box has a specific function, such as an information box, a scientific literacy question box, and a snakes and ladders box that influences the player's position. The game development was motivated by the lecture-dominated nature of science learning, the limited use of digital media, students' difficulties in understanding life cycles, and low scientific literacy skills. The game is expected to increase student engagement, help visualize the life cycle concept, and practice scientific literacy indicators according to PISA standards. The game material refers to the Grade IV Science Learning Outcomes of the Independent Curriculum and the Grade IV Science textbook from the Ministry of Education, Culture, Research, and Technology. The material covers the life cycles of butterflies, frogs, chickens, and plants, including the differences between complete and incomplete metamorphosis. The material is simplified into key points and integrated into the information boxes and questions on the game board. The media design was created using the Canva application with a simple and easy-to-use interface. The main page contains the media title, player score column, and "Roll the Dice" button. The game board features snakes and ladders, as well as a science literacy question box. The design was kept simple to ensure students can easily operate the media and stay focused on the game and material. A storyboard was used as the initial design for the application's appearance and flow, including menu structure, interface design, navigation, and the relevance of features to learning objectives. The developed media is an Android-based digital snakes and ladders application that integrates Android-Based Learning, Digital Game-Based Learning, Multimedia Learning, and OECD/PISA science literacy indicators on the life cycle of living things. Based on the storyboard, the application starts with a welcome page, then the user is directed to determine the number of players. Once the number of players is determined, the application displays the game rules as a guide before the game begins. During the game, players use digital dice to determine their moves on the snakes and ladders board. Each square on the game board has a specific function. If the player stops on a

square with a question mark (?), the application will display a question related to the life cycle of living things.

The questions were designed based on the OECD/PISA scientific literacy indicators, namely: explaining scientific phenomena; interpreting scientific information and evidence; understanding simple investigation processes.

If the player stops on a box with a light symbol (💡), the application will display brief information or materials about the life cycle of living things. This feature serves as a source of knowledge provided directly during gameplay. Thus, the learning process occurs in an integrated manner through gameplay activities. Students gain information, answer challenges, and receive feedback without having to leave the game environment.

(2) Application Flowchart

Flow chart The application is a description of the system workflow and navigation for using Android-based digital snakes and ladders media. This flowchart shows the user interaction process starting from opening the application, accessing the learning menu, running the game, completing the science literacy challenge, to obtaining the evaluation results. Before students use the Android-Based Digital Snakes and Ladders media, the learning activity begins with providing an initial understanding of the Life Cycle of Living Things material. The teacher conducts apperception by showing images or phenomena related to the life cycle of living things, then provides explanations and reinforcement of the basic concepts to be learned. This stage is carried out so that students have adequate initial knowledge before entering the game activity. After students understand the basic concepts, the activity continues with the use of the Android-Based Digital Snakes and Ladders media.

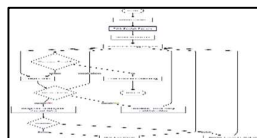


Figure 4.1 Android-Based Digital Snakes and Ladders Media Flowchart

The flowchart shows the flow of media use integrated with the learning process. Before entering the game activity, students first gain an initial understanding of the Life Cycle of Living Things material through apperception and concept reinforcement by the teacher. Next, students access the media, select the number of players, read the game rules, and enter the Digital Snakes and Ladders board. During the game, students obtain learning information in the information box and answer science literacy-based questions in the challenge box. Students' answers receive feedback and scores according to the game's mechanics until the game ends.

When the pawn stops on a certain square, the system will provide a response according to the type of square obtained.

1. Question mark box (?)

This box serves as a learning challenge. Players are

asked questions about the life cycles of living things. Feedback is provided to their answers, allowing for evaluation and reinforcement of the concepts.

2. Light box (💡)

This box serves as a source of information. Players receive brief material on the life cycles of animals and plants, making the game not only competitive but also a learning experience.

3. Regular box

Players simply continue the game according to the rules of snakes and ladders.

After all players complete the game, the app displays the final results, including scores and winners. Through this flow, the app implements the principles of Digital Game-Based Learning, combining game elements and learning objectives in a single digital environment.

(3) Hypothetical Media Model

Based on the results of the objective condition analysis, needs analysis, theoretical study, and design stage, a hypothetical model of Android-based Digital Snakes and Ladders media was developed. The hypothetical model is an initial media design that conceptually describes the relationship between learning needs, materials, game activities, and scientific literacy indicators before the product goes through a validation and trial process. The hypothetical model developed consists of several main components, namely the Life Cycle of Living Things material, an Android device as a media usage platform, the snakes and ladders game mechanism, an information box, a scientific literacy-based challenge box, a scoring system, and feedback on student answers. The use of the media is preceded by providing an initial understanding of the material by the teacher, then students use the game to obtain information, answer questions, discuss, and obtain feedback. The hypothetical model is then validated by media experts, material experts, and learning experts. Suggestions and input from the validator are used as a basis for making improvements before the media is implemented in the limited trial and wider trial stages.



Figure 4.2Hypothetical Model of Android-Based Digital Snakes and Ladders Media

3) Development

The Development stage is the stage to realize the Android-based Digital Snakes and Ladders media design into a product that can be used in learning. The process includes validation by material experts, media experts, and learning experts as well as limited trials. The media was developed using the Canva application by containing material on the Life Cycle of Living Things and scientific literacy-based questions. The initial product was consulted with the supervising lecturer before being validated. During the

validation process, improvements were made based on the validator's suggestions, such as refining the question wording, adjusting the font size, and improving the layout. The media was then tested on a limited basis with 15 fourth-grade students of SDN 17 Tilamuta. Some students were able to follow the game quickly, while some students still needed guidance in understanding the rules of the game. In general, students gave a positive response and were more enthusiastic in learning. The media was declared suitable to be continued after revisions were made based on the results of validation and limited trials.

a) Material Selection

The Android-based Digital Snakes and Ladders Media was designed with practicality, ease of use, and the characteristics of elementary school students in mind. Canva was used as the main platform to create the game board, question box, snake and ladder symbols, dice roll button, and score display. The design was adapted to the fourth grade science material, specifically the Life Cycle of Living Things. The validation process involved validators who were material experts, media experts, and education practitioners (fourth grade teachers). Input from the validators was used as the basis for revising and refining the product before being tested on students.

b) Making Learning Media

The steps for creating media include: Media is designed using Canva with a simple and easy-to-understand display for students, Creating a home page containing the title of the Educational Game Snakes and Ladders - Life Cycle of Living Things, a choice of the number of players, and a "Start Game" button, Arranging a game board of 100 squares, from Start to Finish, with snake and ladder elements, Determining the rules of the game, namely players roll the dice alternately, go up when they get a ladder, go down when they get a snake, answer the questions in the box ?, and read the information in the box 💡. The player who reaches box 100 first is declared the winner. Arrange the materials in the box 💡 in the form of brief and contextual information about the life cycle of various living creatures and the sequence of stages. Arrange the questions in the box ? in the form of multiple choice, true-false, and short answers that measure scientific literacy indicators, such as explaining the stages of the life cycle, distinguishing between complete and incomplete metamorphosis, and understanding the growth process of living things.

c) Application Appearance and Features

The Android-based digital Snakes and Ladders platform features several main interfaces that support the learning process through play. Each feature is designed to integrate educational game elements with material on the Life Cycle of Living Things and scientific literacy indicators.

(1) Display the selection of the number of players

Figure 4.3Player selection display



The initial screen of the application displays the player selection before the game begins. Users can choose between one and four players.

Available features: 1 player choice; 2 player choice; 3 player choice;

1. 4 player option.

This feature is designed to support both individual and group play. Selecting the number of players also provides flexibility in media use depending on classroom learning conditions.

(2) Display of game rules

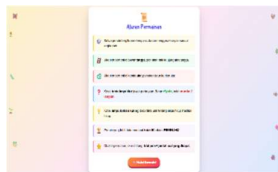


Figure 4.4 Game rules display

After determining the number of players, the application displays the game rules page. This page serves to guide users through the game's mechanics before starting the activity. Available features: rules for using dice; rules for pawn movement; rules for snakes and ladders; explanation of the question mark box (?); light box explanation (!); scoring system; rules for determining the winner.

This page explains that players who stop on a question mark box must answer the question. Correct answers earn points, while incorrect answers incur consequences according to the game's rules. Meanwhile, the light box provides interesting information about the life cycle of living things. This rules page helps students understand the game's flow and allows for effective use of the media.

(3) Digital snakes and ladders game board display



Figure 4.5 Digital snakes and ladders game board display

The game board is the app's main feature. On this page, players play a game of Snakes and Ladders using digital dice and player pawns.

Available features: digital snakes and ladders board; player pawns; dice roll button; player turn information; player position display; scoring system; special question mark and light boxes.

The game board consists of player-guided boxes featuring snakes and ladders elements. Additionally, some boxes feature special symbols that serve as learning elements. The implementation of this game board demonstrates the

concept of Digital Game-Based Learning, which is learning conducted through game activities with rules, challenges, goals, and rewards.

(4) Science Literacy Challenge Box Display (?)



Figure 4.6 Question View

The question mark box is a feature that provides a challenge in the form of a question when the player stops at a certain position.

Available features:

1. questions about the life cycle of living things;
2. answer choices;
3. answer checking system;
4. scoring.

The questions given are arranged based on scientific literacy indicators, namely:

1. Explaining scientific phenomena
Students explain the stages of the life cycle of organisms.
2. Interpreting scientific data and evidence
Students understand information based on images or scientific facts.
3. Evaluating scientific investigations
Students answer questions based on information from observations.

Through this feature, games are not only an entertainment activity, but also a means of evaluating students' conceptual understanding.

(5) Answer Feedback Display

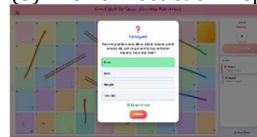


Figure 4.7 Appearance Feedback Answer

After the player answers the question in the challenge box (?), the application provides direct feedback on selected answers. The feedback feature is designed to provide information on the results of the answers while determining the consequences of the game based on the accuracy of the player's answer. Available features: correct or incorrect answer information; scoring; game consequences for incorrect answers; and a continue game button. If the player answers the question correctly, the application will provide a positive response in the form of a score of +5 points. This score will be recorded in the game results as a form of appreciation for the player's success in answering the learning challenge. If the player answers the question incorrectly, the application will display feedback in the form of information that the answer is not correct and the player will receive a game consequence of moving back 2 or 3 steps according to the predetermined rules. This mechanism makes the game activity not only oriented towards achieving the final position, but also considers the

student's understanding of the material. Players who are able to answer questions correctly will receive a higher score, while players who make mistakes must accept the consequences as part of the game rules. The implementation of this scoring and consequence system is a form of implementing the principle of gamification, namely the use of game elements such as challenges, rules, scores, and feedback to increase student motivation and engagement in learning. In the learning aspect, direct feedback helps students reflect on their understanding of the life cycle of living things. Students can find out whether the concepts they understand are correct or still need to be improved through the information provided by the application.

(6) Display of the Information Box for the Life Cycle of Living Things (📄)



Figure 4.8 Unique Information/Facts Display

The light box is a feature that provides learning information when the player stops on a certain box.

Available features: brief information about the life cycle of organisms; simple scientific facts; sequence of stages of development of living things.

An example of the information provided is the life cycle of fish:

Eggs → Larvae → Baby fish → Adult fish

Presenting information concisely and visually helps students understand the concept of the life cycle of living things more concretely.

This feature supports the principles of Multimedia Learning, because information is presented through a combination of text and visual elements.

(7) Final Game Result Display



Figure 4.9 Final Game Result Display

After the game is finished, the application displays the final result of the game.

Available features: winning player information; each player's score; number of questions obtained; final score calculation. The final result of the game rewards players and serves as a form of evaluation of student engagement during the media use. Based on the development results, the Android-based digital snakes and ladders media has features that integrate gameplay and learning. These features include player selection, game rules, a snakes and ladders board, and an information box (📄), challenge box (❓), feedback, and final results show that the application functions not only as a digital game, but also as an interactive learning medium. Through the integration of Digital Game-Based Learning,

Multimedia Learning, and OECD/PISA science literacy indicators, this application provides a learning experience that allows students to understand the concept of the life cycle of living things through engaging and meaningful play activities.

d) Product Revision

Product revisions were conducted after receiving suggestions and input from material expert validators. Product revision is an important stage in development research that aims to refine the product to suit the learning needs and characteristics of students. Through the revision process, the developed media is improved based on the validation results so that the product quality improves before being implemented in the field trial stage. In this study, revisions were made to the Android-Based Digital Snakes and Ladders media based on the validation results from material experts. The validators provided several inputs related to media usage instructions, the sequence of material presentation, and the appearance of the writing on the learning media. All of these inputs were used as the basis for refining the product so that the media was easier to use, the material more systematic, and the information presented was easier for students to understand. The revision process was carried out thoroughly by paying attention to aspects of material content and media appearance so that the developed media could support the learning process optimally. The results of the product revision that had been carried out were based on the suggestions of material expert validators. Based on all stages of development and revision, the final product was an Android-Based Digital Snakes and Ladders media for fourth-grade science learning on the Life Cycle of Living Things material. The media adapted the snakes and ladders game in digital form by integrating learning materials and scientific literacy activities. The media is equipped with a selection of the number of players, digital dice, pawns, game board, information box (📄), challenge box (❓), answer feedback, scoring system, and display of final game results.

4) Disseminate Stage (Spreading)

The dissemination stage is the final stage of the 4D development model to implement a product that has been declared valid and suitable for use. Dissemination begins with a limited trial to determine understanding of media use, material readability, and student responses. The results showed that students were able to use the media well after receiving instructions, were enthusiastic, actively answered questions, and were able to participate in the game independently. After refinement, the media was implemented in a field trial at SDN 17 Tilamuta, SDN 11 Tilamuta, and SDN 05 Tilamuta. Learning began with a pretest, then students were divided into groups of 3–4 people with one Android device. The teacher provided conceptual reinforcement and explained the instructions and rules of the game. Students read information, answered scientific literacy-based questions, discussed the content, and received feedback from the application. After the activity, students conducted reflections and a posttest, while students and teachers completed a response questionnaire

to determine the practicality of the media. The implementation results showed that the media can be used well by students and teachers, creating more interactive learning, increasing student participation, and providing learning experiences through a play-while-learning approach.

3. Validity of Android-Based Digital Snakes and Ladders Media

Media validity was determined based on the assessment of three validators, namely media experts, material experts, and learning experts. Validation was conducted to determine the feasibility of the product before use in learning trials, including the appearance and technical aspects of the media, the suitability of the material, and media support for fourth-grade science learning. Media expert validators assessed the visual appearance, design, readability, navigation, and ease of use. Material expert validators assessed the suitability of the content with the fourth-grade science learning outcomes, the accuracy of the concept of the life cycle of living things, and the suitability of the material and questions. Learning expert validators assessed the implementation of media use, suitability with the characteristics of fourth-grade students, and ease of application in learning. The assessment results and suggestions of validators were used as a basis for revision so that the media used had gone through an assessment and refinement process.

a) Media Expert Validation

Media expert validation was conducted to assess the feasibility of the media from the aspects of appearance, navigation, visual quality, and design consistency, as well as to ensure that the Android-based Digital Snakes and Ladders media meets technical feasibility standards before being applied in learning.

Media Suitability Percentage Calculation Formula:

$$P = \frac{\sum x}{\sum x_i} \times 100\%$$
$$P = \frac{37}{40} \times 100\%$$
$$P = 92,5\%$$

Information:

P= Percentage of eligibility score

$\sum x$ = Total score obtained from media expert validators

$\sum x_i$ = Total maximum score that can be obtained

Based on the calculation results, the Android-based digital snakes and ladders media achieved a percentage of 92.5%, making it included in the very suitable (Valid) category for use in science learning on the life cycle of living things. Despite achieving the very suitable category, the media expert validator provided several suggestions for improving the product before it was used in the trial phase. These suggestions related to the clarity of the game rules, refinement of the illustrations, and improvements to the

game board's appearance.

Based on the validator's input, the researchers revised the product before using it in the trial. Improvements were primarily made to readability, clarity of instructions, and improvements to the application's visual appearance. These revisions made the media easier for students to use and supported the creation of an interactive learning experience. Therefore, the media expert validation results indicated that the Android-based digital snakes and ladders media met the eligibility criteria and could proceed to the implementation stage after improvements were made based on the validator's suggestions.

b) Validation by Material Experts

The validation by material experts aims to assess the appropriateness of the learning media content based on its suitability with the life cycle material of living things in the fourth grade science learning, its suitability with the Learning Outcomes, and the accuracy and completeness of the concepts presented. The validation process is carried out by material expert validators who have competence in the field of elementary school science learning. This validation activity is carried out to ensure that the material presented in the digital snakes and ladders media is in accordance with the applicable curriculum and does not contain conceptual errors.

Calculation Formula for the Percentage of Material Expert Validation

$$P = \frac{\sum x}{\sum x_i} \times 100\%$$
$$P = \frac{37}{40} \times 100\%$$
$$P = 92,5\%$$

Information:

- P = Percentage of eligibility score
- $\sum x$ = Total score obtained from the material expert validator (37)
- $\sum x_i$ = Total maximum score that can be obtained (40)

Based on the calculation results, the Android-based digital snakes and ladders media obtained a percentage of 92.5%, so it is included in the very feasible (Valid) category and is suitable for use in science learning on the life cycle of living things. Although it obtained the very feasible category, the material expert validator provided several inputs to improve the product before it was used in the trial stage. These inputs relate to aspects of readability, clarity of material presentation, and instructions for using the media. Based on the results of the revision, the Android-based digital snakes and ladders media underwent improvements in the content and presentation aspects. Improvements were made so that the material presented was not only conceptually correct, but also easy for students to understand and support the interactive science learning process. Thus, the results of the material expert validation indicate that the developed media has met the eligibility criteria and can be continued to the next development stage after revisions are made according to the validator's suggestions.

c) Learning Expert Validation

Validation by learning experts aimed to assess the media's

feasibility in terms of its implementation in classroom learning, suitability to the characteristics of fourth-grade students, and practicality. Based on the assessment results from the learning expert validators, the media was deemed suitable for use in the learning process. The validators stated that the media had an attractive appearance, easy-to-understand game rules, and material appropriate to the developmental level of elementary school students. Furthermore, the use of games in learning was deemed capable of increasing learning motivation and fostering students' curiosity about the life cycle of living things.

Expert Learning Validation Percentage Calculation Formula

$$P = \frac{\sum x}{\sum x_i} \times 100\%$$

$$P = \frac{75}{84} \times 100\%$$

$$P = 89\%$$

Information:

- P= Percentage of eligibility score
- $\sum x$ = Total score obtained from education practitioners (75)
- $\sum x_i$ = Total maximum score (84)

Based on the calculation results, the Android-based digital snakes and ladders media obtained a percentage of 89%, so it is included in the Very Feasible (Valid) category and is very suitable for use in fourth-grade science learning on the life cycle of living things. Although it received a Very Feasible category, the learning expert validator provided several suggestions for product improvement before it is used in the trial phase.

Some of the input provided by the validator includes: Media is expected to be able to be used without relying on an internet network, Images and illustrations used need to be more adapted to the material on the life cycle of living things, Media needs to be ensured to be in accordance with the learning objectives to be achieved.

Based on the revisions, the Android-based digital snakes and ladders game underwent improvements in terms of appearance, learning content, and usability. These improvements ensured that the game was not only engaging but also effectively supported the science learning process. Therefore, validation by learning experts indicated that the Android-based digital snakes and ladders game met the eligibility criteria and could proceed to the student trial phase.

d. Recapitulation of Validity Results

The recapitulation of validity results was carried out based on the assessment of three validators, namely the media expert validator, the material expert validator, and the learning expert validator. Validation aims to determine the level of feasibility of the Android-Based Digital Snakes and Ladders media before it is used in the learning trial stage. The assessment was carried out on aspects of media, material, and learning according to the instruments that have been prepared. The results of the assessment from each validator were then calculated in the form of a percentage and interpreted based on the established validity criteria. The recapitulation results were used to determine whether the developed media had met the feasibility criteria for use in fourth-grade science learning on the life cycle of living

things. Media expert validation was carried out by Dr. Rustam I. Husain, S.Ag., M.Pd. The validation instrument consisted of 10 statement items covering aspects of visual appearance, content suitability, and ease of use of the media. The validator provided an assessment using a scale of 1 to 4, where score 1 = not good, score 2 = less good, score 3 = good, and score 4 = very good. The following is the recapitulation result of the media expert validator's assessment.

The calculation of the percentage of media suitability is done as follows:

$$P = \frac{\sum x}{\sum x_i} \times 100\%$$

$$P = \frac{37}{40} \times 100\%$$

$$P = 92,5\%$$

Information:

- P= Percentage of eligibility score
- $\sum x$ = Total score obtained from media expert validators
- $\sum x_i$ = Total maximum score that can be obtained

Based on the calculation results, a percentage of 92.5% was obtained. Based on the assessment category, the Android-based Digital Snakes and Ladders media is very feasible (valid) because it has fulfilled the aspects of visual appearance, content suitability, and ease of use. Validation by material experts was carried out by Dr. Gamar Abdullah, S.Si., M.Pd. in April 2026 to assess the learning aspects, curriculum suitability, and material content. The validator provided suggestions in the form of adding user instructions, improving the sequence and completeness of the material, and improving the appearance of the text. Based on these suggestions, revisions were made by adding user instructions, improving the presentation and completeness of the material, and clarifying the appearance of the text. After the revision, the results of the revalidation showed that the media had fulfilled the aspects of learning, curriculum suitability, and material content so that it was suitable for use in the trial stage. The material expert validation instrument consisted of 10 indicators with a rating scale of 1 to 4, namely a score of 1 = not good, 2 = less good, 3 = good, and 4 = very good.

Calculation Formula for the Percentage of Material Expert Validation

$$P = \frac{\sum x}{\sum x_i} \times 100\%$$

$$P = \frac{37}{40} \times 100\%$$

$$P = 92,5\%$$

Information:

- P= Percentage of eligibility score
- $\sum x$ = Total score obtained from the material expert validator (37)
- $\sum x_i$ = Total maximum score that can be obtained (40)

Based on the calculation results, a percentage of 92.5% was obtained. Based on the assessment category used, the results are included in the very feasible (valid) category. Thus, the Android-Based Digital Snakes and Ladders media is declared suitable for use as a learning medium after revisions are made in accordance with the suggestions given by the material expert validator.

Validation of learning experts on the Android-Based Digital Snakes and Ladders media was carried out by Dr. Kudus, S.Pd., M.Pd. This validation aims to determine the feasibility of the media from the aspects of media practicality, media display, graphic feasibility, safety of use, suitability with the curriculum, material provisions, and suitability with the character of students. The assessment was carried out using a validation instrument consisting of 21 indicators with an assessment scale of 1 to 4, where score 1 = not good, score 2 = less good, score 3 = good, and score 4 = very good. The following is the recapitulation of the assessment results from the learning expert validator.

Expert Learning Validation Percentage Calculation Formula

$$P = \frac{\sum x}{\sum x_i} \times 100\%$$

$$P = \frac{75}{84} \times 100\%$$

$$P = 89\%$$

Information:

- P= Percentage of eligibility score
- $\sum x$ = Total score obtained from Learning Experts (75)
- $\sum x_i$ = Total maximum score (84)

Based on the calculation results, a percentage of 89% was obtained. Based on the assessment categories used, the results are included in the very feasible (valid) category. This shows that the Android-based Digital Snakes and Ladders media developed has fulfilled the learning aspects which include practicality of use, media display, graphic feasibility, security of use, curriculum suitability, material provisions, and suitability with student characteristics. Thus, the developed media is suitable for use in the learning trial stage. The feasibility analysis was carried out based on the validation results provided by three validators, namely media expert validators, material expert validators, and learning expert validators. This validation aims to determine the level of feasibility of the Android-based Digital Snakes and Ladders media to Improve Elementary School Students' Science Literacy on the Life Cycle of Living Things Material before being applied to the field trial stage. The validation results from each validator show that the developed media has fulfilled the aspects of media display, material suitability, ease of use, and learning aspects. The percentage of validation results obtained from the three validators. Based on the results of data analysis from the three validators, an average percentage value of 91.33% was obtained with a very valid category. The Android-based Digital Snakes and Ladders media has met the eligibility criteria in terms of media, materials, and learning. The media has an attractive appearance, the materials are in accordance with the achievements and objectives of science learning, and are easy to use by teachers and students. Thus, the media is suitable for use as a learning medium and is continued to the field trial stage to determine its practicality and effectiveness in improving elementary school students' scientific literacy. The practicality of the Android-based Digital Snakes and Ladders media was carried out to determine the level of ease of use of the media on the Life Cycle of Living Things material. Data were obtained through student and teacher response

questionnaires after using the media. Practicality analysis was used to determine whether the media is easy to use, interesting, and can help the learning process in the classroom. Student response questionnaires were given to 47 students who participated in the field trial activities.

Formula:

$$P = \frac{\sum x}{\sum x_i} \times 100\%$$

$$P = \frac{1565}{1692} \times 100\%$$

$$P = 92,61\%$$

Information:

P= Percentage of practicality score
 $\sum x$ = Total score obtained
 $\sum x_i$ = Total maximum score

Based on the table above, the results of the practicality analysis from students obtained a percentage of 92.61% with a very practical category. These results indicate that the Android-based Digital Snakes and Ladders media is easy to use, interesting, helps students understand the material on the Life Cycle of Living Things, and increases interest and motivation during learning. The developed media can be well received by students because it provides a different learning experience from conventional learning. Student interest is seen from the use of digital dice, pawn movements, challenge boxes (?), information box (?), and a scoring system that makes students more active in playing, answering questions, and making decisions. Information box (?) helps students gain additional understanding of the life cycle of living things in a contextual manner, while the challenge box (?) helps recall concepts through scientific literacy-based questions. In the initial stages of use, some students still needed guidance in understanding the game rules and scoring mechanisms. After being given an explanation, students were able to follow the game flow independently. Thus, the Android-based Digital Snakes and Ladders media meets the practical aspect because it is easy to use, interesting, and able to increase student engagement in science learning. In addition to student responses, the practicality of the media was also assessed through a teacher response questionnaire after using the media in the learning process.

Formula:

$$P = \frac{\sum x}{\sum x_i} \times 100\%$$

$$P = \frac{35}{36} \times 100\%$$

$$P = 97,22\%$$

Based on the analysis results, the practicality of the media from teacher responses obtained a percentage of 97.22% with a very practical category. The Android-based digital snakes and ladders media is considered easy to use and can support science learning on the life cycle of living things. Teachers gave positive responses to the clarity of instructions, display, visual appeal, and the media's ability to assist in delivering the material. The flow of media use is systematically arranged, starting from selecting the number of players, game rules, use of dice, to providing questions

and learning information. The game concept also makes learning more interactive through the activity of moving pawns, answering questions in the challenge box, and obtaining information through the information box. On the indicator of media use without complicated additional devices, teachers gave a score of 3 with a practical category because the application requires an Android smartphone. Therefore, the readiness of supporting facilities is needed so that the media can be used optimally. Based on teacher responses, the Android-based digital snakes and ladders media meets the practical aspect because it has easy operation, clear usage procedures, and is able to support student engagement in learning. Effectiveness analysis was conducted to determine the effectiveness of the media in improving elementary school students' scientific literacy on the Life Cycle of Living Things material. Effectiveness data was obtained through pretests and posttests before and after using the learning media. The effectiveness test was conducted on 47 fourth-grade students from SDN 17 Tilamuta, SDN 11 Tilamuta, and SDN 05 Tilamuta. The pretest was given to determine the initial scientific literacy abilities, while the posttest was given after learning using the media to determine the improvement of students' scientific literacy abilities. Based on the description, it is known that the average pretest score of students was 58.50. This value indicates that students' initial scientific literacy abilities are still in the moderate category. After the learning process using the Android-Based Digital Snakes and Ladders media, the average posttest score increased to 89.80. This increase indicates that the media developed is able to help students understand the Life Cycle of Living Things material better. To determine the description of the improvement of students' scientific literacy abilities before and after using the Android-Based Digital Snakes and Ladders media, a descriptive statistical analysis was conducted on the pretest and posttest scores. The results of the descriptive statistical analysis are presented in the following table. Based on the results of descriptive statistical analysis, the average pretest score was 58.50 with a standard deviation of 3.141, while the average posttest score was 89.80 with a standard deviation of 2.570. The pretest standard deviation of 3.141 indicates that students' initial abilities regarding the life cycle of living things are still varied. After learning using the Android-based digital snakes and ladders media, the standard deviation decreased to 2.570, which indicates that students' scores were closer to the average and their scientific literacy skills became more evenly distributed. The decrease in the standard deviation indicates that the Android-based digital snakes and ladders media not only increased the average score, but also provided a relatively uniform and more consistent increase in most students. In addition, the minimum pretest score increased from 50 to 84, while the maximum score increased from 64 to 95 in the posttest. This indicates an increase in students' scientific literacy skills after participating in learning using the developed media. To determine the level of improvement in students' scientific literacy skills, an analysis was conducted using the N-Gain formula as follows:

$$g = \frac{\text{Posttest} - \text{Pretest}}{\text{Skor Maksimal} - \text{Pretest}}$$

The calculation results show that the N-Gain value is 0.75 and is included in the high category. The increase in scientific literacy skills is seen from the average pretest score of 58.50 to 89.80 in the posttest, with an average difference of 31.30 points. All students also showed an increase in scores after participating in learning using the Android-Based Digital Snakes and Ladders media. This increase indicates that the Android-Based Digital Snakes and Ladders media can support students in understanding the concept of the life cycle of living things through interactive and game-based learning. The media provides opportunities to obtain information, answer questions, discuss, and obtain feedback so as to help connect concepts with phenomena in everyday life. The increase in scientific literacy skills includes the ability to understand concepts, explain scientific phenomena, interpret information, and apply scientific knowledge to the material of the life cycle of living things. Thus, based on the increase in pretest and posttest and the N-Gain of 0.75 in the high category, the Android-Based Digital Snakes and Ladders media shows effectiveness in supporting the improvement of students' scientific literacy skills.

B. Discussion

1. Feasibility of Android-Based Digital Snakes and Ladders Media

The results of the study indicate that the Android-based Digital Snakes and Ladders media obtained a very feasible category based on validation by material experts, media experts, and learning experts. The product meets the feasibility aspects in terms of learning content, display quality, and implementation of use in elementary school science learning. The feasibility of the material shows that the content is in accordance with the Fourth Grade Science Learning Outcomes, especially the material on the life cycle of living things. The material is integrated into game activities through information boxes and challenge boxes so that students acquire concepts through reading information, observing illustrations, and answering questions. The presentation is in accordance with the Cognitive Theory of Multimedia Learning (CTML) which explains that the combination of verbal and visual information can help students understand concepts more concretely. From the media aspect, feasibility is influenced by the use of visual and interactive elements such as digital game boards, snakes and ladders, pawns, dice, scores, challenge boxes, and information boxes. This is in accordance with Piaget's cognitive development theory that elementary school students are at the concrete operational stage so that learning is easier to understand through objects, images, or experiences that can be directly observed. The use of game concepts supports the principles of Digital Game-Based Learning (DGBL), because rules, challenges, scores, and feedback make students active in the learning process. This research has different characteristics because it integrates OECD/PISA scientific literacy indicators through questions that train the ability to explain scientific phenomena, interpret scientific information, and apply scientific concepts in everyday life.

2. Practicality of Android-Based Digital Snakes and Ladders Media

The media was categorized as very practical based on

teacher and student responses. Practicality was evident in its ease of use, attractive appearance, understandable game instructions, and its application in fourth-grade science learning. According to teacher responses, the media has a systematic usage flow, starting from selecting the number of players, game rules, use of digital dice, pawn movement, to providing questions and learning information. A clear structure helps teachers manage learning and provide more varied learning alternatives. Positive student responses indicate that the media is able to create an interesting learning experience and actively engage students. Game elements such as dice, pawns, scores, challenge boxes, and information boxes increase student motivation. Students not only receive information but also answer questions, understand scientific information, and accept game consequences based on their answers. The media also has mobile learning characteristics, namely flexible access, ease of use, and the ability to support learning in various situations. Interaction occurs through the activities of selecting the number of players, moving pawns, answering questions, obtaining scores, and receiving feedback. The application of DGBL is also evident in the game's objectives, rules, scientific literacy challenge questions, and scoring system. The use of games provides a learning experience through learning by doing, allowing students to explore concepts, make decisions, and receive reinforcement during the game. This research is different because the media is not only game-oriented, but also supports the development of scientific literacy through OECD/PISA indicators.

3. The Effectiveness of Android-Based Digital Snakes and Ladders Media in Improving Students' Scientific Literacy
The results of the study indicate that the Android-based Digital Snakes and Ladders media is able to improve students' scientific literacy skills on the Life Cycle of Living Things material. Based on the N-Gain analysis, the media obtained a high improvement category, which indicates a positive contribution to improving students' understanding. This improvement occurs because the media not only presents information, but also provides opportunities for students to build understanding through play activities. Students obtain information through information boxes, then test their understanding through challenge boxes. These activities involve the process of observing, understanding, explaining, and applying scientific concepts. According to the OECD/PISA scientific literacy framework, scientific literacy includes the ability to use scientific knowledge to explain phenomena, interpret scientific information, and make decisions based on evidence. The media also uses a combination of images, illustrations, short texts, and interactive activities that are in accordance with the Cognitive Theory of Multimedia Learning. The improvement of scientific literacy is also influenced by the application of DGBL through rules, objectives, challenges, scores, and feedback. Students are involved in decision-making, answering questions, and evaluating the results of their answers through application feedback. The effectiveness of the media takes place in fourth-grade science learning with small groups of 3–4 students and one Android device per group. The teacher acts as a facilitator, providing direction, guiding discussions, and assisting students when they encounter difficulties. Learning is also

supported through information boxes, scientific literacy-based questions, group discussions, and reflections. Therefore, media effectiveness is achieved when the media is used in a targeted manner, adequate Android devices are available, students work in small groups, teachers provide guidance, and game activities are integrated with scientific literacy-based questions and discussions. This study has the advantage of using digital games not only to increase motivation and conceptual understanding but also specifically integrate OECD/PISA scientific literacy indicators. Questions in the challenge boxes train the ability to explain phenomena, understand scientific information, and apply scientific concepts. The use of the Android platform also provides easy access and interactivity that are in line with 21st-century learning.

4. Conclusion

Based on the results of research and development of Android-based digital Snakes and Ladders media to improve elementary school students' scientific literacy on the material of the Life Cycle of Living Things, it can be concluded as follows: 1. The objective conditions of science learning on the material of the Life Cycle of Living Things in the school that is the location of the research show that learning is still dominated by teacher explanations and the use of textbooks, while the use of Android-based digital learning media is not optimal. The results of the needs analysis indicate the need for visual, interactive, easy-to-use learning media via Android devices, integrating materials with game activities, and containing questions and feedback that support scientific literacy. The objective conditions and results of the needs analysis are the basis for the development of Android-based digital Snakes and Ladders media. 2. Android-based digital Snakes and Ladders media meets the validity criteria for use in science learning on the material of the Life Cycle of Living Things. The results of the media expert validation obtained a percentage of 92.5%, the validation of the material expert was 92.5%, and the validation of the learning expert was 89%. The average validation result from the three validators was 91.33% with a very valid category. These results indicate that the media developed has met the aspects of feasibility of content, appearance, and learning. 3. Android-based Digital Snakes and Ladders media meets the criteria of practicality based on teacher and student responses. The results of student responses obtained a percentage of 92.61% with a very practical category, while the teacher's response obtained a percentage of 97.22% with a very practical category. These results indicate that the media is easy to use and can be applied in the science learning process on the Life Cycle of Living Things material. 4. Android-based Digital Snakes and Ladders media meets the criteria of effectiveness in improving students' scientific literacy. Based on the results of the pretest and posttest, an increase in the average value of students' scientific literacy abilities was obtained from 58.50 to 89.80. The results of the analysis using N-Gain obtained a value of 0.75 with a high category, thus indicating an increase in students' scientific literacy abilities after using Android-based Digital Snakes and Ladders media.

BIBLIOGRAPHY

- [1]. Al-Emran, M., Elsherif, H.M., & Shaalan, K. (2016). Investigating attitudes towards the use of mobile learning in higher education. *Computers in Human Behavior*, 56, 93-102. <https://doi.org/10.1016/j.chb.2015.11.033>
- [2]. Ambarsari, Z. (2024). Using Instagram as a medium for learning Indonesian language and literature in the 4.0 era. *Syiar: Journal of Islamic Communication and Broadcasting*, 4(1), 31-42. <https://digilib.unimed.ac.id/id/eprint/41225/1/Fulltext.pdf>
- [3]. Arikunto, S. (2010). *Research procedures: A practical approach*. Rineka Cipta.
- [4]. Arsyad, A. (2013). *Learning media*. RajaGrafindo Persada.
- [5]. Central Statistics Agency of Boalemo Regency. (2024). *Boalemo Regency in figures 2024*. BPS Boalemo Regency.
- [6]. Bybee, R. W. (1997). *Achieving scientific literacy: From purposes to practices*. Heinemann.
- [7]. Campbell, NA, Reece, JB, Urry, LA, Cain, ML, Wasserman, SA, Minorsky, PV, & Jackson, RB (2020). *Biology* (12th ed.). Pearson.
- [8]. Cholid, N., & Achmadi, A. (2001). *Research methodology*. Bumi Aksara.
- [9]. Clark, D. B., Tanner-Smith, E. E., & Killingsworth, S. S. (2016). Digital games, design, and learning: A systematic review and meta-analysis. *Review of Educational Research*, 86(1), 79-122. <https://doi.org/10.3102/0034654315582065>
- [10]. Connyta Elvadola, C., Kurniasih, TI, Juwantara, RA, & Rahmawati, E. (2025). Development of digital snakes and ladders game media in science subjects in elementary schools. *Journal of Law and Social Sciences Cendekia Library*, 2(3), 353-362. <https://doi.org/10.70292/pchukumsosial.v2i3.90>
- [11]. Crompton, H. (2013). A historical overview of mobile learning: Toward learner-centered education. In ZL Berge & LY Muilenburg (Eds.), *Handbook of mobile learning* (pp. 3-14). Routledge.
- [12]. Deterding, S., Dixon, D., Khaled, R., & Nacke, L. (2011). From game design elements to gamefulness: Defining gamification. In *Proceedings of the 15th International Academic MindTrek Conference* (pp. 9-15). ACM. <https://doi.org/10.1145/2181037.2181040>
- [13]. Dewi, NLPAS, Rati, NW, & Sukmana, AIWIY (2022). E-KOMED learning media on the topic of the life cycle of living things for grade IV elementary school. *Journal of Pedagogy and Learning*, 5(3), 455-464. <https://doi.org/10.23887/jp2.v5i3.49243>
- [14]. Dewi, NLPAS, Sholihah, N., & Riyan, A. (2022). Contextual science learning in improving elementary school students' scientific literacy. *Indonesian Journal of Elementary Education*, 9(1), 45-58.
- [15]. Dita, P. (2022). The importance of learning media in improving learning achievement. *Early Childhood Islamic Education Journal*, 3(1), 73-85. <https://doi.org/10.58176/eciejournal.v3i01.679>
- [16]. Fadilah, A., Nurzakiyah, KR, Kanya, NA, Hidayat, SP, & Setiawan, U. (2023). Understanding media, objectives, functions, benefits and urgency of learning media. *Journal of Student Research*, 1(2), 1-17.
- [17]. Fitriani, L. (2022). The effect of using snakes and ladders media on science learning motivation. *Journal of Science Learning Innovation*.
- [18]. Fosnot, C. T., & Perry, R. S. (2020). *Constructivism: A psychological theory of learning*. In CT Fosnot (Ed.), *Constructivism: Theory, perspectives, and practice*. Teachers College Press.
- [19]. Gagné, R. M. (1985). *The conditions of learning and theories of instruction* (4th ed.). Holt, Rinehart and Winston.
- [20]. Gee, J. P. (2007). *What video games have to teach us about learning and literacy* (2nd ed.). Palgrave Macmillan.
- [21]. Gormally, C., Brickman, P., & Lutz, M. (2012). Developing a test of scientific literacy skills (TOSLS): Measuring undergraduates' evaluation of scientific information and arguments. *CBE—Life Sciences Education*, 11(4), 364-377. <https://doi.org/10.1187/cbe.12-03-0026>
- [22]. Hwang, G. J., & Chang, C. Y. (2021). A review of opportunities and challenges of mobile learning in education. *Interactive Learning Environments*, 29(6), 1-15.
- [23]. Ibrahim, A., et al. (2018). *Research methodology*. Gunadarma Science.
- [24]. Istiqlal, A. (2018). Benefits of learning media in the learning and teaching process. *Journal of School Leadership and Administration*, 3(2), 139-144. <https://ejurnal.stkip-pessel.ac.id/index.php/kp/article/view/280/191>
- [25]. Kartika, D., & Kurniawati, A. (2021). Educational games as a medium for science learning. *SNPASCA Proceedings*, 5(1), 45-52.
- [26]. Ministry of Education, Culture, Research, and Technology. (2022). *Learning and assessment guidelines for early childhood education, primary education, and secondary education*. Ministry of Education, Culture, Research, and Technology.
- [27]. Krajcik, J., & Czerniak, C. (2023). *Teaching science in elementary and middle school: A project-based learning approach* (6th ed.). Routledge.
- [28]. Kusuma Ardi, SD, & Dessty, A. (2023). Snakes and Ladders learning media to increase students' numeracy learning motivation in elementary schools. *Learning Tools Development Bulletin*, 5(1). <https://doi.org/10.23917/bppp.v5i1.22934>
- [29]. Lamada, H., Abdullah, G., Arif, RM, Panai, AH, & Arifin, VM (2025). Development of ULTRA (Interactive Snakes and Ladders for Science) learning media to improve student learning outcomes in elementary schools. *SINERGI: Scientific Research Journal*, 2(3), 1443-1454. <https://doi.org/10.62335/sinergi.v2i3.1029>
- [30]. Lestari, P., Sari, EFP, & Ayu, IR (2025). The effect of the Teams Games Tournament learning model assisted by jellyfish media on mathematics learning outcomes. *Bangkiring Journal of Educational and Learning Innovation*. <https://journal.bangkiringjaya.org/index.php/bjipp/a>

- rticle/view/2
- [31]. Mayer, R.E. (2020). *Multimedia learning* (3rd ed.). Cambridge University Press.
 - [32]. Muhson, A. (2010). Development of information technology-based learning media. *Indonesian Journal of Accounting Education*, 8(2), 1–10. <https://doi.org/10.21831/jpai.v8i2.949>
 - [33]. Muhtarom, M., et al. (2016). Development of a questionnaire on beliefs about problem solving and mathematics learning. *Scientific Journal of Mathematics Education*, 2(1).
 - [34]. Narbuko, C., & Achmadi, A. (2001). *Research methodology*. Bumi Aksara.
 - [35]. National Research Council. (2012). *A framework for K-12 science education: Practices, crosscutting concepts, and core ideas*. The National Academies Press. <https://doi.org/10.17226/13165>
 - [36]. Norris, S. P., & Phillips, L. M. (2003). How literacy in its fundamental sense is central to scientific literacy. *Science Education*, 87(2), 224–240. <https://doi.org/10.1002/sce.10066>
 - [37]. Novita, L., Sundari, FS, & Rabani, KR (2020). Application of digital snakes and ladders game media to improve thematic learning outcomes. *Journal of Elementary School Thinking and Development*, 8(2), 126–137.
 - [38]. Nugrahani, R., & Rupa, JS (2017). Visual-based learning media in the form of a snakes and ladders game to improve the quality of teaching and learning in elementary schools. *Educational Science Sheet*, 36(1), 35–44. <https://journal.unnes.ac.id/nju/LIK/article/view/524/481>
 - [39]. Nuraini, E. (2019). Using snakes and ladders media to improve science learning outcomes of fifth grade elementary school students. *Elementary School Mimbar*, 6(3), 123–131.
 - [40]. OECD. (2019). *PISA 2018 assessment and analytical framework: Science, reading, mathematics and financial literacy*. OECD Publishing.
 - [41]. OECD. (2019). *PISA 2018 results: What students know and can do*. OECD Publishing.
 - [42]. OECD. (2023). *PISA 2022 assessment and analytical framework: Mathematics, reading, science and financial literacy*. OECD Publishing.
 - [43]. OECD. (2023). *PISA 2022 results (Volume I): The state of learning and equity in education*. OECD Publishing.
 - [44]. Oktasari, W. (2019). Development of Android application-based science snakes and ladders learning media to improve understanding of science concepts in grade III elementary school/Islamic elementary school students.
 - [45]. Prensky, M. (2001). *Digital game-based learning*. McGraw-Hill.
 - [46]. Purwanti, S., & Anggraini Putri, RZ (2021). Development of a HOTS-based module on theme 6, comparing the life cycles of living things, for fourth grade elementary school. *Elementary School: Journal of Elementary School Education and Learning*, 8(1), 155–160. <https://doi.org/10.31316/esjurnal.v8i1.1080>
 - [47]. Rahmawati, Y., Ridwan, A., & Hadinugrahaningsih, T. (2022). Developing scientific literacy through digital learning environments. *Journal of Science Education and Technology*, 31, 1–14.
 - [48]. Ratnawulan, E., & Rusdiana. (2014). *Learning evaluation*. Pustaka Setia.
 - [49]. Rayanto, YH, & Sugianti. (2020). *ADDIE model development research and R&D: Theory and practice*. Lembaga Academic & Research Institute.
 - [50]. Riyan, M. (2021). The use of Android-based learning media in expository text learning. *Diksi*, 29(2), 205–216. <https://doi.org/10.21831/diksi.v29i2.36614>
 - [51]. Rosa Yuliana, Firdaus, M., & Oktaviana, D. (2022). Development of an Android-based mathematics educational game using Construct 2 software for improving mathematical comprehension. *Journal of Mathematics and Natural Sciences Research*, 1(1), 82–90. <https://doi.org/10.55606/jurrimipa.v1i1.281>
 - [52]. Sadiman, AS, Rahardjo, R., Haryono, A., & Harjito. (2010). *Educational media: Definition, development, and utilization*. Rajawali Pers.
 - [53]. Sailer, M., & Homner, L. (2020). The gamification of learning: A meta-analysis. *Educational Psychology Review*, 32, 77–112.
 - [54]. Samatowa, U. (2011). *Science learning in elementary schools*. Index.
 - [55]. Siregar, S. (2010). *Descriptive statistics for research*. Rajawali Press.
 - [56]. Smaldino, S. E., Lowther, D. L., & Mims, C. (2019). *Instructional technology and media for learning* (12th ed.). Pearson.
 - [57]. Sudijono, A. (2012). *Introduction to educational statistics*. RajaGrafindo Persada.
 - [58]. Sudjana. (1989). *Statistical methods*. Tarsito.
 - [59]. Sugiyono. (2019). *Educational research methods*. Alfabeta.
 - [60]. Sugiyono. (2022). *Research and Development (R&D) Methods*. Alfabeta.
 - [61]. Suharsimi, A. (2010). *Research procedures: A practical approach*. Rineka Cipta.
 - [62]. Sunarti, S., Amril, M., & Vebrianto, R. (2020). Development of science snakes and ladders learning media to support understanding of science learning concepts in elementary schools. *EduHumaniora: Journal of Elementary Education*, 12(1).
 - [63]. Suprihatin, S., & Wulandari, R. (2020). The effectiveness of snakes and ladders media on science learning outcomes. *Scientific Journal of Elementary Education*, 7(2), 45–54.
 - [64]. Thiagarajan, S., Semmel, D. S., & Semmel, M. I. (1974). *Instructional development for training teachers of exceptional children: A sourcebook*. Indiana University.
 - [65]. UNESCO. (2023). *Global education monitoring report 2023: Technology in education*. UNESCO Publishing.
 - [66]. Wati, A. (2021). Developing a snakes and ladders game media to improve elementary school students' learning outcomes. *Mahaguru: Journal of Elementary School Teacher Education*, 2(1), 68–73. <https://doi.org/10.33487/mgr.v2i1.1728>