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DEVELOPING EDUCAPLAY FROGGY JUMPS TO SUPPORT COGNITIVE LEARNING IN BIOLOGY

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ABSTRACT

Biology learning requires interactive media that can engage students in practicing and strengthening cognitive understanding. However, Biology learning at Grade 10 of SMK Raudlatul Ulum Ledokombo, Jember, still relied largely on conventional media, resulting in limited interactive learning experiences. This condition indicated the need for an accessible game-based digital medium aligned with Biology learning objectives. Therefore, this study aimed to develop and evaluate Educaplay Froggy Jumps for learning Ecosystems and Environment. The study employed a Research and Development (R&D) design using the ADDIE model, involving two material experts, two media experts, and 28 Grade 10 students. Data were collected through expert validation sheets, pretest and posttest assessments, and student-response questionnaires, and analyzed using percentage analysis and normalized gain (N-Gain). The developed product consisted of 25 multiple-choice questions covering cognitive levels C1–C4 and incorporated interactive game elements, feedback, scoring, and online access. The material validation score reached 87.50%, media validation 88.89%, and overall feasibility 88.20%, categorized as very feasible. The mean cognitive score increased from 52.14 to 78.57, with an N-Gain of 0.55, indicating moderate improvement. Student responses reached 82%, categorized as very positive. Thus, Educaplay Froggy Jumps is a feasible and positively received supplementary medium for interactive Biology learning.

Keywords: Educaplay; Froggy Jumps; Biology Learning; Game-Based Learning; Learning Outcomes.

ABSTRAK

Pembelajaran biologi memerlukan media interaktif yang dapat melibatkan siswa dalam berlatih dan memperkuat pemahaman kognitif. Namun, pembelajaran Biologi di Kelas 10 SMK Raudlatul Ulum Ledokombo, Jember, masih sangat bergantung pada media konvensional, yang mengakibatkan pengalaman pembelajaran interaktif yang terbatas. Kondisi ini menunjukkan perlunya media digital berbasis permainan yang dapat diakses dan selaras dengan tujuan pembelajaran Biologi. Oleh karena itu, penelitian ini bertujuan untuk mengembangkan dan mengevaluasi Educaplay Froggy Jumps untuk pembelajaran Ekosistem dan Lingkungan. Studi ini menggunakan desain Penelitian dan Pengembangan (R&D) dengan model ADDIE, melibatkan dua ahli materi, dua ahli media, dan 28 siswa Kelas 10. Data dikumpulkan melalui lembar validasi ahli, penilaian pretest dan posttest, serta kuesioner respons siswa, dan dianalisis menggunakan analisis persentase dan normalized gain (N-Gain). Produk yang dikembangkan terdiri dari 25 pertanyaan pilihan ganda yang mencakup tingkat kognitif C1–C4 dan menggabungkan elemen permainan interaktif, umpan balik, penilaian, dan akses online. Skor validasi materi mencapai 87,50%, validasi media 88,89%, dan kelayakan keseluruhan 88,20%, dikategorikan sebagai sangat layak. Skor kognitif rata-rata meningkat dari 52,14 menjadi 78,57, dengan N-Gain sebesar

0,55, menunjukkan peningkatan yang moderat. Respon siswa mencapai 82%, dikategorikan sebagai sangat positif. Dengan demikian, Educaplay Froggy Jumps adalah media tambahan yang layak dan diterima dengan baik untuk pembelajaran Biologi interaktif.

Kata Kunci: Educaplay; Froggy Jumps; Pembelajaran Biologi; Pembelajaran Berbasis Permainan; Hasil Belajar.

A. Introduction

Biology learning at the secondary school level is not only directed toward mastering facts and terms but also toward students' ability to understand concepts, connect information, apply knowledge, and analyze life phenomena (Saragih, 2026). The demand is becoming increasingly relevant in today's educational needs, which place the utilization of digital technology and active student engagement as an important part of the learning process (Fajriati et al., 2024). In this context, learning media holds a strategic position because it can help concretize concepts, provide more varied learning experiences, and create interactions that do not solely rely on the teacher's verbal explanations.

The issue becomes even more important in the context of Biology learning for 10th grade at SMK Raudlatul Ulum Ledokombo Jember. Based on the analysis of the initial learning conditions, it shows that cognitive learning outcomes are not yet optimal, the learning media used are still less interactive, and student involvement in learning is not yet maximal. Media such as books, blackboards, images, and worksheets still have a function in learning, but their use has not yet fully provided an active and engaging learning experience.

This condition indicates a need for media that not only conveys material but also provides students with the opportunity to interact directly with learning content thru more dynamic activities. If this condition is not addressed thru learning innovations, the process of mastering Biology concepts is likely to proceed suboptimally. Learning that relies too heavily on conventional media can limit students' opportunities to gain interactive learning experiences, especially when the material requires an understanding of terms, structures, processes, interconceptual relationships, and biological phenomena (Buckley, 2000). The impact is not only related to low student engagement but can also be reflected in cognitive abilities that have not developed according to learning objectives. This research specifically places cognitive learning outcomes as the main focus, including the abilities to remember, understand, apply, and analyze, so that the learning issues are not directed toward motivation or psychomotor skills as the main variables.

The condition indicates the need for digital learning media that can integrate

learning activities with exercises and evaluations in a more interactive manner (Azzahra & Prasetyo, 2024). One relevant alternative is Educaplay, specifically the Froggy Jumps feature that packages multiple-choice questions into an educational game (Adelia et al., 2025). This feature allows students to read questions, select answers, follow game challenges, receive feedback, and achieve a certain score. These characteristics make Froggy Jumps different from conventional exercises because cognitive activities are placed within a more visual and interactive game mechanism (Dharmawan & Ruja, 2025). In this study, the product is designed for 10th-grade students who need a practical, visual, and non-monotonous learning experience, while still being directed toward achieving cognitive indicators in Biology learning.

Several previous studies provide an empirical basis for the use of digital media and gamification in learning. Annisa et al., (2025) shows that Educaplay can increase student engagement and make learning more interesting. On the other hand, Anwar and Jasiah (2025) showing that Educaplay can be utilized as a game-based evaluation media that increases student participation, while Husada et al., (2026) emphasizing the increase in activity and positive response from students toward the use of Educaplay. In the realm of gamification, Kalogiannakis et al. (2021) demonstrate that gamification in science education has the potential to support motivation, engagement, and understanding, while Zainuddin et al. (2020) show that gamified quizzes can support engagement and learning outcomes. Although the direction of these findings is consistent in demonstrating the potential of digital media and educational games, the focus of previous research remains diverse, ranging from motivation, activity, participation, to overall learning outcomes.

However, previous research still shows room for development in the relationship between specific Educaplay game features, Biology material, and the measurement of students' cognitive learning outcomes in the context of vocational schools. Research on Educaplay has demonstrated its benefits as an interactive and evaluative medium, but it has not specifically developed the Froggy Jumps feature as a learning product designed for Biology lessons in the 10th grade at SMK Raudlatul Ulum Ledokombo Jember. Similarly, research on gamification has supported the use of game elements in learning, but has not directly tested the development of the Educaplay Froggy Jumps media with a focus on enhancing cognitive abilities. These conditions indicate the need for product development that does not stop at the use of digital platforms, but integrates

game characteristics with cognitive learning outcome indicators and the real needs of users.

Based on that need, the Educaplay Froggy Jumps media in this study was developed as an educational game based on multiple-choice questions specifically designed for 10th-grade Biology learning. The product contains materials and questions tailored to the learning objectives and cognitive indicators from C1 to C4. The characteristics of the product include the appearance of the frog jump game, answer choices, challenges, scores, and immediate feedback. The media is also designed to be accessible via a link or QR Code, making it relatively easy to use in learning activities. With these characteristics, the product does not merely transfer conventional exercises to a digital environment, but packages practice and evaluation activities into a game-based learning experience.

This research contributes in two ways. Academically, the research expands the development of game-based digital learning media by integrating the Educaplay platform, the Froggy Jumps feature, Biology learning, and the measurement of cognitive learning outcomes. Practically, the product is intended to help teachers provide alternative training and evaluation media that are more interactive, as well as to help students gain a more engaging learning experience. The quality of the product is not only assessed by its appearance but also thru evaluations by subject matter experts and media experts, the improvement in learning outcomes thru pretest and posttest comparisons, and student responses to the appearance, ease of use, clarity, attractiveness, benefits, and motivation. Thus, the developed product is aimed at meeting the aspects of feasibility, effectiveness, and user acceptance in the context of 10th-grade Biology learning.

Based on this description, this research aims to develop the Educaplay Froggy Jumps media for 10th-grade Biology learning at SMK Raudlatul Ulum Ledokombo Jember and to determine the feasibility, effectiveness, and student response to the developed product. The feasibility of the product is determined thru validation by subject matter experts and media experts, effectiveness is reviewed thru changes in cognitive learning outcomes based on pretest and posttest scores analyzed using N-Gain, while student responses are known thru a questionnaire after using the media. With this aim, the research is directed to produce game-based digital learning media that is pedagogically relevant to the needs of Biology learning and can empirically assess the quality of its use.

B. Methods

This study employed a Research and Development (R&D) design using the ADDIE model, which consists of Analysis, Design, Development, Implementation, and Evaluation stages (Rusdi et al., 2022). The study aimed to develop Educaplay Froggy Jumps, an interactive game-based learning medium for Grade 10 Biology at SMK Raudlatul Ulum Ledokombo, Jember. The development process began with an analysis of learning needs, student characteristics, Biology content, and existing learning conditions; continued with product design and development; and proceeded to expert validation, classroom implementation, and evaluation (Dwitiyanti et al., 2020). The product was designed as an online interactive medium containing Biology multiple-choice questions integrated into the Froggy Jumps game format.

The development procedure consisted of five stages. Analysis identified learning needs, student characteristics, content requirements, and classroom conditions. Design involved determining the content, cognitive indicators, question structure, game format, and assessment instruments (Suartama et al., 2020). Development involved constructing the medium on the Educaplay platform, followed by material and media expert validation and revision based on expert feedback. Implementation involved applying the finalized product to Grade 10 students using a One-Group Pretest–Posttest Design. Students completed a pretest, participated in learning activities using Educaplay Froggy Jumps, completed a posttest, and responded to a questionnaire. Evaluation was conducted by integrating expert validation, learning-outcome improvement, and student responses to determine the overall quality of the product.

The participants comprised material experts, media experts, and Grade 10 students at the research site. Material experts assessed content feasibility, conceptual accuracy, alignment with learning objectives, question clarity, cognitive indicators, and language, while media experts assessed appearance, navigation, readability, interactivity, usability, design consistency, and attractiveness. The student participants were selected through purposive sampling because they represented the intended users of the developed medium. The available research document reports the participant numbers as ranges; therefore, these are retained as documented. Data were collected through expert validation sheets, cognitive learning tests, and student-response questionnaires. The cognitive test was administered as a pretest and posttest, while the questionnaire assessed appearance, ease of use, clarity,

attractiveness, usefulness, and motivation using a five-point Likert scale (Mirnawati et al., 2026).

Table 1. Research Participants, Sample Size, and Roles in Product Evaluation

Participants	Number	Main purpose
Material experts	1–2	Assess content and instructional feasibility
Media experts	1–2	Assess technical and visual feasibility
Grade 10 students	25–30	Product trial, pretest–posttest, and response assessment

Quantitative data were analyzed using percentage analysis and normalized gain (N-Gain), while qualitative comments and suggestions from experts were used descriptively to guide product revision. Expert validation and student-response scores were converted into percentages using $P=(\sum x/\sum xi)\times 100\%$, where $\sum x$ is the obtained score and $\sum xi$ is the maximum score (Riduwan, 2020). A score of 61–80% was categorized as feasible and 81–100% as very feasible. The effectiveness of the medium was assessed from the improvement between pretest and posttest scores using $g=(Spost-Spre)/(Smax-Spre)$ (Ariana et al., 2026). An N-Gain value of $g<0.30$ was categorized as low, $0.30\leq g\leq 0.70$ as moderate, and $g>0.70$ as high; the medium was considered effective when the mean N-Gain reached the moderate or high category.

C. Result and Discussion

1. Development and Feasibility of Educaplay Froggy Jumps

The development process produced Educaplay Froggy Jumps, a digital game-based learning medium designed for Grade 10 Biology on the topic of Ecosystems and Environment. The product was developed through the ADDIE framework, comprising Analysis, Design, Development, Implementation, and Evaluation. The analysis identified the need for a more interactive learning medium because Biology instruction was still supported predominantly by textbooks, worksheets, pictures, whiteboards, and teacher explanations, while students had limited opportunities to engage in interactive practice activities. The design stage subsequently translated these needs into a digital game containing curriculum-aligned multiple-choice questions.

The final product consisted of 25 multiple-choice questions covering cognitive levels C1–C4. The content addressed ecosystem concepts, biotic and abiotic components, interactions among organisms, food chains, energy flow, environmental pollution, conservation, and environmental degradation. The game was accessible through a link or QR code and

incorporated a frog character, answer choices, feedback, and a final score. Thus, the product was designed as an interactive medium for practice, reinforcement, and formative evaluation rather than merely as a digital repository of questions.

The feasibility of the product was assessed by two material experts and two media experts. Material validation examined content accuracy, alignment with learning objectives, content depth, question clarity, cognitive-level appropriateness, and language. Media validation examined visual presentation, navigation, readability, interactivity, usability, design consistency, and attractiveness. The material experts produced scores of 90% and 85%, resulting in an average of 87.50%, whereas the media experts produced an average of 88.89%. The overall feasibility score was therefore 88.20%, categorized as very feasible.

Table 2. Feasibility of Educaplay Froggy Jumps

Evaluation component	Percentage	Category
Material expert validation	87.50%	Very feasible
Media expert validation	88.89%	Very feasible
Overall feasibility	**88.20%**	**Very feasible**

These results indicate that the developed medium met both instructional-content and technical-media requirements before classroom implementation. The high material score indicates that the questions and Biology content were considered appropriate, while the high media score indicates that the product's visual and interactive characteristics were suitable for its intended users. The expert feedback also led to revisions concerning question wording, answer choices, instructions, readability, and design consistency.

2. Learning Outcomes and Students' Responses

The implementation involved 28 Grade 10 students. Students completed a pretest before using the medium and a posttest after participating in Biology learning activities using Educaplay Froggy Jumps. The mean cognitive learning score increased from 52.14 in the pretest to 78.57 in the posttest, representing an increase of 26.43 points. Learning mastery also increased from 7 students (25%) in the pretest to 24 students (85.71%) in the posttest.

The effectiveness analysis produced the following normalized gain:

$$g = \frac{S_{\max} - S_{\text{pre}}}{S_{\text{post}} - S_{\text{pre}}}$$

$$g = \frac{100 - 52.14}{78.57 - 52.14}$$

$$g = 0.55$$

The resulting N-Gain of 0.55 was categorized as moderate.

Table 3. Learning Outcome Improvement

Indicator	Pretest	Posttest	Change
Number of students	28	28	—
Mean score	52.14	78.57	+26.43
Learning mastery	25.00%	85.71%	+60.71 percentage points
N-Gain	—	**0.55**	Moderate

Students' responses were also collected after implementation. The questionnaire covered appearance, ease of use, clarity, attractiveness, usefulness, and motivation. The total score was 2,296 out of 2,800, corresponding to 82%, which was categorized as very positive. Appearance obtained the highest score at 84.52%, followed by attractiveness at 83.33%. Ease of use and clarity obtained 80.95% and 80.48%, respectively, while usefulness and motivation reached 81.25% and 81.79%.

Table 4. Students' Responses to Educaplay Froggy Jumps

Aspect	Percentage	Interpretation
Appearance	84.52%	Very positive
Ease of use	80.95%	Positive
Clarity	80.48%	Positive
Attractiveness	83.33%	Very positive
Usefulness	81.25%	Very positive
Motivation	81.79%	Very positive
Overall	**82.00%**	**Very positive**

Overall, the results demonstrate three complementary dimensions of product quality: very high feasibility (88.20%), moderate improvement in cognitive learning outcomes (N-Gain = 0.55), and very positive student responses (82%).

3. Discussion

The main findings demonstrate that Educaplay Froggy Jumps was highly feasible for Grade 10 Biology learning, was accompanied by a moderate improvement in students' cognitive learning outcomes, and received very positive responses from the students. The product achieved an overall feasibility score of 88.20%, while students' mean cognitive score increased from 52.14 to 78.57 and produced an N-Gain of 0.55. At the same time, students' overall response reached 82%. These findings suggest that the developed medium successfully addressed the initial need for a more interactive and engaging form of Biology practice while maintaining alignment with the intended cognitive learning objectives (Fernandes, 2026).

The findings can be interpreted as the result of an alignment between instructional content, game-based interaction, and learner characteristics. The product was not designed simply to make Biology learning visually attractive; it incorporated 25 questions across C1–C4 and required students to actively select answers within the Froggy Jumps

environment. This design transformed question practice from a conventional written activity into a sequence of active responses. Students read a question, selected an answer, received feedback through the game mechanism, and continued to the next task. Such repeated interaction provides opportunities for retrieval, immediate correction, and reinforcement of concepts. The positive response scores for appearance, attractiveness, usefulness, and motivation further indicate that students experienced the activity as more engaging than conventional question-based practice (Hsia et al., 2022; Pratiwi & Fathurrahman, 2025).

The underlying mechanism can therefore be understood through the interaction between active cognitive processing and game-supported feedback (Zumbach et al., 2020). Conventional exercises generally require students to answer questions, but the Froggy Jumps format adds challenge, visual representation, progression, and immediate feedback to the same cognitive activity. These elements may help sustain students' attention while they repeatedly process Biology concepts. Importantly, the game mechanics were connected to the learning task rather than functioning independently from it. The questions remained the central activity, while the game format provided the environment through which students completed them. This distinction is important because gamification is more educationally meaningful when game elements are integrated with instructional objectives rather than added merely for entertainment (Christopoulos & Mystakidis, 2023).

The findings are theoretically consistent with game-based learning, which conceptualizes games as learning environments in which challenge, interaction, feedback, and goal-oriented activity can support learning processes (Rye et al., 2025). Empirical evidence provides substantial support for this relationship. Lei et al. (2022), in a meta-analysis of 41 studies involving 6,256 participants, found a positive overall effect of game-based learning on science achievement, with an effect size of g=0.705. Similarly, Wang et al. (2022) synthesized 33 studies involving 3,894 participants and reported a moderate positive effect of digital game-based STEM education on learning achievement. These findings provide theoretical and empirical support for interpreting the present improvement in Biology learning as consistent with the broader potential of digital game-based learning.

Nevertheless, the present findings should not be interpreted as equivalent to the larger effects reported in meta-analyses. The N-Gain of 0.55 represents moderate improvement, and the research

design used only one group without a control condition. Consequently, the improvement cannot be attributed exclusively to Educaplay Froggy Jumps because students may also have benefited from teacher instruction, prior exposure to the material, repeated testing, or other classroom factors. This distinction is important because the evidence supports an improvement following implementation rather than a definitive causal effect. In addition, the literature indicates that the effects of game-based learning vary according to educational level, intervention duration, assessment type, and implementation conditions.

The positive student response provides another explanation for the usefulness of the product. The highest response was obtained for appearance (84.52%), followed by attractiveness (83.33%), while usefulness and motivation were also above 81%. These results indicate that students accepted the visual and interactive characteristics of the medium and perceived them as relevant to their learning experience. This is important because a learning medium that is technically valid but difficult or unattractive to students may not be used effectively (Fitra & Maksum, 2021). In this study, the positive response appears to complement the learning-outcome improvement: students were not only able to use the product but also perceived it as useful and engaging.

At the same time, the response results reveal an important area for refinement. Clarity (80.48%) and ease of use (80.95%) were the lowest-rated aspects, although they remained positive. This suggests that future versions should prioritize concise instructions, clearer question wording, and interface simplicity rather than focusing exclusively on additional visual or game elements. This is particularly relevant because digital game-based learning can produce mixed outcomes when game mechanics distract from learning objectives (Sun & Skourdoumbis, 2026). Recent study has emphasized that game design needs to maintain an appropriate balance between educational goals and game characteristics (Jiang & Shangguan, 2022). Therefore, the present findings support a restrained form of gamification in which game elements facilitate the learning task rather than compete with it.

From a practical perspective, Educaplay Froggy Jumps is best positioned as a supplementary learning medium rather than a replacement for teacher-led instruction (Anandita & Kurniawan, 2026). The product can be integrated into practice activities, concept reinforcement, formative assessment, and post-instruction review. Its online accessibility through a link or QR code also allows teachers to use it flexibly in

classroom activities or independent practice. The research findings similarly recommend its use for practice, reinforcement, formative assessment, and reflection, with teacher guidance before and discussion after the activity. For teachers, the practical value therefore lies in providing an additional mechanism through which students can repeatedly engage with Biology questions in a relatively accessible format.

Theoretically, the findings reinforce the proposition that game-based digital media are most useful when game mechanics are structurally connected to cognitive learning objectives (Ke et al., 2016). In this study, the game format was not separated from the curriculum; the 25 questions were explicitly designed around C1–C4 cognitive processes. The study therefore provides an example of how a relatively simple digital game can be transformed into a pedagogically meaningful medium by embedding curriculum-aligned cognitive tasks, rather than relying on gamification alone (Kay & Plati, 2025). This extends the application of game-based learning from the broader category of digital games toward a more focused model of interactive game-based assessment and practice in Biology.

The contribution of the study consequently lies in the integration of Educaplay Froggy Jumps, Biology content, C1–C4 cognitive objectives, and empirical evaluation of feasibility, learning improvement, and student acceptance within a Grade 10 secondary-school context. While previous meta-analytic evidence establishes the broader value of game-based learning for science achievement, the present study demonstrates how this principle can be operationalized through a relatively simple, accessible, web-based game format. The contribution should therefore be understood not as evidence that game-based media universally improve Biology achievement, but as empirical support for a specific instructional product that was highly feasible, positively received, and associated with moderate improvement in cognitive learning outcomes.

D. Conclusion

This study developed Educaplay Froggy Jumps as a digital game-based learning medium for Grade 10 Biology on the topic of *Ecosystems and Environment* using the ADDIE development model. The developed medium consisted of 25 multiple-choice questions covering cognitive levels C1–C4 and incorporated interactive game elements, feedback, scoring, and online access through a link or QR code. Expert evaluation demonstrated that the product was highly feasible, with an overall feasibility score of 88.20%, consisting of 87.50% from material experts and 88.89% from media experts.

The implementation involving 28 students showed an improvement in cognitive learning outcomes, with the mean score increasing from 52.14 on the pretest to 78.57 on the posttest. Learning mastery increased from 25% to 85.71%, while the normalized gain was 0.55, indicating a moderate level of improvement. Students also responded very positively to the developed medium, with an overall response of 82%. These findings indicate that Educaplay Froggy Jumps is a feasible and positively received supplementary medium for supporting Biology learning, particularly for interactive practice, concept reinforcement, and formative assessment.

The findings have practical implications for Biology teachers seeking accessible digital media that can combine curriculum-aligned cognitive tasks with game-based interaction. However, the findings should be interpreted within the limitations of the one-group pretest–posttest design, which does not include a comparison group and therefore does not allow the observed improvement to be attributed exclusively to the developed medium. Future studies should involve larger and more diverse samples, comparison or control groups, and longer implementation periods to examine the consistency of learning effects across different contexts. Further development may also improve the clarity and ease of use of the medium, which received relatively lower student-response scores than its other aspects.

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