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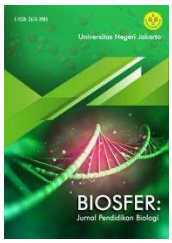

Enhancing students' conceptual understanding of biodiversity through gamification-based learning using FaunaPlay

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ABSTRACT

Conceptual understanding in biology is crucial for addressing global and complex issues. However, students often struggle to grasp biological concepts, thus requiring the support of interactive and engaging learning media. This study aims to develop and evaluate a gamification-based learning approach using PowerPoint media to enhance conceptual understanding of biodiversity, specifically the Felidae family. The research method used in this study is Educational Design Research (EDR) with the Hannafin and Peck (1988) model. Hannafin and Peck model is structured around three distinct phases i.e. needs assessment, design, and development/implementation. Each phase includes evaluation and revision. Data analysis includes assumption tests such as normality and homogeneity tests, as well as effectiveness tests including paired sample T-tests and normalized gain analysis. The subjects of this research are 10th-grade students and Biology teachers at SMAN X Jakarta Timur. The gamification-based PowerPoint learning media (FaunaPlay) is highly feasible to be used as a learning tool and is effective in enhancing the conceptual understanding of 10th grade high school students on the topic of biodiversity, specifically the Felidae family. This study recommends implementing the gamification-based learning media (FaunaPlay) in classroom instruction to enhance conceptual understanding of biodiversity (Felidae). The media can be utilized by teachers as a practical tool during teaching and learning activities. Furthermore, it provides a valuable reference for researchers to develop similar gamified learning media aimed at improving educational quality.

INTRODUCTION

Biology is one of the branches of science studied at the upper secondary level. It is the science that explores various aspects of life and is closely related to everyday experiences. Biology plays an important role in addressing global issues, but is often perceived as difficult due to students' conceptual misunderstandings (Herdani et al., 2015; Torkar & Kubiatko, 2017; Lestari et al., 2021). The formation of concepts to be taught is of great importance in biology education, as it substantially influences students' mastery of the subject matter (Smarabawa et al., 2013). The 21st-century skills, known as 4C, include creative thinking, critical thinking, communication, and collaboration (Kivunja, 2015; Erdoğan, 2019; Tohani & Aulia, 2022; Hapsari & Prasetyarini, 2025). In practice, students tend to rely on rote memorization of concepts and often struggle to apply them when faced with real-life problems related to those concepts (Watters, 2007; Trianto, 2011; Purnamasari et al., 2025). Biology instruction should be linked to practical benefits and recent discoveries that are relevant to everyday life (Sahil et al., 2022). The 4C skills can be supported through the independent curriculum, which is designed to be flexible and contextual, thereby enabling students to more easily understand and apply biological concepts in real-life situations.

The independent curriculum is a curriculum that emphasizes intracurricular learning through various approaches, aiming to optimize students' conceptual understanding and strengthen their competencies (Alawyah et al., 2024). Learning outcomes to the learning competencies that students are expected to achieve at each phase (Ichiana et al., 2023). Based on the expected learning outcomes related to elements of Biology mastery, by the end of Phase E, learners should be able to formulate solutions to problems associated with local, national, or global issues concerning biodiversity and its significance, the functions of viruses, advancements in biological technology, ecosystem components and their interactions, as well as environmental changes (*Kementerian Pendidikan, Kebudayaan, Riset, dan Teknologi*, 2024). In the biodiversity topic, based on the learning objective progression outlined in *(Kementerian Pendidikan, Kebudayaan, Riset, dan Teknologi,* 2022)students are expected to: identify levels of biodiversity and the biodiversity of Indonesia, explain the classification of living organisms, analyze interactions within ecosystems, and explain the importance of biodiversity conservation. To achieve these learning objectives, the use of appropriate learning media is necessary.

Instructional media are tools that function and serve to convey learning messages (Sanaky, 2013). In the learning system, instructional media act as supporting tools that facilitate message delivery and reinforcement, enabling teachers to present information accurately, clearly, and engagingly (Kustandi in Mustaqim, (2016). The use of instructional media can assist students in mastering and absorbing information more easily from the material presented (Kurniawan & Risnani, 2021). One of the most used types of instructional media is PowerPoint. PowerPoint is an interactive learning media that is easily accessible, user-friendly, and adaptable to various student needs (Dila Rukmi Octaviana et al., 2022). PowerPoint facilitates the integration of various media elements, such as text, visuals, audio, video, and animations, enabling the creation of interactive and dynamic instructional materials that enrich the teaching and learning process for both educators and learners (Nikmah & Rahmawati, 2022). PowerPoint also includes interactive features that can enhance the learning experience by incorporating mechanisms often found in video games.

The development of online games in Indonesia has shown significant progress over the past decade (Adnan et al., 2023). The Indonesia Internet Survey for 2021–2022 reported a continuous increase in internet users, reaching 220 million people by early 2022. Before the pandemic, the number was approximately 175 million users. This increase was driven by the need for communication during the COVID-19 pandemic. As a result, Indonesia became the country with the third-largest number of online game players in the world, with 94.5% of the population aged 16–64 recorded as online game players in January 2022 (Rahayuningrum et al., 2022). Engaging in gaming activities has become a prevalent behavior among adolescents, occurring not only during their free time but also within social interactions, such as in cafés or educational environments (Ifdil et al., 2024). Gamification refers to the process of creating experiences or sensations similar to those found in gameplay, but applied within contexts that are not inherently game-related (Khauli et al., 2022). The development of gamification-based PowerPoint serves as an innovative solution that leverages students' interests to facilitate the learning process particularly in enhancing conceptual understanding of complex topics such as biodiversity.

Biodiversity is one of the essential aspects that supports the sustainability of ecosystems across the globe (Sukarni & Widyani, 2021). Large mammals play a crucial role in ecosystems, functioning as apex predators that regulate prey populations, help control the growth of understory vegetation as herbivores, and act as agents for seed dispersal (Maryanto et al., 2012). One example is the family Felidae, which includes major predators such as tigers and leopards that are vital in maintaining ecological balance.

The Felidae family exhibits a wide range of body sizes, from large cats such as tigers and leopards to smaller species such as domestic cats. Felidae possess the broadest body size range among all extant carnivoran families, with weights ranging from 1 kg to 140 kg (Saparudin et al., 2024). All members of the Felidae family share fundamentally similar body structures and forms (Sicuro & Oliveira, 2011). They are characterized by dentition anatomically adapted for hunting (Christiansen, 2008). Members of the Felidae family possess a dental formula comprising either 28 or 30 teeth, characterized by the following arrangement: three incisors (I) on each side of both jaws, one canine (C), two to three premolars (P) in the upper jaw and two in the lower, and one molar (M) on each side of both jaws (Lamberski, 2014). Felidae possess five toes on their forelimbs and four on their hind limbs, with retractable claws that do not leave visible marks in their tracks (Francis, 2019).

There are several species from the Felidae family found in Indonesia, including *Panthera tigris sumatrae*, *Panthera pardus melas*, *Pardofelis marmorata*, *Catopuma temminckii*, *Catopuma badia*, *Prionailurus planiceps*, *Prionailurus bengalensis*, *Prionailurus viverrinus*, *Neofelis diardi*, *Felis chaus*, and *Felis catus* (Francis, 2019; Hearn et al., 2016; Cheyne et al., 2013). As reported by the International Union for Conservation of Nature (IUCN, 2024), eight species within the Felidae family are presently classified as being at risk of extinction. Several of these threatened species in Indonesia include both large and small cats, namely *Panthera tigris sumatrae*, *Catopuma badia*, *Prionailurus planiceps*, *Neofelis diardi*, *Panthera pardus melas*, *Prionailurus viverrinus*, *Pardofelis marmorata*, and *Catopuma temminckii*. The alarming conservation status of these species is crucial for students to understand the ecological roles of Felidae species in Indonesia, along with their conservation status. This aligns with the learning outcomes of the independent curriculum for Phase E, which emphasize the development of solutions to local, national, and global issues related to biodiversity and its roles.

Based on the results of a needs assessment involving 189 students, it was found that 84.1% of the students perceived biology as a subject that requires memorization of content. Furthermore, 85.2% of the students stated that they found it easier to understand the topic of biodiversity (Felidae) when it was presented using images and videos rather than text alone. Similarly, the needs assessment involving teachers revealed that 100% of the instructional media used in teaching biodiversity (Felidae) were deemed ineffective.

To date, there has been no gamification-based learning through PowerPoint media to enhance conceptual understanding of biodiversity, specifically focusing on the Felidae family, particularly within the Felidae family. However, several previous studies have explored the use of gamified PowerPoint media in various subject areas. Rahmadi et al., (2024), for instance, developed a gamified PowerPoint learning media on the topic of colloid systems; however, this media still required a facilitator to control its use, making it less flexible for independent learning. Similarly, Khauli et al., (2022) designed gamified instructional media for mathematics, yet the dominance of game elements risked distracting students from the intended learning objectives. Akhmati et al. (2024) developed gamified media for vocational students on the topic of animal-based food products, but the focus was primarily on motivation and affective learning outcomes, rather than on in-depth exploration of conceptual understanding as a cognitive domain. Furthermore, Zahrandika, (2024) created an interactive PowerPoint-based gamified media titled GamiPlant for plant tissue topics, but it was still aligned with the 2013 curriculum, which has since been replaced by the independent curriculum in Indonesia.

In response to these gaps, this study presents the development of gamification-based learning through PowerPoint media to improve conceptual understanding of biodiversity, specifically the Felidae family, introducing several innovations not found in prior research. The learning material focuses on biodiversity content that has not been previously explored in gamified media development. Additionally, the dependent variable in this study is students' conceptual understanding, particularly among tenth-grade high school students. FaunaPlay incorporates a more comprehensive and varied set of gamification elements, which are rarely found together in previous similar media. It also includes interactive multimedia features such as authentic audio recordings of each Felidae species, animations

that illustrate their morphological characteristics, and other interactive components embedded in PowerPoint. FaunaPlay is designed for independent use by students and is aligned with the learning objectives outlined in the independent curriculum, providing a more student-centered and flexible learning experience.

In current instructional practice, students tend to memorize concepts rather than apply them to real-world problems related to the material they have learned. Although instructional media are available, its utilization remains limited and suboptimal. This is particularly concerning in light of the demands of the independent curriculum, which emphasizes intracurricular learning through various approaches aimed at maximizing conceptual understanding. Based on these issues, the research question posed in this study is as follows: Is gamification-based learning through PowerPoint media (FaunaPlay) effective in enhancing conceptual understanding of biodiversity?

METHODS

Research Design

This research employed the Educational Design Research (EDR) method (Plomp & Nieveen, 2013) using the Hannafin and Peck development model (1988). The Hannafin and Peck model consists of three main stages, i.e. need assessment, design, and development/implementation stage. Each of these stages is followed by an evaluation and revision process (Park & Hannafin, 1991). The framework of the Hannafin and Peck (1988) development model is illustrated in Figure 1.

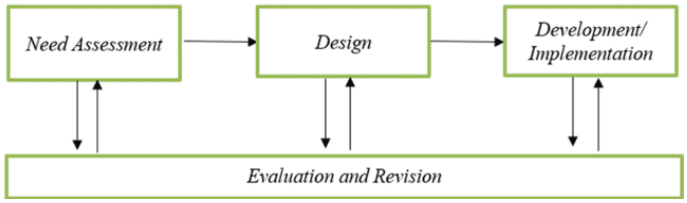


Figure 1. Hannafin and Peck modified. Adapted: Dinata et al., (2023)

Population and Samples

The population of this study consisted of 47 tenth-grade students from SMA Negeri X, East Jakarta. The students, both male and female, were approximately 15–17 years old. A simple random sampling technique was employed. To determine the appropriate sample size, the Slovin formula was used with a 5% margin of error, resulting in a required sample of 42 students. The demographic data can be seen in Table 1.

Table 1
Demographic data

Category	Sub-category	Frequency (f)	Percentage (%)
Gender	Male	11	26.2%
	Female	31	73.8%
Total		42	100%
Age	15	16	38.1%
	16	24	57.1%
	17	2	4.8%
Total		42	100%

Instrument

This study began with a need assessment. The development of the need assessment instrument grid was based on the instrument proposed by (Ulumudin et al., 2017). The distribution of need assessment instruments for both teachers and students was conducted to collect data regarding the needs, as well as the media and the biology learning process in schools. FaunaPlay, a gamification-based PowerPoint learning media, was evaluated based on both media and material aspects. The media evaluation focused on visual appearance, user-friendliness, consistency, and language, while the material feasibility assessment encompassed subject matter, language, and presentation. All feasibility instruments, including those used for small group and teacher assessment, were developed according to the framework proposed by (Chaeruman, 2015).

Pre-test and post-test instruments were developed based on four key dimensions of concept mastery, namely factual and procedural knowledge, connection, knowledge transfer, and metacognition (Mills, 2016). The assessment scale employed a Likert scale, which was used to evaluate the feasibility of the media, content, and user responses to the media. The data obtained were then presented and converted based on the Likert scale, referring to (Ristanto et al., 2020). After calculating the percentage value, the feasibility of the learning media can be assessed through the interpretation of the feasibility test results. The analysis was conducted on the pre-test and post-test instruments used in this study. This included validity, reliability, difficulty index, and item discrimination for each test item using Microsoft Excel.

Procedure

Need Assessment

The needs assessment phase represents the initial stage in the development of instructional media, aimed at identifying students' learning challenges and needs. During this phase, a need assessment instrument was developed and administered to 189 student respondents. The questionnaire was distributed via Google Forms, allowing for convenient dissemination and direct completion by both students and teachers. The results of the assessment were then used as the basis for designing instructional media tailored to the specific needs of students and teachers.

Design

In the design phase, the instructional media was designed based on the results of the need assessment that had been evaluated and revised in the previous stage. This phase produced a storyboard, which served as a visual representation of the media flow to be developed. The creation of elements and icons was carried out using the Canva website. The generated objects were then embedded into Microsoft PowerPoint. Revisions and evaluations were also carried out at this stage through feasibility testing by media experts, subject matter experts, and students. In this phase, item analysis was also conducted, including tests of validity, reliability, difficulty index, and item discrimination for each test item using Microsoft Excel.

Development and Implementation

After the revision and evaluation processes, the next stage was the implementation of the learning media product (FaunaPlay) by students and teachers during the teaching and learning activities. The implementation involved a large group trial, with a pre-test administered at the beginning and a post-test conducted at the end of the lesson after the FaunaPlay learning media was implemented.

Data Analysis Techniques

The data analysis technique used in this study employed a quantitative method. The item analysis of the test instruments covered validity, reliability, difficulty index, and discrimination power, conducted using Microsoft Excel. A one-group pre-test and post-test design was employed. To assess the effectiveness of the FaunaPlay learning media, a paired sample t-test was conducted to determine whether there was a statistically significant difference between the pre-test and post-test scores. Prior to this, assumption tests were performed, including the Shapiro-Wilk test for normality and Levene's test for homogeneity. Additionally, a normalized gain (N-Gain) analysis was conducted to further enrich the data interpretation.

RESULTS AND DISCUSSION

This study produces a gamification-based learning media product (*FaunaPlay*). This media is utilized in the learning process to enhance students' conceptual understanding of biodiversity, specifically focusing on the Felidae family. The research employs the Hannafin and Peck (1988) model, which consists of three stages: need assessment, design, and development/implementation. Each stage is described in detail as follows:

1. Need Assessment

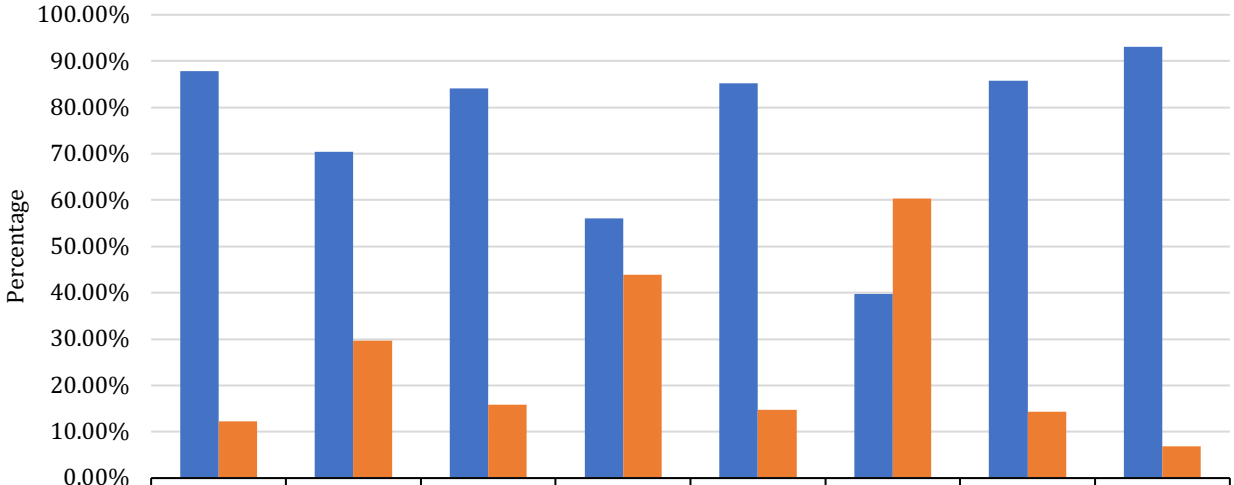
a. Literature Review

The needs assessment and literature review were conducted by examining various research journals that discuss the implementation of gamification in biology learning, particularly on the topic of animal biodiversity. The literature review is intended to provide insights into the needs of both students

and teachers concerning the development of instructional media that align with learners' characteristics and educational objectives.

The needs assessment conducted through a literature review found that Zahrandika, (2024) 44.9% of students still do not understand gamification-based learning media. This finding aligns with research indicating that the application of gamification elements in learning remains limited (Yahaya et al., 2022). Meanwhile, the needs assessment by Awaludin & Rostikawati, (2020) revealed that students prefer media with numerous images and examples; however, animal biodiversity material is still perceived as difficult. In addition, the dominant teaching method remains lecture-based, which limits students' interaction with the subject matter. Sari & Alberida, (2022) found that students at SMAN 7 Padang still lacked conceptual understanding in identifying levels of biodiversity. A similar situation was observed at SMP Negeri 3 Bangkalan, where students misidentified the taxonomic levels of *Panthera pardus* and *Panthera tigris* (Amalia et al., 2023).

b. Student Needs Assessment



	Projector & Internet	Laptop Access	Obligation to memorize	Biodiversity Difficulty	Visual Learning Ease	Gamification PowerPoint	FaunaPlay Importance	FaunaPlay Approval
Yes	87.80%	70.40%	84.10%	56.10%	85.20%	39.70%	85.70%	93.10%
No	12.20%	29.60%	15.90%	43.90%	14.80%	60.30%	14.30%	6.90%

Figure 2. Student Needs Assessment

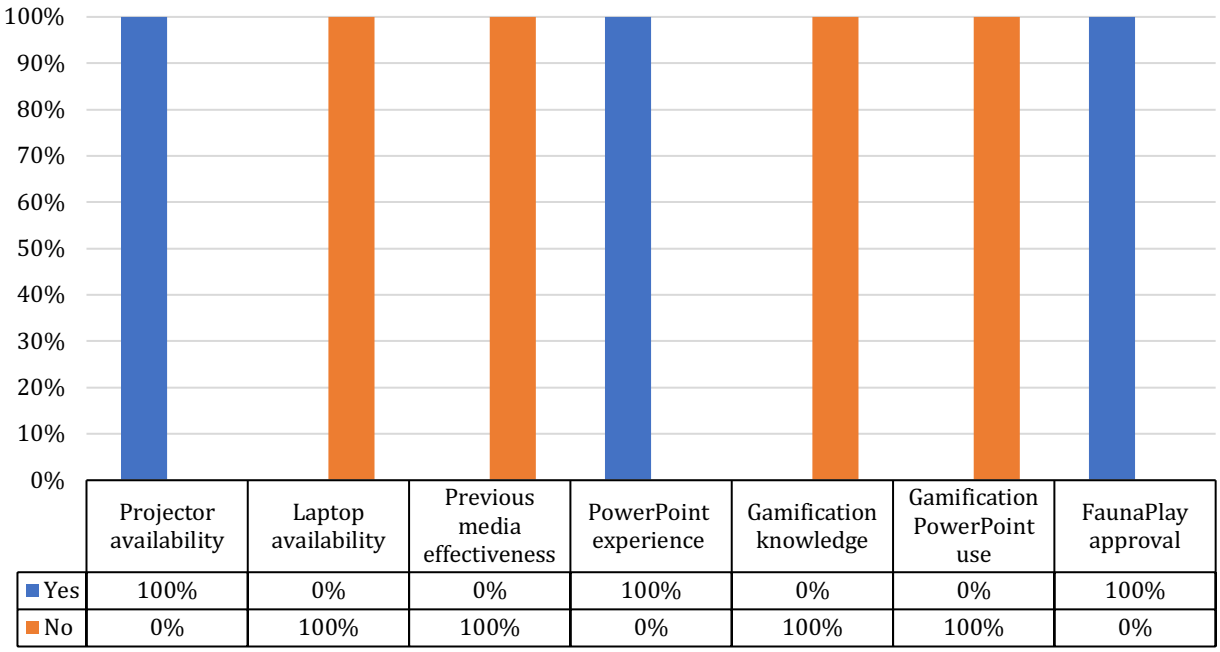
The needs analysis results indicated that students possessed adequate facilities to support biology learning. The presence of learning facilities plays a crucial role in improving student learning outcomes; however, it does not automatically enhance the quality of education. Therefore, these facilities must be optimally utilized to achieve educational objectives (Frameiliada et al., 2023). Furthermore, 84.1% of students agreed that biology lessons require memorization of learning materials. This finding suggests that most students still focus on memorizing terms and definitions rather than developing a deep conceptual understanding. Previous studies have shown that students tend to memorize concepts without being able to apply them to solve real-world problems related to the learned material (Trianto, 2009). Biology learning that relies solely on rote memorization leads to difficulties in retaining the material in long-term memory (Sumiati et al., 2018).

In terms of the difficulty level of biodiversity material (Felidae), 56.1% of students reported having trouble. This is due to the dense nature of the material, which includes various species with diverse characteristics and taxonomic differences that often cause confusion. A total of 85.2% of students reported finding it easier to understand biodiversity material (Felidae) when it is presented through images and videos rather than just text. This finding indicates that visualization in learning plays a vital role in helping students comprehend complex concepts. Similarly, Hanif, (2020) found that students better understand and construct new knowledge using video and image media rather than textual materials. Audiovisual learning media offer several benefits, including helping students

comprehend and clarify the learning material delivered by teachers and facilitating the teaching and learning process (Roy et al., 2020). Moreover, the use of animated videos helps students transform abstract material into a more concrete understanding (Alifa, 2021). One media that can integrate various learning elements, such as text, images, audio, animation, and visual effects, is PowerPoint.

Only 39.7% of students had previously used gamification in PowerPoint media in biology learning. This relatively low percentage indicates that the application of gamification in biology learning remains limited, despite its potential to increase student engagement during the learning process. The data align with previous research indicating that gamification has not yet been widely implemented in classroom learning (Ariani, 2020). A total of 85.7% and 100% of students perceived the development of the FaunaPlay learning media as important and agreed with its implementation. These findings support the development of gamification PowerPoint media (FaunaPlay) to enhance conceptual understanding of biodiversity (Felidae) among Grade 10 high school students.

c. Biology Teacher Needs Assessment



	Projector availability	Laptop availability	Previous media effectiveness	PowerPoint experience	Gamification knowledge	Gamification PowerPoint use	FaunaPlay approval
Yes	100%	0%	0%	100%	0%	0%	100%
No	0%	100%	100%	0%	100%	100%	0%

Figure 3. Biology Teacher Needs Assessment

The results of the biology teacher needs analysis indicate a positive perception toward the use of gamification, PowerPoint learning media in teaching biodiversity (Felidae). Although teachers have previously used PowerPoint as a learning media, its implementation has not yet been effective. This highlights the need for instructional innovation to increase student engagement and enhance conceptual understanding. This aligns with the study by Djatmika and Praherdhiono (2024), which suggests that the development of gamification-based interactive multimedia offers an innovative solution to improve learning effectiveness. Furthermore, research by Srimuliyani, (2023) shows that the use of gamification significantly increases student engagement in the classroom.

2. DESIGN

a. Model Feasibility

The product developed during the design phase underwent a feasibility test prior to being implemented with students. This testing aimed to evaluate the feasibility of the FaunaPlay learning media, conducted by experts in their respective fields, as well as through a small group feasibility test involving students. In addition, the feedback provided by the experts was used to revise and refine the product.

1) Results of Media Feasibility Testing

The media feasibility test covered four assessment aspects: appearance, ease of use, consistency, and language. Table 2 presents the results of the media feasibility assessment before any revisions were made. Evaluation was conducted by media experts to ensure that the developed media met appropriate design and usability standards.

Table 2
Results of Media Validity Test Before Revision

No.	Aspect	Score	Interpretation
1.	Appearance	78.5	Feasible
2.	User-Friendliness	87.5	Very Feasible
3.	Consistency	87.5	Very Feasible
4.	Language	100.0	Very Feasible
	Average	88.37	Very Feasible

In addition, the developed product received feedback in the form of suggestions and comments, which were followed up with evaluation and revision.After being revised and improved, FaunaPlay was submitted again to the media expert for a follow-up feasibility evaluation. This iterative process aimed to enhance the quality and effectiveness of the learning media before implementation.

Table 3
Results of Media Validity Test After Revision

No.	Aspect	Score	Interpretation
1.	Appearance	92.85	Very Feasible
2.	User-Friendliness	100.00	Very Feasible
3.	Consistency	93.75	Very Feasible
4.	Language	100.00	Very Feasible
	Average	96.65	Very Feasible

Table 3 presents the results of the validity testing of the FaunaPlay learning media conducted by experts, which falls into the "very feasible" category with a percentage of 96.65%. The validity test instrument grid refers to Chaeruman (2015) with modifications. The media validity assessment covers four aspects: Appearance (92.85%), User-Friendliness (100%), Consistency (93.75%), and Language (100%). Appearance aspect is measured by seven indicators, including the suitability and quality of graphic and visual utilization, font selection, background and text color contrast, relevance of illustrations within the media, icon appropriateness according to their functions and the information conveyed, and layout that facilitates user interaction. User-friendliness aspect is measured by two indicators: the availability of interactive features within the learning media and the ease with which users can navigate all sections of the media. Consistency aspect is measured by two indicators: the consistency and relevance of audio and narration used with the material, and the consistency of animations in the learning media according to the content. Language aspect is assessed through indicators such as the appropriateness of font type and size to ensure user comfort in reading, as well as the consistency of words, terms, and sentences within the media.

A previous similar study by Zahrandika, (2024) on the development of *GamiPlant* for plant tissue material obtained a media validation score of 91.87%, categorized as highly feasible. Development of interactive learning media based on PowerPoint obtained a media feasibility test score of 82.50%, categorized as very feasible (Anyan et al., 2020). Development of PowerPoint media on virus material received a media feasibility score of 70%, categorized as feasible (Sinta & Hera, 2020). Meanwhile, the development of multimedia learning media on plant tissue material obtained a score of 87%, categorized as highly feasible (Zairana et al., 2020).

FaunaPlay learning media is considered feasible from the media aspect as it fulfills the Gestalt principles, namely figure/ground, proximity, closure, similarity, and continuity (Khamis et al., 2023). The figure or ground principle refers to the situation where an object or topic is more prominent compared to its background (Khamis et al., 2023). Proximity is applied by grouping similar information elements (Black et al., 2017). Closure involves forming separate elements into one complete and meaningful pattern (Khamis et al., 2023). Similarity groups elements that share common attributes such as color, shape, or size (Fraenkel et al., 2012). Continuity indicates that a well-formed continuous

pattern can lead users to perceive that the pattern extends further (Khamis et al., 2023). In the context of learning, these principles serve as the foundation in developing interactive learning media that is not only visually appealing but also effective in delivering the material.

The figure/ground principle is applied in FaunaPlay by providing color contrast between the background and main elements, enabling students to easily recognize navigation buttons and content. Proximity is used by grouping elements with similar functions, such as buttons. Additionally, closure is implemented in the quiz-level lock icon, where the icon is not fully drawn but consists only of a circle and two holes; nevertheless, students can still recognize this icon as a lock indicating a locked level. Similarity is applied by arranging elements that share the same shape and color, such as uniform navigation buttons, quiz level boards, and quiz answer options. This arrangement creates visual order and enhances design consistency. Continuity is implemented through the next, back, and home buttons, which indicate a continuing pattern to facilitate navigation, as well as in the level-based quizzes that maintain the sequence of questions and answer options to keep the gameplay flow clear and structured.

2) Results of Subject Matter Feasibility Testing

The subject matter feasibility test included three assessment aspects: content feasibility, language, and presentation. The evaluation was conducted only after revision, as the expert provided the assessment following the improvement of the media.

Table 4
Results of Subject Matter Validity Test After Revision

No.	Aspect	Score	Interpretation
1.	Subject Matter Feasibility	94.44	Very Feasible
2.	Language	93.75	Very Feasible
3.	Presentation	100.00	Very Feasible
	Average	**96.06**	**Very Feasible**

Table 4 presents the results of material validity testing for the FaunaPlay learning media conducted by experts, which falls into the very feasible category with a percentage of 96.06%. The material validity instrument grid refers to Chaeruman (2015) with modifications. Material validity assessment covers three aspects: Subject Matter Feasibility (94.44%), Language (93.75%) and Presentation (100%).

Subject matter validity aspect is measured by nine indicators, including: the material aligns with the learning outcomes stated in the curriculum; clarity of learning objectives; the material corresponds with concepts, facts, and theories; the material contains accurate concepts free from misconceptions; the learning media includes relevant real-life examples and applications; the material covers the latest and relevant information; reference sources are recent publications or reliable sources; the material addresses all important and relevant aspects of the topic; and explanations of each concept are presented with adequate detail.

Language aspect is assessed through four indicators: appropriate font type and size for readability; information is presented sequentially and logically; effective and efficient use of language; and grammar and spelling conform to the Indonesian General Spelling System (PUEBI).

The Presentation aspect is measured by two indicators: references originate from reliable sources such as journals, books, or official documents; and a logical relationship exists between the main concepts in the material.

Previous similar studies include research by Ramadhani (2024), which developed gamification-based multimedia supported by PowerPoint on colloid system material, obtaining a material expert validation score of 72% categorized as feasible. Gamiplant, developed for plant tissue material, received a material validation score of 92.29%, categorized as highly feasible (Zahrandika, 2024). Development of Megali on waste management material achieved a material validation score of 95.98%, also categorized as highly feasible (Widianto & Prastiwi, 2024). An interactive PowerPoint media on virus material obtained a material validation score of 97.14%, categorized as highly feasible (Telaumbanua & Lase, 2022). Additionally, a PowerPoint-based media developed for virus material received a material feasibility validation score of 84%, categorized as feasible (Hera, 2020).

FaunaPlay is considered feasible from the material aspect because it aligns with constructivist learning theory, which emphasizes interactivity in interactive learning media consistent with constructivism's focus on learner-centered knowledge construction (Tishana et al., 2023). Prominent constructivist theorists, such as Piaget, state that concepts are formed from experience, while Vygotsky emphasizes the importance of scaffolding to foster learner independence. Montessori views learning as a social process, whereas Bruner stresses structured concept understanding (Suryana et al., 2022; Nurlina & Bahri, 2021; and Muzakki et al., 2021).

Within constructivist learning theory, the teacher is not the sole source of knowledge. During the learning process, learners do not merely listen to teacher explanations but must discover knowledge themselves by connecting personal experiences with information obtained from peers, the surrounding environment, or other sources. The teacher acts as a facilitator who provides guidance and supports the learning process (Muadzin, 2021). Consistent with constructivist principles, gamification in learning media provides stimuli that support cognitive stimulation, as seen in the design of constructivist gamified environments that emphasize cognitive structure stimulation (Machmud et al., 2023). Thus, the use of gamification in learning not only increases engagement but also strengthens conceptual mastery through active learner interaction.

3) Results of Small Group Feasibility Testing

The feasibility test of the gamification-based PowerPoint learning media (FaunaPlay) covered several aspects, including subject matter, language, visual design, and usefulness. Table 5 illustrates the findings from the small group feasibility assessment.

Table 5
Results of Small Group Validity Test

No.	Aspect	Score	Interpretation
1.	Content	97.50	Very Feasible
2.	Language	93.33	Very Feasible
3.	Visual Display	93.125	Very Feasible
4.	Uselfulness	96.25	Very Feasible
	Average	**95.05**	**Very Feasible**

Student feedback from the small group on the use of FaunaPlay provided valuable input for refining the gamification-based PowerPoint learning media (FaunaPlay) before its application in a large group trial. In the small group feasibility test involving students, several responses were obtained. The FaunaPlay learning media was perceived as engaging, unique, and provided a more enjoyable learning experience compared to conventional learning media. Some students appreciated the level-based quiz feature, the use of supportive visuals and audio, the opportunity to learn about cat species previously unknown to them, as well as the interactivity that facilitated easier understanding of the material and enhanced their learning enthusiasm.

Table 5 presents the results of the small group feasibility trial of FaunaPlay conducted with students. The results showed a score of 95.05%, categorized as very feasible. Feasibility trial of the learning media by the small group covered four aspects: Content (97.5%), Language (93.33%), Visual Display (93.125%), and Usefulness (96.25%). Content aspect consists of three indicators: features within the learning media that facilitate conceptual mastery, media content aligned with the learning outcomes, and media content that corresponds to the concepts and learning objectives. Language aspect comprises three indicators: language that is easy to understand, effective language use, and clear, readable font type and size. Visual Display aspect includes four indicators: the appropriateness of audio and visual elements, ease of use of the media, user enthusiasm and interest in using the media, and a positive impression of the media's use. Usefulness aspect consists of two indicators: promoting students' conceptual mastery and encouraging students to apply the learned concepts.

The results of the small group feasibility trial by students are consistent with the findings of several previous similar studies. For example, the development of interactive multimedia on plant tissue material using Adobe Flash obtained a score of 80.7%, which was categorized as feasible (Zairana et al., 2020). Gamification-based learning on the topic of the organization of living organisms using mobile augmented reality achieved a score of 82.2%, categorized as very feasible (Hidayat et al., 2018).

Development of interactive learning media using PowerPoint on cell material for grade XI students obtained a score of 86.77%, categorized as very feasible (Septiani, 2017). Development of gamification to improve learning outcomes achieved a score of 98%, categorized as very feasible (Setyaedhi, 2023). Development of GamiPlant on plant tissue material obtained a score of 96.56%, also categorized as very feasible (Zahrandika, 2024).

The media feasibility test conducted by the teacher serves as additional data to provide insights into the use of gamification-based learning media (FaunaPlay). This testing covers several aspects, including content, appearance, and benefits. Table 6 presents the results of the media feasibility assessment conducted by the teacher.

Table 6
Results of the Media Validity Test by the Biology Teacher

No.	Aspect	Score	Interpretation
1.	Content	83.33	Very Feasible
2.	Display	85.00	Very Feasible
3.	Usefulness	87.50	Very Feasible
	Average	85.27	Very Feasible

Table 6 presents the results of the feasibility trial of the FaunaPlay media conducted by biology teachers. The trial obtained a score of 85.27%, categorized as very feasible. The feasibility trial by the teachers covered three aspects: Content (83.33%), Display (85%), and Usefulness (87.5%). These results indicate that FaunaPlay meets the quality standards expected by educators, particularly in terms of the accuracy of the material, the attractiveness of its visual presentation, and its practical benefits in supporting the learning process. Therefore, FaunaPlay is considered highly appropriate to be used as a biology learning media, especially for biodiversity (Felidae).

The final version of FaunaPlay was developed based on feedback from experts, students, and biology teachers. Revisions and evaluations were conducted iteratively to improve the learning media product by students' needs. Both media and content aspects were refined based on the evaluation results and were deemed highly feasible. This final version of FaunaPlay is ready to be implemented in classroom learning to enhance students' conceptual understanding of biodiversity, particularly the Felidae topic.

b. Item Analysis

The analysis was conducted on the pre-test and post-test instruments, encompassing validity, reliability, difficulty index, and item discrimination of each test item using Microsoft Excel. This analysis aimed to evaluate the appropriateness of the test items prior to their distribution in the large group trial, which assessed the effectiveness of the product. Item analysis is an essential step for teachers to improve the quality of the test items they have developed (Farida & Musyarofah, 2021).

1) Validity

This validation test employed the point-biserial validity test. The obtained $rpbi$ values were compared with the critical r values at a 5% significance level. An item is considered valid if $rpbi > rtabel$ (Arikunto, 2021). Based on the results, out of 25 items, 20 were categorized as valid. This means that only 20 items were used in the pre-test and post-test, while the remaining 5 invalid items were eliminated. These invalid items were excluded from subsequent analyses. The item validity testing produced two categories: valid items and dropped (invalid) items. In the calculation of test reliability coefficients, items classified as dropped (invalid) were not included and were removed from further analysis (Puger et al., 2021).

2) Reliability

The reliability test aims to ensure that the measurement instrument yields consistent and stable results across repeated administrations and can be considered dependable (Anshari et al., 2024). In this study, the KR-20 reliability test was employed. The obtained reliability coefficient of 0.91 indicates that the pre-test and post-test instruments are reliable and fall into the very high category. This suggests that the instrument used is consistent in measuring students' conceptual understanding.

3) Difficulty Index

The difficulty index analysis revealed that the test items fell into the moderate category. The difficulty index indicates the level of difficulty or ease of a test item, determined based on students' ability to answer it correctly, rather than from the perspective of the teacher as the item writer. This result aligns with the findings of (Aldila, 2023), which stated that the more students who correctly answer a question, the easier the item is considered to be. Conversely, if only a few students answer correctly, the item is categorized as difficult.

4) Item Discrimination

The results of the item discrimination analysis indicated that the test items fell into the good category. The variation in item discrimination values reflects that the pre-test and post-test instruments were sufficiently optimal in measuring students' conceptual understanding. If high-achieving student groups answer the question correctly while low-achieving groups answer it incorrectly, the item is considered to have a high discrimination power (Purba et al., 2021).

3. Implementation

At the beginning of the learning process, students were given a pre-test to determine their level of conceptual understanding regarding biodiversity (Felidae). The sample was then subjected to a treatment in the form of biodiversity (Felidae) learning activities, in which students utilized a gamification-based learning media (FaunaPlay). Upon the completion of the learning process, a post-test was administered to assess the differences between pre-test and post-test scores.

A one-group pre-test and post-test design was utilized in this study, with data analyzed through both descriptive and inferential statistics. Descriptive statistics encompassed the minimum, maximum, mean, and standard deviation. Before conducting inferential analysis, prerequisite tests were administered, namely the normality and homogeneity tests. Subsequently, the effectiveness of the intervention was evaluated using parametric inferential statistics, specifically the paired sample t-test and normalized gain analysis.

Descriptive statistics indicated that students' pre-test scores had a minimum of 35, a maximum of 80, a mean of 57.02, and a standard deviation of 12.050. Meanwhile, the post-test scores had a minimum of 60, a maximum of 100, a mean of 81.90, and a standard deviation of 10.704. These results show an increase in the average score, indicating an enhancement in students' conceptual understanding.

Table 7.
Descriptive Statistical Results

	N	Minimum	Maximum	Mean	Std. Deviation
Pre-test	42	35.00	80.00	57.02	12.05
Post-test	42	60.00	100.00	81.90	10.70
Valid N (listwise)	42				

a. Assumption Tests

Prerequisite testing for analysis is conducted to ensure that the data meet the necessary conditions before performing statistical analysis. This testing aims to determine whether parametric or non-parametric statistical methods should be used. In this study, the prerequisite tests include normality and homogeneity tests.

1) Normality

The normality test was conducted using the Shapiro-Wilk method, as the sample size in this study was less than 50, namely 42 samples. Based on Table 9, the results of the normality test showed a significance value of 0.153 for the pre-test and 0.063 for the post-test, both of which are greater than the significance level (α) of 0.05. Accordingly, the data follow a normal distribution.

Table 8.
Results of the Normality Test

Test Results	df	α	Sig.	Description
Pre-test	42	0.05	0.15	Normal
Post-test	42	0.05	0.06	Normal

2) Homogeneity

The homogeneity test was conducted using Levene's test, as it is considered effective for data with both normal and non-normal distributions (Brown & Forsythe, 1974). Based on Table 10, the results of the homogeneity test show a significance value of 0.511, which is greater than 0.05. Therefore, the data are considered homogeneous.

Table 9.
Results of the Homogeneity Test

	Levene Statistic	df1	df2	Sig.	Description
Based on Mean	0,436	1	82	0,511	Homogenous

b. Effectiveness tests

The effectiveness test was conducted after confirming that the data were normally distributed and homogeneous through the prerequisite tests. This study employed the paired sample t-test and normalized gain (N-Gain) analysis to evaluate effectiveness. The t-test aimed to determine whether there was a mean difference between two related samples or a significant difference between students' pre-test and post-test scores. Meanwhile, the normalized gain analysis was used to measure the extent of improvement in students' conceptual understanding of biodiversity (Felidae) after utilizing the FaunaPlay learning media.

1) Paired Sample T-Test

The results of the paired sample t-test showed a significance value (Sig. 2-tailed) of 0.000, which is below 0.05, leading to the rejection of the null hypothesis (H_0). This indicates a statistically significant difference between the pre-test and post-test scores, highlighting the positive impact of the gamified PowerPoint-based learning media (FaunaPlay) on students' conceptual understanding of biology, particularly on the topic of biodiversity (Felidae). This difference is not only numerical but also statistically significant. The improvement in scores did not occur by chance but was a result of the learning intervention. Based on these findings, the use of FaunaPlay effectively contributed to enhancing students' conceptual understanding. This finding is consistent with Sukarelawan et al., (2024), who stated that the difference between pre-test and post-test scores is not coincidental but holds relevant statistical significance.

2) Normalized Gain Analysis

The calculation yielded an N-Gain score of 0.57, which falls into the media category, and an N-Gain percentage of 57%, categorized as moderately effective. This is in accordance with Hake, (1998), who classified the interpretation of N-Gain scores into three categories. These results indicate that the use of the FaunaPlay learning media is effective in enhancing the conceptual understanding of Grade X senior high school students on the topic of biodiversity (Felidae). N-Gain provides a comprehensive overview of the effectiveness of the learning media, as it evaluates the improvement in students learning outcomes with a focus on the group center (Sukarelawan et al., 2024). Table 10 displays the outcomes of the normalized gain analysis.

Table 10
Results of the Homogeneity Test

	N	Minimum	Maximum	Mean	Std. Deviation
N Gain_score	42	0.13	1.00	0.57	0.22
N Gain_Percent	42	12.50	100.00	57.68	22.66
Valid N (listwise)	42				

The FaunaPlay learning media that has been developed possesses both strengths and limitations. Based on the development stages undertaken, one of the strengths of FaunaPlay is that it presents a gamified learning media on biodiversity (Felidae), representing an innovative approach that has not been widely explored previously. This learning media integrates gamification elements that create an experience like that of playing a game, such as incorporating a game-flow element through a leveled quiz using hyperlinks in PowerPoint. Additionally, the leveled quiz feature in this media is

designed based on the conceptual understanding matrix dimensions (Mills, 2016), which include factual and procedural knowledge, connection, knowledge transfer, and metacognition. Other gamification elements embedded in FaunaPlay include challenges, difficulty levels, badges, and collaboration, all of which are applied within this learning media.

In addition to textual content, the FaunaPlay learning media also includes images, audio, animations, and visual effects. By integrating multimedia elements, students can gain a clearer understanding of biodiversity (Felidae) in Indonesia. Another notable advantage is that FaunaPlay can be used without internet access and is accessible at any time. Students can use the gamified PowerPoint learning media on computers or laptops without needing to install Flash Player, unlike other interactive media applications that require software installation (.apk or .exe) (Zahrandika, 2024).

However, FaunaPlay has certain limitations, such as the absence of gamification features like point tracking and leaderboards, which are not supported by Microsoft PowerPoint. In addition, the large file size may result in slow button responses, especially when accessed via mobile devices.

CONCLUSION

The development of the gamified PowerPoint learning media (FaunaPlay) was carried out through the Educational Design Research (EDR) process, using the Hannafin and Peck (1988) development model. FaunaPlay, which focuses on the biodiversity topic of the Felidae family, was found to be highly feasible as a learning media. Moreover, its implementation proved effective in enhancing the conceptual understanding of Grade X senior high school students. In line with its purpose, this study successfully developed and evaluated a gamified learning approach using PowerPoint media to improve students' conceptual understanding of biodiversity, particularly concerning the Felidae family.

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