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Nature Ninja Edugame as an interactive learning solution for improving integrated science and social studies learning achievement in primary school

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ABSTRACT

Technology-based learning is increasingly evolving in elementary education, including developing interactive media to enhance student learning outcomes. This study aimed to develop and evaluate the feasibility, practicality, and effectiveness of the Nature Ninja Edugame based on Articulate Storyline for the fifth-grade Natural and Social Sciences. The research followed a Research and Development approach with the ADDIE model. Data collection techniques included observations, interviews, questionnaires, documentation, and tests. Validation results indicated high feasibility, with an average score of 90% from media and material experts. The t-test effectiveness test showed that Sig. was lower than 0.05, indicating a significant difference between pretest and posttest learning outcomes. Additionally, the N-gain test showed a moderate increase (0.6336) in the small-scale trial and a high increase (0.7114) in the large-scale trial. Based on the questionnaire results, teacher and student responses were highly positive. The study concludes that Nature Ninja Edugame is effective, feasible, and practical for enhancing fifth-grade students' science and social studies learning outcomes. This research highlights the importance of innovative and interactive learning media as an effective strategy to improve student performance and enrich technology-based learning experiences in elementary education.

Nature Ninja Edugame sebagai solusi pembelajaran interaktif untuk meningkatkan prestasi belajar ilmu pengetahuan alam dan sosial di sekolah dasar

Kata Kunci:

model ADDIE, articulate storyline, Nature Ninja Edugame, hasil belajar, ilmu pengetahuan alam dan sosial

ABSTRAK

Pembelajaran berbasis teknologi semakin berkembang dalam pendidikan dasar, termasuk dalam pengembangan media interaktif untuk meningkatkan hasil belajar siswa. Penelitian ini bertujuan untuk mengembangkan dan menguji kelayakan, kepraktisan, serta keefektifan media Nature Ninja Edugame berbasis Articulate Storyline pada mata pelajaran Ilmu Pengetahuan Alam dan Sosial kelas V SD. Metode penelitian yang digunakan adalah Research and Development dengan model ADDIE. Teknik pengumpulan data mencakup observasi, wawancara, angket, dokumentasi, dan tes. Hasil validasi menunjukkan bahwa media ini memiliki kelayakan tinggi, dengan rata-rata skor 90% dari ahli media dan materi. Uji keefektifan t-test menunjukkan bahwa nilai Sig. < 0,05, yang berarti terdapat perbedaan signifikan antara hasil belajar sebelum dan sesudah penggunaan media. Selain itu, hasil uji N-gain menunjukkan peningkatan hasil belajar dengan kriteria sedang

(0,6336) pada skala kecil dan kriteria tinggi (0,7114) pada skala besar. Respon guru dan siswa terhadap media ini juga sangat positif berdasarkan hasil angket. Kesimpulan dari penelitian ini adalah bahwa Nature Ninja Edugame efektif dalam mengoptimalkan hasil belajar Ilmu Pengetahuan Alam dan Sosial serta layak dan praktis digunakan dalam pembelajaran siswa kelas V SD. Implikasi dari penelitian ini menunjukkan bahwa pengembangan media pembelajaran inovatif dan interaktif dapat menjadi strategi efektif dalam meningkatkan hasil belajar siswa dan memperkaya pengalaman belajar berbasis teknologi di sekolah dasar.

Contribution to the literature

This research contributes to:

- Providing a concrete example of technology integration through the Nature Ninja Edugame, relevant to the local Indonesian context—particularly biodiversity—as an innovative solution within the Natural and Social Sciences curriculum.
- Generating valid empirical data on the effectiveness of educational games in enhancing learning outcomes in Natural and Social Sciences, thereby supporting their integration as a fundamental component of learning.
- Through the Nature Ninja Edugame, we demonstrate how complex learning materials can be presented as more engaging and contextually relevant for Indonesian students, enhancing the quality and appeal of Natural and Social Sciences education.

1. INTRODUCTION

Education is the foundation of a nation's progress, and its success reflects the advancement of a country [1]. Through education, individuals develop their potential, acquire knowledge, and gain skills and values essential for social life, enabling them to become intelligent, skilled, and morally upright individuals [2]. n effective learning process fosters creativity, innovation, and the ability to face global challenges. According to the Decree of the Head of the Education Assessment Curriculum Standards Agency No. 1152/H3/SK.02.01/2023, Natural and Social Sciences are crucial in education. They encompass the study of living and non-living things in the universe and their interactions, as well as human life as an individual and a member of society interacting with the environment [3]. A key aspect of learning Natural and Social Sciences is enabling students to transform experiences into applicable concepts [4]. This involves many activities, including acquiring scientific knowledge, engaging in scientific practices, and effectively communicating scientific findings and ideas [5]. Learning Natural and Social Sciences not only equips students with an understanding of natural phenomena but also effectively develops 21st-century skills essential for students, such as communication, collaboration, critical thinking, creativity, and innovation [6]. Through this learning process, students grasp scientific concepts and integrate these skills, preparing them to face future global challenges.

However, implementing Natural and Social Sciences education in elementary schools presents several challenges. Based on an interview with a fifth-grade teacher at SD (Elementary School) Negeri 01 Karanggondang, several issues were identified in the teaching of Natural and Social Sciences. The teacher noted that students struggle to explore and discover information independently, requiring continuous guidance, which prevents

the learning process from being fully student-centred. In an era of rising global education standards, modern education systems should be more developed and student-oriented, emphasizing personal growth, critical competence, self-efficacy, and independent learning [7]. Additionally, teachers rarely employ innovative teaching media, methods, or models due to the heavy administrative workload they must manage. The increased administrative burden under the *Merdeka Curriculum* affects classroom learning effectiveness by consuming valuable time, increasing stress, reducing collaboration, hindering innovation, and adding financial costs [8].

The observation activities have identified several issues in the fifth grade, particularly the low interest and learning outcomes of students in Natural and Social Sciences. The lack of student interest in these subjects is evident from the questionnaire results, which show that 70% of the 23 fifth-grade students at SD Negeri 01 Karanggondang dislike Natural and Social Sciences. They perceive the material as difficult to understand, overly theoretical, and requiring excessive memorization, making it unengaging. This issue aligns with the findings of Zakirman *et al.* [9], who stated that students often consider learning Natural Sciences challenging due to the habit of rote memorization. Additionally, classroom learning frequently relies on textbooks without incorporating diverse media, leading to student boredom.

Further observations reveal that conventional lecture-based teaching methods are a major factor contributing to students' low comprehension of Natural and Social Science materials. The tendency of students to memorize information without deeply understanding the concepts suggests disengagement in the learning process. This is reinforced by the questionnaire results, which indicate that 48% of students prefer interactive learning media for Natural and Social Sciences, while 43% favor multimedia-based learning, such as images and videos. These findings are consistent with research by Widyaningrum *et al.* [10], which highlights that students often lose interest in learning science due to teachers' limited use of engaging teaching media.

Given the rapid development of technology, it is crucial to utilize available facilities and infrastructure effectively. The questionnaire results show that all 23 fifth-grade students at SD Negeri 01 Karanggondang can operate gadgets proficiently, and 74% use gadgets for more than two hours daily. Additionally, the data indicates that all students use their gadgets primarily for playing games and watching YouTube for entertainment. This frequent use of gadgets negatively impacts their learning outcomes, as most students prioritize gaming over educational activities. Research supports this, showing that students who frequently use gadgets for entertainment, such as playing games or watching YouTube and TikTok videos, tend to have lower interest and academic performance due to reduced motivation to study and difficulty understanding the material presented by teachers [11]. One of the negative consequences of excessive gaming is addiction, which can lead to decreased learning motivation, reduced peer interaction, and a preference for gaming or internet browsing over productive activities.

The uncontrolled use of gadgets has significantly impacted student learning outcomes, particularly in subjects such as Natural and Social Sciences. The assessment results for the 1st Midterm Test in these subjects show low student performance. Among the 23 fifth-grade students at SD Negeri 01 Karanggondang, 15 (62%) did not meet the Minimum Mastery Criteria. In comparison, only eight students (38%) achieved the required score of 70 for Natural and Social Science subjects.

To address these challenges, an innovative solution is required to enhance learning, specifically by developing engaging learning media. Learning media should be tailored to students' characteristics to capture their interest and encourage active lesson participation

[12]. Properly utilizing learning media can create a multisensory learning experience that engages both sight and hearing, ultimately improving comprehension and positively impacting learning outcomes [13]. Therefore, educational games can serve as an effective alternative to address these learning difficulties.

Educational games are a type of game that is not only entertaining but also conveys knowledge to users [14]. These games engage students in all aspects, both individually and in groups. Through educational games, students are stimulated to enjoy learning. Learning media in the form of educational games can address the challenge of students learning while playing [15]. They can increase student motivation, help students better understand learning materials, diversify learning methods [16], and enhance their creative thinking skills. By actively involving students in the learning process, educational games are enjoyable and effective in optimizing students' learning potential, particularly in understanding abstract concepts that are often difficult to explain through conventional methods, especially in Natural and Social Science subjects.

Several previous studies have demonstrated that educational games have significant potential in improving student learning outcomes. Research has found that educational games can enhance learning motivation [16], student engagement, and conceptual understanding [17]. Additionally, educational games have been proven effective in teaching complex concepts [9], such as those found in Natural and Social Science subjects. Moreover, they can help students develop creative thinking and problem-solving skills [18]. Although extensive research has been conducted on educational games, several gaps still need to be addressed. First, studies on the effectiveness of educational games in Natural and Social Sciences subjects remain limited. Second, further exploration is needed to design an optimal educational game to enhance learning outcomes in these subjects.

To address these gaps, this study develops and evaluates the educational game Nature Ninja, specifically designed to optimize learning outcomes in Natural and Social Sciences. The game employs an innovative design approach using an Articulate Storyline, considering student characteristics and the Natural and Social Sciences curriculum. Additionally, it integrates local content relevant to the Indonesian context, focusing on biodiversity topics for fifth-grade elementary school students in Indonesia.

This research presents several novel contributions. First, it focuses on developing and evaluating an educational game specifically designed to enhance learning outcomes in Natural and Social Sciences. Second, it employs an innovative design approach considering student characteristics and curriculum requirements. Based on these potentials, this research develops an educational game called Nature Ninja, designed to enhance students' understanding of science concepts through fun and interactive gameplay, focusing on biodiversity materials for fifth-grade elementary school students in Indonesia. Nature Ninja is an educational game developed using Articulate Storyline, which can be accessed via gadgets or other devices anytime and anywhere with an internet connection. Articulate Storyline can present interactive [19] and engaging [20], [21] learning materials, thereby increasing student motivation, facilitating more effective learning, and providing a more enjoyable learning experience when delivered in a game format.

Based on the description above, this research aims to develop Nature Ninja, an educational game based on Articulate Storyline software, focusing on biodiversity topics in Indonesia to enhance motivation and optimize student learning outcomes in Natural and Social Sciences subjects. Additionally, this study seeks to assess the developed product's feasibility, practicality, and effectiveness. The primary benefit of this research is to provide insights into the role of educational games in supporting education, particularly in learning Natural and Social Sciences.

2. METHOD

The research model used was Research and Development (R&D), which produced Articulate Storyline-based Nature Ninja Edugame media on biodiversity in Indonesia for fifth-grade elementary school students. The development model in this study followed the ADDIE model, which consisted of five stages: Analyze, Design, Development, Implementation, and Evaluation [22]. After receiving ethics approval, the research was conducted.

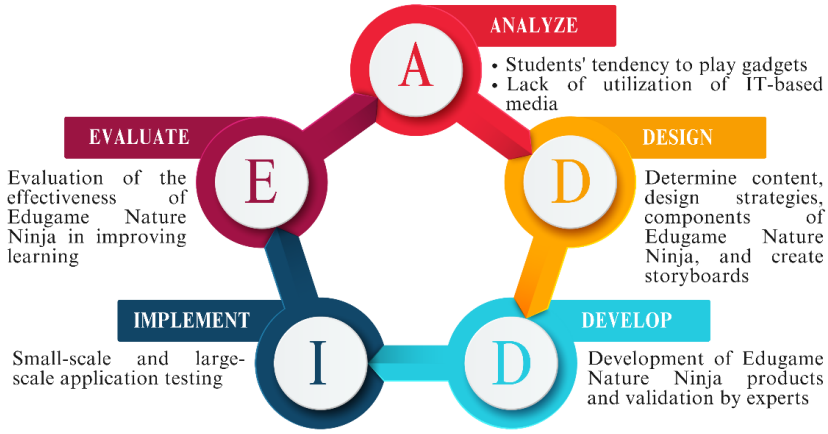

Figure 1. ADDIE Development Model [22]

At the Analyze stage, the research focused on problem identification needs analysis, tasks, curriculum, and materials. Problem identification was conducted through interviews, observations, questionnaires, and document analysis in the form of student learning outcomes. The needs analysis and task analysis fund were completed through a questionnaire assessing student and teacher needs. Curriculum and material analysis were conducted by studying the curriculum used, namely the independent curriculum, and by determining the material for developing learning media based on student needs questionnaires.

At the Design stage, the product prototype design was developed based on the needs analysis results. The steps in designing products included: (1) preparation of appropriate educational game design materials, format, and layout; (2) creation of media prototypes; and (3) application of the design in making educational games.

At the Development stage, the previously designed educational game media was realized into a real product, considering the material's structure, content, and presentation. The initial results of this stage were validated by media and material expert validators, followed by improvements based on their criticism and suggestions. Next, a small group trial was conducted with six students to obtain direct feedback. The results of this trial served as the basis for making final improvements to the media.

At the Implementation stage, the product was tested on a large group to assess the application of the learning media and its effect on determining the effectiveness of the media based on student learning outcomes from pretest and posttest results. After the media was tested, students and teachers were given a questionnaire to assess their response to the Articulate Storyline 3-based educational game on Natural and Social Sciences subjects, particularly on biodiversity in Indonesia.

The Evaluation stage involved analyzing students' and teachers' responses to the questionnaire assessment of the learning media. The goal was to determine how the developed learning media achieved its learning objectives. The results of this analysis were then used to correct deficiencies and improve the quality of the media in learning.

This research was conducted at SD Negeri 01 Karanggondang, Banjarnegara Regency, during the 2024/2025 school year. This school had diverse student characteristics regarding academic background and socio-economic conditions. However, in general, students at this school showed a high interest in technology, as evident from their frequent use of gadgets daily. After obtaining consent from parents and students, the research was conducted.

The subjects of this study were grade V students, totalling 23 students. This number included all fifth-grade students in the school, so the sampling technique used was saturated sampling. The use of saturated sampling was considered appropriate since the number of students was not too large, allowing researchers to collect data from the entire population. This aligns with Sugiyono's opinion [23], which states that saturated sampling can be used if the population is relatively small, typically less than 30 students. Thus, the data obtained was expected to provide a comprehensive picture of the effectiveness of using Nature Ninja Edugame in improving the learning outcomes of fifth-grade students at SD Negeri 01 Karanggondang.

The data collection techniques used in this study were test and non-test techniques. The test technique was conducted through a pretest to determine the student's initial knowledge and learning outcomes before using the media. A posttest was then conducted to assess the students' learning outcomes after using the Nature Ninja educational game on biodiversity in Indonesia in Natural and Social Sciences subjects. In this study, the pretest results were compared with the posttest results to determine the effectiveness of the media.

The pretest and posttest questions were developed based on expert validators' assessments, tested on students, and analyzed for validity, reliability, difficulty level, and differentiation. The non-test technique was conducted through interviews and observations to identify problems and teacher and student questionnaires to analyze media needs. Additionally, expert validation questionnaires and teacher and student response questionnaires were used to assess the feasibility of the media.

To determine the feasibility of the developed product, the data were analyzed based on the assessments of material and media experts. Furthermore, student and teacher response questionnaires were used after the product had been developed to evaluate the product's practicality. These questionnaires employed a four-point Likert scale, ranging from very feasible (score of 4) to less feasible (score of 1). The feasibility of the product could be tested using the following formula [24].

$$NP = \frac{R}{SM} \times 100\% \qquad (1)$$

The results of the percentage of media and material feasibility, as well as student and teacher responses, were interpreted into the eligibility criteria modified by Riduwan [25], as shown in Table 1.

Table 1. Media Feasibility Criteria [25]

Feasibility Percentage	Criteria
81% - 100%	Highly Feasible
61% - 80%	Feasible
41% - 60%	Moderately Feasible
21% - 40%	Less Feasible
<21%	Not Feasible

Then, data analysis was carried out using the N-gain test based on students' pretest and posttest scores on the large-scale trial to determine the product's effectiveness. The criteria for interpreting the N-gain index [26] are as follows:

Table 2. N-Gain Criteria [26]

Percentage	Criteria
N-gain ≥ 0,70	High
0,30 < N-gain< 0,70	Moderate
N-gain ≤ 0,30	Low

3. RESULTS AND DISCUSSION

3.1 Analyze

At this stage, problem identification was carried out through observation, questionnaires, interviews, and document analysis in the form of the learning outcomes of fifth-grade students at SD Negeri 01 Karanggondang. The pre-research data showed that learning often relied on conventional lectures. Educators frequently used student and teacher books as student worksheets as learning resources, while teaching aids and learning media were not maximally utilized, especially IT-based media. This was due to educators not understanding how to operate IT-based learning media. Learning without media often made students feel bored and uninterested in the material presented. Students also tended to use gadgets to play games and watch entertainment videos, negatively impacting their learning outcomes. The percentage of completeness showed that the learning outcomes of the 1st Midterm Assessment in Natural and Social Sciences for fifth-grade students at SD Negeri 01 Karanggondang were low and had not reached the minimum completeness criteria for these subjects, which was 70.

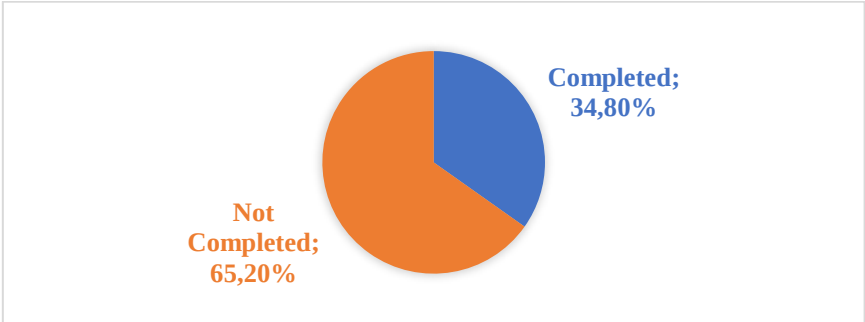

Figure 2. Percentage of Completion of Natural and Social Science Learning Outcomes

The results of this analysis were in line with Bruner's learning theory, which emphasized the importance of students' active involvement in the learning process[27]. Conventional learning, which was dominated by lectures, tended to be passive and did not facilitate students in building their understanding. Kusmiati's research [20] also showed that innovative learning media, such as educational games, improved learning motivation, student engagement, and learning outcomes. Educational games provide a fun and interactive learning experience, motivating students to learn more. In addition, educational games also helped students understand abstract and complex concepts in a more visual and concrete way. Therefore, interactive learning that actively involved students was more effective in improving students' understanding.

3.2 Design

Figure 3. The Design Stage

The design stage involved a series of activities that focused on formulating learning objectives, selecting and analyzing content, planning learning strategies, and determining the media to be used. This stage was also known as creating a blueprint. The educational game design was tailored to the learning outcomes and learning objectives to be achieved.

Nature Ninja Edugame contained various types of media, such as audio, text, images, animations, and videos, which were integrated with biodiversity material in Indonesia. Several processes were carried out in this design stage, including material collection using various software. This stage also included the creation of storyboards and gameplay. Adobe Photoshop was used to create assets in the form of varied writings. Canva was used to create most of the assets, such as backgrounds and supporting display elements. Then, the educational game was developed using Articulate Storyline software and compiled into an application that could be used on Android by adding text, audio, video, images, and animations.

The Articulate Storyline-based Nature Ninja Edugame contained various menus, including instructions, materials, games, and a bibliography. This learning medium also featured various navigation buttons that enabled students to access each page easily, control music, and view the developer's bio. The final result of this media was an application that could be used on Android, both on smartphones and tablets, without requiring an internet connection for operation. The design of Nature Ninja Edugame was based on the principles of multimedia learning, which emphasized the importance of using various types of media to stimulate students' senses and enhance deeper understanding [28]. This game's combination of audio, text, images, animation, and video made learning more engaging, facilitated a more comprehensive understanding of concepts and improved information retention. Constructivism theory also emphasizes that students learn by constructing new knowledge based on their experiences and prior knowledge [29]. Therefore, using varied and interactive media helped students better understand the learning material.

3.3 Development

Various learning components, such as teaching materials, learning media, and student activities, were created and tested in this stage. In this development stage, the Nature Ninja Edugame was developed following the structural framework, content systematics, and material presentation from the design stage. This process involved collaboration between content experts and media developers. Each component was aligned with the intended learning outcomes. The references used in the design stage were guidelines for developing the Nature Ninja Edugame, which consisted of the following parts.

Figure 4. Log in Page & Main Menu

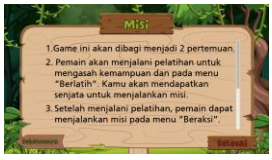

Figure 5. Mission Menu Page (Instruction)

Figure 6. Exercise Page (Material)

Figure 7. Character & Zones Options

Figure 8. The Gameplay Menu Page

Figure 9. Result Page

This development stage applied instructional design principles, where learning materials were organized and presented systematically to achieve predetermined learning objectives [30]. The constructivism learning theory [31] was also relevant at this stage, as students interacted with the educational game and built their understanding of the biodiversity material. Feedback from expert validators was essential to ensure that the educational game met quality and validity standards. This validation process was also part of the formative evaluation process, where the learning product was evaluated and revised throughout the development process.

Thus, the initial results of this stage were validated by the validator. At this stage, the feasibility of Android-based educational games on Natural and Social Sciences subjects related to biodiversity in Indonesia was validated by competent media expert validators, namely lecturers of learning media courses in elementary school teacher education study programs, and material experts, namely lecturers of science clusters in elementary school teacher education study programs. Their role was to assess the feasibility of the products developed by researchers. After being assessed by expert validators, researchers received input on the developed products, allowing them to make necessary revisions.

Table 3. Media and Material Expert Validation Index

Aspects	Validation Indeks (%)	Description
Media Expert	88	Highly Feasible
Material Expert	92	Highly Feasible

Table 3 above showed that the value given by the media expert validator was 88%, categorized as very feasible, while the value given by the material expert was 92%. The average validation value obtained was 90%, which was categorized as valid because obtaining a value above 70% was included in the feasible criteria [32]. The Nature Ninja Edugame, based on Articulate Storyline in Natural and Social Sciences subjects on biodiversity in Indonesia, was declared feasible for use in terms of content or material, appearance or media, and language and was ready to be tested.

The multimedia-based design of Nature Ninja Edugame supported these excellent validation results, accurate material content aligned with the Natural and Social Sciences curriculum, and an attractive and easy-to-use interface. These factors contributed to the positive assessment, as multimedia learning enhanced comprehension, valid content ensured relevance and a well-designed interface facilitated user interaction. A good combination of solid content and appealing design was essential to creating an effective and enjoyable learning experience for students.

Thus, the results of this validation showed that Nature Ninja Edugame met the set quality standards. This validation provided confidence that the educational game was of good quality and had the potential to optimize student learning outcomes. This was particularly important considering the characteristics of elementary school learners, who generally enjoyed playing [33]. The educational game was designed to capitalize on students' natural inclination to play, making it a fun and effective learning experience. Therefore, this validation guaranteed the quality of the game's content and design and confirmed its relevance to the learning styles of students, who tended to be active and interactive.

3.4 Implementation

The product was tested in small groups after making improvements based on the criticisms and suggestions of media and material expert validators. In the small group trial, six fifth-grade students were selected heterogeneously based on their ability levels, namely two students with low scores, two with medium scores, and two with high scores. After the students completed the learning process, both students and teachers were given an answer sheet containing 15 questions with a Likert scale, which had to be filled in based on their experience using the developed product.

In testing the practicality of Nature Ninja Edugame, a teacher and student response questionnaire was distributed, which assessed three technical qualities: appearance, presentation of material content, and language. These three aspects were then described in six indicators: the appearance of the media, instructions for use, presentation of material, presentation of exercise questions, use of language in the media, and the display of images, text, and colours.

Table 4. Small-group Response Questionnaire Results

Respondent	(%)	Description
Teacher	93	Very Practical
Small-group Students	98	Very Practical
Large-group Students	99	

Table 4 shows that the teacher and student responses to the Nature Ninja Edugame media were very positive, as they received a score above 85%. The acquisition of student response questionnaire scores above 85% with a valid statement indicated that the Articulate Storyline educational game was classified under the excellent criteria with a valid statement. Hence, revisions to the learning media were not necessary [34]. Therefore, it can be concluded that the Articulate Storyline-based Nature Ninja Edugame was practical for use in learning activities. The Nature Ninja Edugame, based on Articulate Storyline, was declared very positive and practical based on 15 questions on a Likert scale.

After completing the small group trial, the media was implemented in a large group of all fifth-grade SD Negeri 1 Karanggondang students, totalling 17 students. The trial use of the Edugame in Natural and Social Sciences subjects, specifically on getting acquainted with our Earth and its influences, aimed to determine the media's effectiveness based on student learning outcomes. After the media was implemented, researchers distributed questionnaires to teachers and students to assess their responses to the Nature Ninja Edugame in the Natural and Social Sciences subject on biodiversity in Indonesia.

Table 4 shows that the responses of teachers and students to the Nature Ninja Edugame, based on Articulate Storyline, were overwhelmingly positive. Nearly all responses on the Likert scale received a score of 4, indicating a highly positive and practical response. This aligns with previous research, which stated that the teacher and student response questionnaire for the Articulate Storyline-based Nature Ninja Edugame scored above 85%, demonstrating a highly positive value. This result confirms that the Nature Ninja Edugame is practically applied to learning activities [35]. Additionally, this positively impacted student learning outcomes, as evidenced by the increase in pretest to posttest scores shown in Table 5.

Table 5. The Comparison between Pretest-Posttest Scores

Description	Average	Average Difference
Small-group Pretest	61	24
Small-group Posttest	85	
Large-group Pretest	40	43
Large-group Posttest	83	

Based on Table 5, it was found that the average student learning outcomes increased by 24 in the small-scale product trial, while in the large-scale trial, the increase was 43. The data in the table showed differences in student learning outcomes in Natural and Social Sciences subjects on biodiversity in Indonesia in class V at SD Negeri 01 Karanggondang before and after using the Nature Ninja Edugame. Evidently, the average student learning outcomes improved after using the Nature Ninja Edugame. This aligned with research [36] which indicated that students' reactions to educational games were very positive, as this medium could enhance their interest and motivation for learning.

An N-gain analysis was conducted by comparing the difference between N-gain and pretest scores to determine whether there was a significant increase between pretest and posttest scores. A normality test was conducted first, followed by the t-test and N-gain test to measure effectiveness.

Table 6. The Normality Test Result

Description	Sig.	Description
Small-group Pretest	0.945	Normal
Small-group Posttest	0.557	Normal
Large-group Pretest	0.261	Normal
Large-group Posttest	0.435	Normal

A Sig. value greater than 0.05 in the Shapiro-Wilk test indicated that the data on student learning outcomes were normally distributed before and after using Nature Ninja Edugame. This normality assumption was important because it served as the basis for using the next parametric statistical test, the t-test. The t-test required the data to be normally distributed to ensure that the results obtained were valid and reliable. With the normality assumption fulfilled, the t-test was used to analyze the average difference in student learning outcomes before and after using Nature Ninja Edugame, as shown in Table 7.

Table 7. T-test on the Small-group Kelompok Kecil

Description	Mean	Sig.
Small-group Trial	-24.000	0.000
Large-group Trial	-42.353	0.000

The t-test results, both small-scale and large-scale, showed a sig. value of 0.00 < 0.05, indicating a significant difference between the learning outcomes before and after the treatment. Therefore, it could be concluded that there was a significant difference in student scores from the pretest to the posttest before and after using the *Nature Ninja Edugame* media on biodiversity material in Indonesia. Furthermore, the N-Gain test was conducted to determine the effectiveness of *Nature Ninja Edugame*, as shown in Table 8.

Table 8. N-Gain Score

Description	Mean
Small-group N-Gain Score	0.6336
Large-group N-Gain Score	0.7114

Based on Table 8, it was found that the N-Gain in the small-scale trial was 0.6336, which was categorized as medium, while the N-Gain in the large-scale trial was 0.7114, which was categorized as high. Based on these data, it could be concluded that Nature Ninja Edugame was effective in learning because it optimized student learning outcomes. Articulate Storyline game-based learning media has proven highly effective in enhancing student learning outcomes [37]. Rohmah [38], in her research, also supported these findings by stating that the increase in student learning outcome scores demonstrated the

success of learning media in facilitating the learning process. Therefore, it could be concluded that Articulate Storyline games effectively optimize learning outcomes.

The results of this implementation showed that Nature Ninja Edugame was effective and practical for learning Natural and Social Sciences material on biodiversity in Indonesia. The improvement in student learning outcomes after using this educational game aligned with cognitive learning theory, emphasizing the importance of active student involvement in the learning process [39]. This educational game provided an interactive and engaging learning experience, motivating students to learn and understand complex material. Okra's research [12] also showed that educational games improved student learning outcomes in Natural and Social Sciences subjects. Educational games helped students develop critical thinking, problem-solving, and collaboration skills [20]. Additionally, educational games provided immediate and personalized feedback, allowing students to learn from their mistakes and enhance their understanding.

3.5 Evaluation

The final stage of product development involved revising the final product based on the development and implementation of products used by students and educators during the learning process. This revision was conducted based on suggestions and feedback from the classroom teacher and fifth-grade students of SD Negeri 01 Karanggondang to further improve the Nature Ninja Edugame media.

Based on the questionnaire responses from teachers and students, it was found that Nature Ninja Edugame had an attractive appearance, where text, images, videos, and animations were clearly visible. This media was also easy to use individually and in groups because it was equipped with clear instructions, could increase student interest in learning, and presented complete and easily understandable material. Learning evaluation was provided through games with various engaging questions, fostering students' critical thinking skills. Articulate Storyline-based educational games in science learning helped students understand the material more easily, made learning more interesting, effective, and efficient, and motivated students throughout the learning process [40].

The results of this evaluation indicated that the developed Nature Ninja Edugame received positive responses from teachers and students, highlighting its potential to be used effectively with Articulate Storyline software. The positive responses from teachers and students showed that Nature Ninja Edugame successfully met their Natural and Social Sciences needs. This was in line with behaviourist theory, which emphasized the importance of repetition and rewards in learning [41]. Nature Ninja Edugame was designed with features that supported these principles. As behaviourist theory states that learning from media provides a sense of repetition and reward, Nature Ninja Edugame applied this principle in its design. The reward feature, in the form of points and stars for correct answers and repeated questions for incorrect answers, served as reinforcement to increase student motivation and learning outcomes.

The findings of this study aligned with previous research supporting the use of Articulate Storyline-based educational games in learning due to their interactivity, practicality, and ease of access via smartphones and other devices [42]. Additionally, Articulate Storyline-based educational games facilitated student understanding of the material [43] and increased the validity and practicality of the learning process [44], [45]. These features make them a promising tool for diverse educational settings and learner profiles. Thus, educational games based on Articulate Storylines in Natural and Social Sciences subjects, particularly on biodiversity topics, enhanced learning effectiveness and student learning outcomes.

The development of Nature Ninja Edugame based on Articulate Storyline had positive implications in optimizing the learning outcomes of Natural and Social Sciences. This edugame offered interactive and engaging learning, increasing students' motivation and understanding of complex Natural and Social Science concepts. Articulate Storyline's flexibility allowed content to be tailored to the curriculum and student needs and facilitated personalization of learning so students could learn at their own pace and learning style. Nature Ninja Edugame's online access supported distance and independent learning and was highly relevant in the digital age. The development of this game also encouraged innovation in Natural and Social Science learning, making technology an integral part of the learning experience. Thus, Nature Ninja Edugame had the potential to be an innovative learning medium that could improve the quality of education. Previous research has shown that educational games can improve student learning outcomes [12]. However, research on the effectiveness of educational games in the context of Natural and Social Sciences, especially on biodiversity material in Indonesia, was still limited. Some studies, such as those conducted by Rohmah [38] and Fitri [40], examined educational games' use in learning Natural and Social Sciences. Still, these studies focused more on different materials or did not specifically examine their effect on student learning outcomes on biodiversity materials in Indonesia.

This research positively contributed to the development of learning media for Natural and Social Sciences, especially on the biodiversity material in Indonesia. The Nature Ninja Edugame developed in this study had the potential to be an effective and innovative learning medium, which could increase student learning motivation, facilitate better concept understanding, and ultimately improve student learning outcomes. This research also provided insights into how technology could be effectively integrated into the learning of Natural and Social Sciences and offered concrete examples of educational game development relevant to the curriculum context in Indonesia.

Although the Articulate Storyline-based Nature Ninja Edugame offered a lot of potential, some drawbacks needed to be considered. This study had limitations, namely that it was only conducted in one elementary school with student characteristics and an environment that might have differed from other schools. In addition, this study only focused on one subject matter and measured short-term learning outcomes. Therefore, there was a need for careful and continuous evaluation to ensure that Nature Ninja Edugame was effective and accessible to teachers and students who needed it, with long-term learning outcome measurements. Further research is needed to explore overcoming device and internet access limitations to make Nature Ninja Edugame accessible to all students.

4. CONCLUSION

Based on the research results, it can be concluded that the Nature Ninja Edugame, developed using Articulate Storyline, motivated and optimized student learning outcomes in Natural and Social Science subjects, particularly biodiversity material in Indonesia. This was evidenced by the results of the product validation assessment conducted by experts, with an average product assessment score of 90%. The pretest and posttest results indicated that the Nature Ninja Edugame was effective in optimizing student learning outcomes, as seen from the t-test effectiveness test and the N-gain test. The t-test showed that Sig. < 0.05, meaning there was a significant difference between learning outcomes before and after the treatment. The N-gain test on a small scale showed an increase of 24, with an N-gain of 0.6336, which was classified as moderate. Meanwhile, on a larger scale, the score increased by 43, with an N-gain of 0.7114, which was classified as high.

Based on the distributed response questionnaire, teachers and students provided positive feedback. From these findings, it can be concluded that the Nature Ninja Edugame, developed using Articulate Storyline, effectively optimized learning outcomes in Natural and Social Sciences. It was also deemed feasible and practical for use in teaching fifth-grade students.

AUTHOR CONTRIBUTION STATEMENT

FCP contributed to research, product development, data analysis, and article writing. IR supervised the research activities and article writing.

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