Development of Interactive Multimedia Based on Articulate Storyline for Force Material to Improve Learning Outcomes

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ARTICLE INFO

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A B S T R A C T

This study aims to describe the development, feasibility, and effectiveness of interactive multimedia based on Articulate Storyline to improve fourth-grade students' learning outcomes at SDN Purwoyoso 01, Semarang. The research follows the Research & Development (R&D) method using the Borg and Gall model. Data collection techniques include tests (pre-test and post-test) and non-test methods (observation, interviews, questionnaires, and documentation). Data analysis involves normality tests, t-tests, and N-Gain tests. The developed multimedia consists of a main page, guidelines, learning materials, instructional videos, a virtual laboratory (PhET Simulation), interactive quizzes (Quizizz), and student worksheets (Live Worksheets). Feasibility assessments showed high validity from material experts (93.75%), media experts (93.33%), teacher responses (100%), and student responses (98.80%), categorizing it as highly feasible. The effectiveness was demonstrated by a 26.40% increase in pre-test and post-test scores, a paired sample t-test significance value < 0.001, indicating a significant difference, and an N-Gain score of 0.728 (high category). In conclusion, the interactive multimedia was successfully developed, deemed feasible, and proven effective in enhancing fourth-grade IPAS students' learning outcomes on force material at SDN Purwoyoso 01, Semarang.

1. Introduction

Education is a structured effort to develop an individual's knowledge, curiosity, and character, encompassing behavior, spiritual dimensions, and skill enhancement. It serves as a fundamental human necessity, enabling individuals to process and develop their potential in preparation for interaction with their surroundings. Education facilitates students in nurturing their potential, talents, and interests. This is outlined in Permendikbudristek Number 47 of 2023, which regulates the planning, implementation, and supervision of educational activities conducted by educational institutions at the early childhood, primary, and secondary education levels. Each educational level plays a significant role in shaping students' development. One of the foundational stages in education is

primary education, particularly in elementary schools, which serve as the initial stepping stone in a student's academic journey.

Students at the elementary education level require adequate education to support the learning process and achieve optimal learning outcomes. Learning is an interactive process between students, educators, and learning resources within a learning environment. Therefore, a deep understanding of students' characteristics at this level is essential for designing appropriate and effective learning strategies. This aligns with the reseach by Wahyuni et al. (2021) which states that learning is an interaction process that occurs between students, educators, and learning resources or media used to achieve specific competencies through learning activities conducted either directly or indirectly.

Elementary school students are divided into two groups: lower-grade students and upper-grade students. This classification is supported by Nur & Rahayu (2019) who explain that students' characteristics are shaped by both physical and cognitive development. At ages 6–13, students enter the concrete operational stage, where they begin to develop logical thinking but still rely on direct experiences. Lower-grade students (grades one, two, and three) are typically between 6–9 years old. Upper-grade students (grades four, five, and six) fall within the 9–13 age range. For lower-grade students, learning strategies should incorporate variety and engagement to accommodate their developmental needs and maintain their interest in the learning process.

The cognitive development of lower-grade students can be observed through their ability to classify objects, identify differences, and arrange or sequence items based on their characteristics. They also begin to expand their vocabulary, develop an interest in written numbers, actively engage in conversations, and understand cause-and-effect relationships. Elementary school children are in a phase of cognitive development that has not yet reached full maturity (Bahri & Akhmad, 2022). Upper-grade students in elementary education tend to be more practical in daily life, have a high level of curiosity, enthusiasm for learning, a realistic outlook, and show interest in specific subjects. In general, the characteristics of elementary school students include a love for playing, moving, working in groups, and engaging in hands-on activities. Therefore, teachers are encouraged to develop varied teaching methods that allow students to move, engage in activities, collaborate in groups, and actively participate in the learning process.

This has implications for learning in schools, particularly in elementary education. The elements of science learning in elementary schools include scientific understanding and process skills. This aligns with the research by Pendidikan & Dan (2024), which states that scientific understanding involves students developing scientific thinking skills, such as classifying living things and objects, as well as understanding motion and force. Science learning facilitates students in developing critical thinking skills, teamwork, scientific attitudes, and communication skills, which are essential aspects of life skills. Additionally, it enables them to apply fundamental scientific concepts in everyday life.

Technology-based science learning facilitates students in engaging with lessons in a more interactive and engaging manner. his is supported by (Rajagukguk & Rambe, 2022), who state that the rapid advancement of science and technology can be leveraged by educators to enhance the learning process, particularly in the development of instructional tools. Furthermore, technology enables the use of interactive media such as videos, animations, and simulations, making the learning process more engaging and easier to understand.

Data analysis from digital learning systems also helps teachers adjust their teaching strategies to meet students' needs, leading to better learning outcomes (Dhiya et al., 2024). Therefore, various efforts should be made to develop learning methods that align with modern advancements while capturing students' interest, ensuring a more engaging learning experience. Educators must first understand their students before delivering material and adjust the use of learning media to encourage critical thinking. Additionally, learning media play a crucial role in creating an enjoyable learning environment. Hence, the development of interactive multimedia is essential to support effective learning activities.

Interactive multimedia is a powerful tool that enhances the learning process, creating a dynamic and adaptive learning environment. This allows students to organize and select the sequence of learning materials based on their individual preferences. As stated by (Anggito & Sartono, 2022) interactive multimedia integrates various elements such as graphics, text, animations, videos, and audio, presented in an electronic format to deliver engaging learning materials. This captures students' attention and motivates them, ultimately improving their understanding.

This aligns with the research by Kusnadi & Azzahra (2024), which found that the implementation of interactive multimedia makes learning more engaging, increases student motivation, and enhances comprehension. Additionally, interactive multimedia creates an effective learning experience, allowing students to progress according to their individual abilities. Based on the preliminary research conducted through observations, interviews, and needs assessment surveys on September 9, 2024, in Grade IV at SDN Purwoyoso 01, Semarang, it was found that the technology-based learning media used by teachers was not yet optimal.

This issue stems from the limited and unsystematic use of media. Teachers primarily rely on YouTube videos, PowerPoint presentations (PPT), and simple teaching aids available in students' surroundings. As a result, there is a lack of consistency in delivering material, making it difficult for students to grasp key concepts. When learning media are not structured systematically, teachers struggle to determine when and how to use them effectively, reducing the overall effectiveness of the learning process. Teachers mainly use visual and audiovisual media, such as images and YouTube videos. Although they integrate videos and PPT slides, the slides contain only text without images, even though elementary students tend to be more engaged when presented with visuals and concise text explanations. Furthermore, teachers have yet to introduce interactive educational

games or hands-on practice activities, both of which are crucial for enhancing student engagement and comprehension. While visual and audiovisual media play an important role, over-reliance on them may overlook other media options that better suit students' learning styles and needs. Therefore, this research will present the topic of Force through an interactive multimedia platform based on Articulate Storyline to improve learning engagement and comprehension.

This is supported by the fact that student learning outcomes in Grade IV at SDN Purwoyoso 01, Semarang, for the topic "Forces Around Us" in the Odd Semester of the 2024/2025 academic year remain low. Based on the diagnostic cognitive assessment, 67.08% (14 students) scored below the Minimum Mastery Criteria (KKTP), while 32.92% (12 students) scored above the threshold. The KKTP for the IPAS subject in Grade IV at SDN Purwoyoso 01 is 67. These results indicate that Chapter 3: Forces Around Us has not been effectively taught. The diagnostic cognitive assessment analysis identified several misconceptions, particularly in the areas of function, application, types, and effects of forces. Given these findings, it is necessary to develop innovative learning media that align with the characteristics of the material. Such media should be able to visualize concepts in a more concrete and easily understandable way, ensuring better student comprehension and engagement.

Students still struggle to understand the concept of force, which leads to low comprehension levels and an inability to apply force concepts in real-life situations. This difficulty arises because students tend to perceive force merely as a push or pull, whereas force exists in various forms, including frictional force, gravitational force, and magnetic force. Many students misconstrue that force has no effect on stationary objects. Regarding gravitational force, they fail to recognize that the downward movement of an object can alter its shape and size. Additionally, students often overlook the significance of frictional force in daily life.

They assume that all objects will move freely when force is applied, neglecting the role of friction. However, friction affects motion when objects are at rest. While friction may act as a resistance, it can also be beneficial, such as when walking—the friction between shoes and the ground prevents slipping and enables movement. Given these challenges, engaging and interactive learning media are needed to help teachers effectively deliver the material and create an enjoyable learning experience for students. Therefore, this study aims to develop an innovative learning approach by designing interactive multimedia based on Articulate Storyline, complemented by a virtual laboratory using PhET Simulation, which provides simulations of different types of forces.

Articulate Storyline is a software tool designed to create and present interactive learning media. The learning materials developed using this software can be accessed via smartphones and laptops. According to Nasril & Desyandri (2023) Articulate Storyline 3 offers several advantages, including ease of application, simple publication process, and accessibility via the internet. It supports the HTML5 format, allowing it to be accessed on computers, and includes a quiz

feature that can be used for practice exercises. Additionally, it is interactive, engaging students actively in the learning process. In the learning environment, students are expected to actively participate in lessons to enhance their understanding, which can be facilitated through adequate infrastructure. Research by Safira et al. (2021) suggests that engaging and well-structured Articulate Storyline media can improve students' comprehension of the material. Furthermore, this learning medium also helps teachers in delivering lessons more effectively. This interactive multimedia will integrate images and text, along with interactive edugames through its built-in quiz platform. Additionally, it will incorporate a PhET Simulation virtual laboratory to support students in preparing for practical experiments, making learning more engaging and effective.

This research is supported by a study conducted by Safira et al. (2021) titled "Development of Web-Based Interactive Learning Media Using Articulate Storyline for Science Learning in Fifth-Grade Elementary School." The media development trial involved media experts, subject matter experts, and instructional design experts, yielding an average score of 95%, which falls under the "highly feasible" category. The one-to-one trial received an average score of 98.8%, while the small group trial achieved 99.4%. Based on data analysis using the Miles and Huberman model, the Articulate Storyline-based learning media was deemed highly suitable for use by fifth-grade students in elementary science learning.

Additionally, a relevant study by Averina & Widagda (2021) titled "Development of Interactive Learning Media Using Articulate Storyline to Improve IPAS Learning Outcomes at SDN Karangroto 01, Semarang" also supports this research. The validation results showed that the developed learning media received a 96% score from media experts and 86% from subject matter experts, with an overall average of 91%, categorized as "highly feasible." Thus, Articulate Storyline-based interactive learning media is considered effective and applicable in elementary schools to support the learning process and enhance students' understanding and engagement in science education.

Based on the previously explained background, the development of Articulate Storyline-based Interactive Multimedia by the researcher introduces a new innovation, particularly in fourth-grade science education on the topic of force (gaya). The development and testing of this interactive multimedia are expected to provide a creative and innovative solution to address challenges in science learning while also enhancing students' cognitive abilities and learning outcomes. This study aims to describe the development design of the interactive multimedia, assess its feasibility, and measure its effectiveness in improving fourth-grade students' science learning outcomes at SDN Purwoyoso 01, Semarang.

2. Methodology

This study employs the Research and Development (R&D) method. According to Sugiyono (2019), research and development aim to produce a specific product and

test its effectiveness. To develop Articulate Storyline-based Interactive Multimedia, the researcher utilizes the Borg and Gall development model. This model focuses on validating and refining a product (Sugiyono, 2019:394) and consists of 10 sequential stages, which are (1) Identifying potential and problems, (2) Reseach and infromation collecting, (3) Development preleminary form of product, (4) Product validation, (5) Design revision, (6) Preliminary field testing, (7) Main product revision, (8) Operasional feild testing, (9) Final product revision, and (10) Disseminasion and implementasion. The stages of the Borg and Gall development model are illustrated in Figure 1.
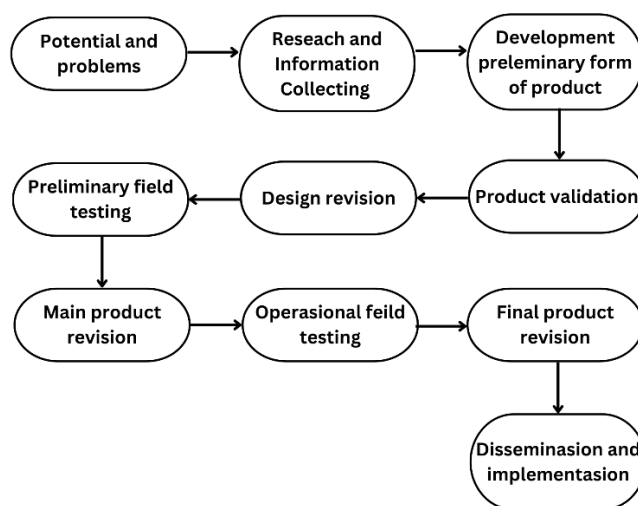

Figure 1. Borg and Gall Development Design (Sugiyono, 2022)

This research was conducted at SDN Purwoyoso 01 Kota Semarang during the first semester of the 2024/2025 academic year with a total of 26 students. The researcher used 6 students for small group trials and 20 students as subjects for large group implementation trials. In this study, two data collection techniques were employed: test techniques, which included pre-tests and post-tests, and non-test techniques, which consisted of observations, interviews, questionnaires, and documentation. The data analysis techniques used in this study were the normality test, t-test, and N-Gain test.

3.   Result and Discussion

This research resulted in the development of an interactive multimedia product based on Articulate Storyline, designed for IPAS learning with the topic of Force for fourth-grade students at SDN Purwoyoso 01 Kota Semarang. The research findings include (1) the design of interactive multimedia development based on Articulate Storyline, (2) the feasibility of the interactive multimedia, and (3) the effectiveness of the interactive multimedia based on Articulate Storyline.

Development of Interactive Multimedia Based on Articulate Storyline

Potential and problems

The first stage conducted by the researcher involved analyzing potential and existing problems. In this phase, the researcher carried out observations, interviews, questionnaires, and data documentation. These steps were taken to analyze issues, potential, and the needs of students. Based on the preliminary research, the problem identified in Grade IV at SDN Purwoyoso 01 was that teachers had not yet optimized the use of technology-based learning media, and the instructional media used lacked interactivity. Science subjects cover a broad scope and are closely related to everyday life. If the teaching process is monotonous, students may lose motivation to learn, ultimately affecting their understanding of science concepts (Wahyuni* et al., 2022). Students' low learning outcomes in the topic of force were due to difficulties in understanding the concept. Many students often believed that force was limited to only two types—pull and push forces. However, force can take many forms, including frictional force, gravitational force, and magnetic force. Another common misconception among students was the belief that force does not affect stationary objects. Most students assumed that force always causes objects to move. Additionally, students often failed to recognize the importance of force in daily life, assuming that all objects would move unhindered when a force was applied.

SDN Purwoyoso 01 possesses several potential strengths, including well-equipped learning facilities. Each classroom is furnished with a projector or LCD, enabling teachers to present learning materials visually and interactively. The school also has a stable internet connection, which is essential for accessing information and integrating technology into the teaching and learning process. Additionally, sound systems are available to support effective communication during classroom activities and school events. These advantages provide SDN Purwoyoso 01 with a significant opportunity to create innovative and interactive learning experiences. Based on the existing potential and challenges, the researcher analyzed students' needs and developed a product aimed at improving their learning outcomes. The product developed is a technology-based learning medium in the form of interactive multimedia using Articulate Storyline.

Reseach and infromation collecting

During the data collection stage, data gathering activities were conducted to identify the needs for product development. This statement aligns with (Okpatrioka, 2023) who stated that after analyzing existing potentials and issues, a product plan or design is formulated, covering several aspects: (a) the purpose of product use, (b) the target users of the product, and (c) a description of the product components and how they are used. The data collected by the researcher was obtained through teacher and student questionnaires regarding the need for media in the topic of force. The results indicate that users prefer content that is interactive, engaging, and easily accessible. Most respondents emphasized the importance of user-friendly design and features that support various learning

styles. Several learning styles can be observed, including visual, auditory, and kinesthetic learning styles (Agustina Silitonga & Magdalena Universitas Muhammadiyah Tangerang, 2020). Visual learners learn by seeing and observing, auditory learners learn by listening and paying close attention, and kinesthetic learners learn by touching and doing. The researcher also designed simple experiments by incorporating a virtual laboratory to support kinesthetic learners.

In discussions with teachers, it was revealed that they face challenges in delivering complex material to students, including the use of stimuli, presenting easily understandable content, conducting simple practical experiments, and incorporating cognitive level-based questions. Teachers expressed the need for learning media that can simplify difficult concepts, making learning more engaging and aligned with instructional needs to create an effective and efficient learning process. This indicates that interactive multimedia must have the ability to present information in a more visual and engaging manner, such as through animations, videos, and simulations. Additionally, the interactive multimedia content being developed should be relevant to current educational needs and aligned with the applicable curriculum standards. Based on the data obtained, both teachers and students require interactive multimedia based on Articulate Storyline, specifically designed for the topic of force, ensuring that it is engaging and easy to use.

Development preliminary form of product

The third stage is product design. The initial product development involves creating a blueprint of the intended product, which should be as detailed as possible (Okpatrioka Okpatrioka, 2023). At this stage, interactive multimedia based on Articulate Storyline is designed by structuring the interactive multimedia framework and planning the presentation of learning materials. The development of this interactive multimedia is closely tied to the results of the needs assessment survey. The outcome of the product design phase is a prototype. The interactive multimedia prototype based on Articulate Storyline consists of several components, including: a main page containing material identification, a login menu where students can enter their names and school names, a main menu equipped with usage instructions, activity guidelines, a concept map, structured learning materials, instructional videos, a virtual laboratory using PhET Simulation as an interactive educational game, interactive quizzes with Quizizz, and student activity sheets using Live Worksheet.

Interactive multimedia is also equipped with various buttons, including a start button to begin, buttons for navigating to the previous or next page, a button to enable/disable the audio explanation of the material, a close button to exit the interactive multimedia, a home button to return to the main menu, and a "learn more" button for further exploration of the material. This aligns with the statement by (Syamsiani Syamsiani, 2022) that interactive multimedia includes control tools operated by users, allowing them to choose their preferred actions for the next process. This interactive multimedia provides student activity guides in the form of "Let's Observe," "Let's Sing," "Let's Read," "Let's Analyze," and "Let's

Practice." Additionally, it includes learning outcomes and objectives that must be achieved. The supporting information contains the core material, which focuses on forces. Student Worksheets (LKPD) are presented as experiments to prove force concepts. Moreover, the multimedia features a bibliography and a developer profile. The researcher designed interactive learning media using Articulate Storyline software. Articulate Storyline is a software tool that can be used for presentations or communication. The software will be adapted into a web-based platform, allowing interactive multimedia to be accessed flexibly. In this mode, students will interact with the multimedia using various features presented in an application. The product design aims to assist teachers in conducting student-centered learning. This is supported by (Saski, N.H. & Tri, S., 2021) , who state that Articulate Storyline is an e-learning-based software designed as a teaching aid with an interactive display. The results of the interactive multimedia design based on Articulate Storyline can be seen in Figures 2, 3, 4, 5, and 6 below.
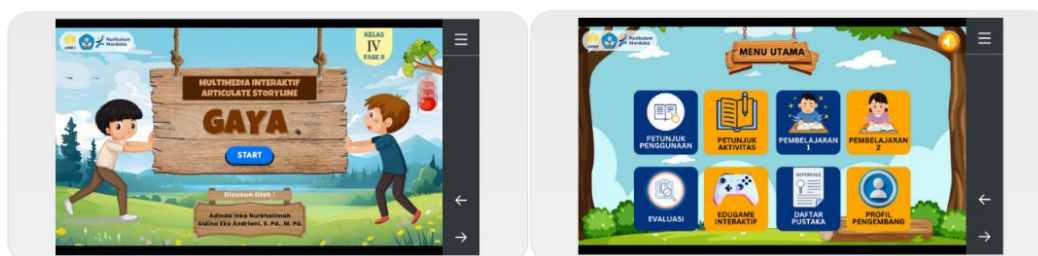

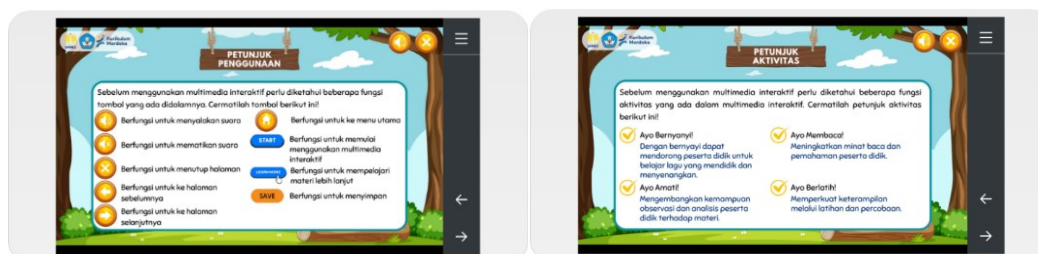Figure 2. Main Page and Main Menu
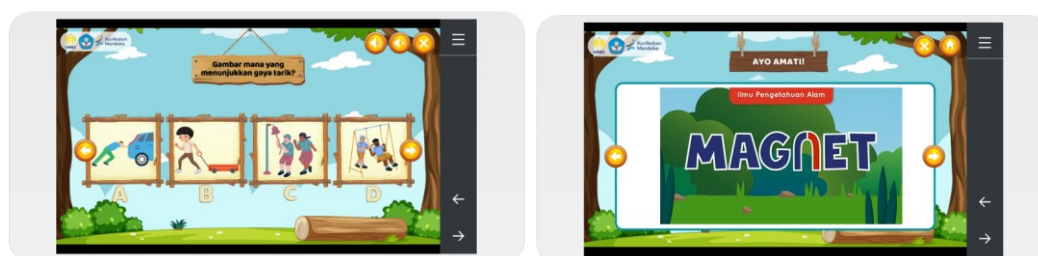

Figure 3. Usage Instructions and Activities

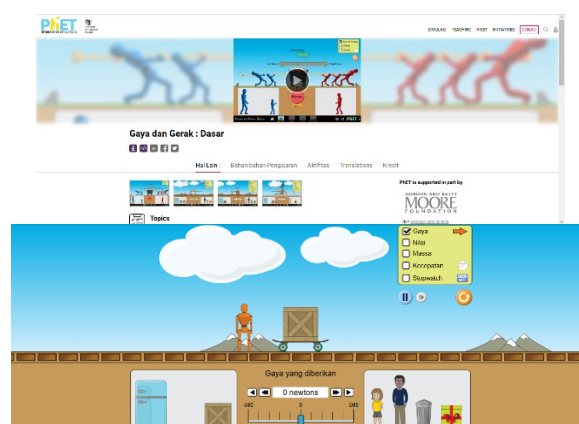Figure 4. Learning Material Presentation 1 & 2

Figure 5. Virtual Laboratory: PhET Simulation

Figure 6. Student Worksheet: Live Worksheet

The design development of interactive multimedia based on Articulate Storyline, conducted by the researcher, is designed by combining text, images, videos, and audio to enhance students' understanding and learning outcomes. The advantages of this interactive multimedia include various innovations, such as an engaging combination of colors and backgrounds tailored to the learning material on force, featuring animations, images, and videos of children or individuals demonstrating different types of forces, such as pushing and pulling. This is supported by the statement from (Legina & Sari, 2022) that Articulate Storyline is an e-learning-based software designed as an interactive learning tool. Each lesson is equipped with a concept map aimed at identifying the material to be studied by students. In addition to the concept map as the main planning tool, there is also a presentation of learning objectives and achievements, which serve to explain in detail the competencies students must attain in each lesson.

The novelty of interactive multimedia based on Articulate Storyline lies in its presentation of learning materials tailored to the learning syntax. The inclusion of audio explanations narrated by the developer allows users to activate or deactivate it flexibly according to their needs. This interactive multimedia is further modified

by incorporating an interactive edugame featuring the PhET Simulation virtual laboratory, enabling students to conduct simulated experiments as pre-practical support to strengthen their conceptual understanding during the learning process. Additionally, the development of Articulate Storyline-based interactive multimedia includes an interactive quiz feature accessible via Quizizz, allowing students to assess their understanding of the material. Through Quizizz, students receive immediate feedback on their answers, helping them recognize mistakes and improve their comprehension. The researcher also integrates student worksheets (LKPD) accessible through Live Worksheet, aiming to enhance student engagement and enthusiasm. This feature enables direct interaction with the content, real-time responses to questions, and instant feedback. Some functionalities also allow students to collaborate or compete with one another, fostering motivation and enthusiasm in learning.

Product validation

The fourth stage is product validation. Product design validation is conducted to analyze the feasibility of the developed product by involving media and subject matter experts who assess it using a validation instrument (Waruwu, 2024). The assessment results are essential in determining the feasibility level of the product developed by the researcher. This product validation is carried out using a research instrument in the form of a questionnaire. The validation process by media experts focuses on visualization and feasibility aspects, while subject matter experts evaluate content suitability, accuracy, and overall content feasibility. The evaluation results from media and subject matter validators serve as a reference for revising and improving the product based on the given scores, suggestions, and feedback. The developed interactive multimedia has been validated and deemed highly feasible for implementation in learning.

Product revision

The fifth stage is product revision. This stage follows the guidance provided by subject matter and media experts to ensure that the product aligns with the specified classifications in terms of both content and design. The revision process is conducted to refine the developed media, address deficiencies, and enhance its quality (Waruwu, 2024). The researcher made revisions based on feedback and suggestions from subject matter experts by adding e-LKPD (electronic student worksheets) and e-evaluation to the media while adjusting the title accordingly. The LKPD was structured sequentially based on the learning objectives and the content in the teaching materials. After the revisions were made, the media was deemed suitable for use.

Preliminary field testing

The sixth stage is product testing. This research proceeded to the small group trial stage, involving six fourth-grade students from SDN Purwoyoso 01 Kota Semarang. The purpose was to obtain feedback, suggestions, and necessary improvements for the interactive multimedia based on Articulate Storyline.

In this stage, the six students were grouped according to their level of understanding, categorized as less proficient, proficient, and highly proficient. Before conducting the trial, the researcher administered a pre-test. After the trial, a post-test was given to assess the students' progress. Additionally, the researcher distributed response questionnaires to both teachers and students to determine whether any improvements were needed before proceeding with large-scale testing.

Main product revision

The seventh stage is product revision. This revision is conducted to evaluate the feasibility and effectiveness of the product. The goal of this step is to refine the design based on the results of the small group trial. The initial product improvement was carried out after a limited field trial. The product revisions were made based on the analysis of teacher and student response questionnaires during the product trial stage. These revisions could include improvements in design, content, and other aspects to make the product more relevant and supportive of students' learning needs. However, the analysis of teacher and student response questionnaires indicated that no revisions were necessary, as the interactive multimedia based on Articulate Storyline had already met the required criteria. Therefore, the product was deemed ready for large-scale testing.

Operasional feild testing

The eighth stage is the usage trial. This step involves large-scale product testing, including an evaluation of the product design's effectiveness. The outcome of this trial is the development of an effective design in terms of both substance and methodology. The purpose of the usage trial is to assess the broader effectiveness of the product and obtain representative data. This stage was conducted with a larger group of 20 fourth-grade students at SDN Purwoyoso 01 Kota Semarang. Before the product trial, the researcher distributed a pre-test to the students. After the product trial with the large group, a post-test was administered. Additionally, the researcher provided teacher and student response questionnaires to ensure that the interactive multimedia based on Articulate Storyline was feasible and effective for use in the learning process.

Final product revision

The ninth stage is product revision. At this stage, the revision is the final step taken by the researcher before proceeding to mass production. This phase of product revision is based on the teacher and student response questionnaires collected after conducting trials with the large group. This step serves as the final refinement of the product following field trials, incorporating feedback and results from the large-group testing. The results of the teacher and student response questionnaires indicated that no revisions were needed for the interactive multimedia developed by the researcher. Therefore, this study was concluded at the ninth stage.

Feasibility of Interactive Multimedia Based on Articulate Storyline

The feasibility of interactive multimedia based on Articulate Storyline in science subjects, specifically on the topic of force, was determined through an evaluation conducted by expert validators in content and media, as well as responses from teachers and students via questionnaires. Before being tested on students, this assessment aimed to evaluate the feasibility and measure the quality of the developed learning media (Victorio Isya Erlangga et al., 2023). The content expert validators were given an assessment instrument consisting of five aspects, including: 1) accuracy in relation to learning components, 2) suitability with students cognitive levels, 3) support for learning evaluation content, 4) stimuli that aid in understanding the material, 5) appropriateness for supporting factual, conceptual, and principle-based learning content. The media expert validators assessed the multimedia based on three aspects: 1) content quality and objectives, instructional aspects, technical or visual aspects. Additionally, researchers distributed response questionnaires to teachers and students, covering several aspects understanding of the material, ease of using the media and learning process, media presentation, media quality, learning quality, the feasibility analysis results from content and media expert validators are presented in Table 1.

Table 1. Evaluation Results of Material Experts and Media Experts

Validator	Assesment Percentage (%)	Criteria
Material Expert	93,75%	Highly Feasible
Media Expert	93,33%	Highly Feasible

Based on Table 1, the development of interactive multimedia using Articulate Storyline is deemed highly feasible, with an assessment score of 93.75% from the material expert validator and 93.33% from the media expert validator. The feasibility of the material aspect is based on the relevance of the content presented in this interactive multimedia. The developed material focuses on the concept of force in science learning, where the use of interactive multimedia enables a clearer presentation of concepts through a combination of images, text, videos, animations, and audio to illustrate various types of forces and their effects in everyday life (Nasril & Desyandri, 2023). According to the media expert validator's assessment, the functional and visual aspects incorporate engaging stimuli to facilitate students' learning and capture their attention. The development results of interactive multimedia using Articulate Storyline are further supported by the analysis of teacher and student response questionnaires, as shown in Table 2.

Table 2. Analysis Results of Teacher and Student Response Questionnaires

Response	Assessment Percentage (%)	Criteria
Teacher	100%	Highly Feasible
Students	98,80%	Highly Feasible

Based on Table 2, the questionnaire results indicate that the teachers' response to the trial usage reached 100%, categorized as highly feasible, while the students' response was 98.80%, also classified as highly feasible. Based on the feasibility

analysis of the media and material in Table 1, along with the teacher and student response questionnaire results in Table 2, it can be concluded that the interactive multimedia using Articulate Storyline is highly suitable for use in science learning, particularly on the topic of force. The variation of stimuli, including text, images, videos, and interactive edu-games, aligns well with the learning objectives and needs, making it easier to understand abstract concepts. The engaging and interactive presentation enhances students' motivation and involvement in learning.

The interactive multimedia based on Articulate Storyline, developed by the researcher, is designed to be as engaging as possible by incorporating images, animations, videos, a virtual laboratory, and interactive quizzes. The combination of appealing visuals and functional elements aims to capture students' attention. This approach is based on Gagné's information processing theory, which states that information or stimuli that attract attention become more meaningful, allowing the information to be encoded more effectively and stored in long-term memory. As a result, the science concepts that students acquire through this interactive multimedia will be retained in their long-term memory, improving the quality of their information reception and processing. Additionally, engaging media directly impact students' motivation in the learning process. A high level of learning motivation leads to better learning outcomes. Student motivation significantly influences their academic performance (Yogi Fernando et al., 2024).

The questionnaire results on media quality and usage indicate that students were enthusiastic and eager to participate in the learning process. Therefore, the interactive multimedia based on Articulate Storyline is highly suitable for use in science learning, particularly on the topic of force.

Effectiveness of Interactive Multimedia Based on Articulate Storyline

Effectiveness testing is conducted to measure the success of media usage in improving students' learning outcomes. The effectiveness of interactive multimedia based on Articulate Storyline can be assessed by comparing the improvement in pre-test and post-test scores. The pre-test scores are obtained by administering a test before using the interactive multimedia in the learning process, while the post-test scores are collected after its implementation. The comparison of pre-test and post-test results provides insight into the impact of the multimedia on students' understanding and knowledge retention. The analysis of pre-test and post-test scores is presented in Table 3.

Table 3. Pre-Test and Post-Test Results of Usage Testing

Aspect	Pre-test Score	Skor Post-test
Average	63.20	89.60
Maximum Score	80	100
Minimum Score	44	80

Based on Table 3, there was an average increase in student learning outcomes of 26.40, from a pre-test average score of 63.20 to a post-test score of 89.60. After

determining the pre-test and post-test average scores, the next step in the research was data analysis using SPSS version 3.0. The initial data analysis conducted was the normality test, while the final data analysis included the t-test and N-Gain test.

The normality test aims to determine whether the data follows a normal distribution. This test is conducted to select the appropriate statistical analysis method. In this study, the researcher used SPSS software with the Shapiro-Wilk formula. The results of the normality test analysis are presented in Table 4.

Table 4. Normality Test Results of Usage Testing

Shapiro-Wilk	Significance Value (Sig.)	Description
Pre-test	.114	Normal
Post-test	.190	Normal

The normality test criteria are determined based on the significance value. Data is considered to be normally distributed if the Sig. value is greater than 0.05. Conversely, if the Sig. value is less than 0.05, the data is considered not normally distributed. Based on Table 4, the normality test results show that the Sig. value for the pre-test data using the Shapiro-Wilk test is 0.114, and for the post-test data, it is 0.190. Since both Sig. values are greater than 0.05, it can be concluded that the pre-test and post-test data are normally distributed.

After confirming that the data is normally distributed, the next step in the research was conducting the final data analysis, which included the t-test and N-Gain test. The t-test aims to determine the effect or difference in students' average learning outcomes based on pre-test and post-test results. According to Sugiyono (2019), the t-test is used to measure the extent to which the independent variable influences the dependent variable partially. If H_0 is accepted, it means the independent variable does not have a significant effect on the dependent variable. Conversely, if H_0 is rejected, it indicates a significant influence between the independent and dependent variables. The researcher conducted a Paired Sample T-Test for this study. The results of this analysis are presented in Table 5.

Table 5. T-Test Results of Pre-Test and Post-Test in Usage Testing

Treatment	N	Mean	T	Sig (2-tailed)
Pre-test	20	63.20	-14.313	<,001
Post-test	20	89.60		

Based on Table 5, the results of the Paired T-test indicate a significant difference between the average pre-test and post-test scores. The calculated t-value obtained is -14.313, with an average pre-test score of 63.20 and an average post-test score of 89.60, based on a sample size of 20. The Paired T-test results show that the Sig. (2 tailed) value is less than 0.05, specifically < .001, leading to the rejection of H_0 and acceptance of H_a. Therefore, it can be concluded that there is a significant difference in learning outcomes before and after using interactive multimedia based on Articulate Storyline as a learning medium. This finding demonstrates that interactive multimedia using Articulate Storyline effectively enhances

students' learning outcomes, particularly in science education on the topic of force.

Uji analisis data yang terakhir adalah uji N-Gain yang bertujuan untuk mengetahui dan mengukur sejauh mana peningkatan hasil belajar peserta didik sebelum dan sesudah menggunakan multimedia interaktif berbasis Articulate Storyline. Hasil pengujian N-Gain dapat dilihat pada Tabel 6.

Tabel 6. Hasil Uji N-Gain pada Uji Coba Penggunaan

Treatment	Aspect	N-Gain	Criteria
Pre-test	63.20	.728	High
Post-test	89.60		

Based on Table 6, it is evident that the use of interactive multimedia based on Articulate Storyline in Grade IV of SDN Purwoyoso 01, Semarang, for the topic of force resulted in an average N-Gain of 0.7280, which falls into the high category. This value indicates a significant improvement in learning outcomes in the large-group trial class after using the interactive multimedia. Thus, the developed media has been proven to be effective in the learning process (Agustina et al., 2021). The improvement in students' average learning outcomes during the usage trial of the interactive multimedia based on Articulate Storyline is illustrated in Figure 7 below.
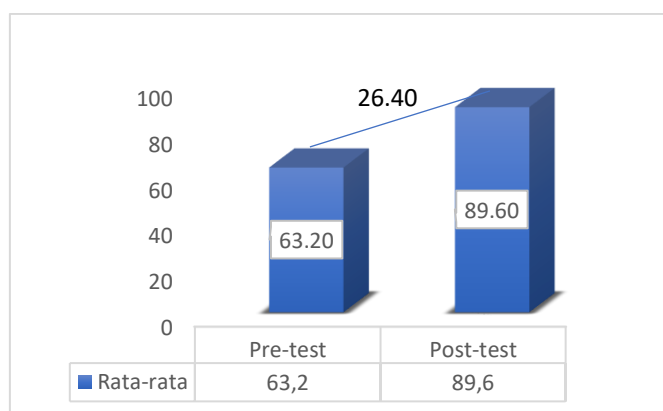

Figure 7. Average Pre-Test and Post-Test Scores of Grade IV Students at SDN Purwoyoso 01, Semarang

The increase in the average pre-test and post-test scores in the large-group trial was 26.40. The distribution in the large-group trial consisted of 6 students in the highly proficient category, 7 students in the proficient category, and 7 students in the less proficient category. This variation in scores resulted from differences in students' levels of understanding and abilities. Additionally, the learning process was facilitated by the use of technology such as mobile phones and laptops, which helped minimize obstacles in using the interactive multimedia based on Articulate Storyline.

The interactive multimedia based on Articulate Storyline developed by the researcher can be used flexibly, not limited to classroom learning. This enhances students' learning experiences, making the learning process more efficient and effective. This finding aligns with the study by (Mata et al., 2024), which found that teachers support the development of Articulate Storyline-based media in science learning. The engaging design of the media helps capture students' attention and assists teachers in delivering material in a structured manner using the available features. Similarly, research by (Febrianto et al., 2022), howed that using website-based Articulate Storyline media effectively improved students' science learning outcomes. The present study further confirms that interactive multimedia based on Articulate Storyline is an effective tool for enhancing student learning outcomes.

Interactive multimedia can significantly enhance the effectiveness and efficiency of the learning process. Its use in education makes learning more engaging, encourages students to be more active, and increases their motivation to participate in lessons. This is supported by Olvah & Suciptaningsih (2024) who state that interactive multimedia plays a crucial role in helping students grasp new concepts, develop skills, and improve competencies. High learning motivation during the learning process positively contributes to academic achievement the greater the students' interest, the better their performance. Therefore, the development and utilization of interactive multimedia should be aligned with students' characteristics and advancements in technology. The interactive multimedia product developed in this study has been proven to be valid, feasible, and effective for implementation in elementary school education.

The findings of this study indicate that learning with the implementation of interactive multimedia provides a significant improvement compared to learning before using Articulate Storyline-based interactive multimedia. This is evidenced by the higher post-test scores, with a 26.40% increase. The use of Articulate Storyline-based interactive multimedia in learning made students more engaged and active throughout the lesson. Students demonstrated greater involvement, as the material was presented in a more engaging manner with interactive elements such as quizzes, animations, and simulations, helping them better understand the concepts being taught. Students also responded very positively to the use of interactive multimedia.

They found the material easier to understand, and the learning process became more enjoyable. This was because students were enthusiastic and focused during the lessons, actively asking questions when they did not understand the material, and confidently participating in class activities (Dani & Arief, 2023). Furthermore, the self-paced learning facilitated by this platform allows students to learn at their own speed, while instant feedback after activities helps them correct mistakes and enhance their understanding. Thus, this study highlights that interactive multimedia not only boosts learning motivation but also provides a more relevant and personalized learning experience, ultimately positively impacting students' learning outcomes. In line with this(Sajidah & Wulandari, 2024) stated that increased learning interest contributes to improved student

learning outcomes. This occurs because the use of Articulate Storyline-based interactive learning media makes the learning process more effective and efficient.

4.   Conclusion

Based on the results and discussion, it can be concluded that the design and development of Articulate Storyline-based interactive multimedia was successfully implemented, incorporating various interactive multimedia components, including: main page, learning materials, educational video, virtual laboratory PhET Simulation, interactive quizzes (Quizizz), student worksheets (Live Worksheets). The feasibility of Articulate Storyline-based interactive multimedia, as evaluated by media and subject matter experts, received a highly feasible rating. This is because the quality of content and objectives, visual design, and usability of the provided stimuli met the required standards.

The effectiveness of this interactive multimedia was evident from the increase in pre-test and post-test scores, supported by t-test results and an N-Gain score classified as high. Thus, Articulate Storyline-based interactive multimedia was successfully developed, deemed feasible and effective in improving science learning outcomes specifically on the topic of force for Grade IV students at SDN Purwoyoso 01, Semarang. Overall, this research demonstrates that the development of interactive multimedia on the topic of force significantly enhances students' learning outcomes in science. By integrating engaging interactive and visual elements, students become more involved and motivated in the learning process, leading to better conceptual understanding. The data analysis results show a significant improvement in students' learning scores after using this interactive multimedia, proving that innovative, technology-based learning approaches have a positive impact on students' learning outcomes in science, particularly in understanding the concept of force.

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