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Web-based Interactive Visual Media in Teaching Momentum and Impulse to Improve Students' Conceptual Understanding

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Abstract

This study aims to develop a visual and interactive learning platform using Google Sites to enhance students' understanding of momentum and impulse concepts. The research applies a Research & Development with the 4-D model: Define, Design, Develop, and Disseminate. The research instruments included tests, expert validation, and a User Experience Questionnaire, which was completed by students and teachers, covering six dimensions of assessment. The research findings show: (1) The validity scores for the material (94.29%), media (98.3%), and language (96.88%) aspects all fall into the "Highly Feasible" category. These results indicate that the Google Sites–based instructional media is highly feasible for teaching Momentum and Impulse concepts. (2) In terms of practicality, the media achieved scores of attractiveness (2.143), clarity (1.764), efficiency (2.136), accuracy (1.886), stimulation (2.150), and novelty (1.929). These results reflect a highly positive user experience across all aspects measured by the UEQ. (3) The N-Gain test results show a score range of 0.46-0.95 with an average of 0.74 (high category), proving that Google Sites instructional media is quite effective in improving students' conceptual understanding. The use of this instructional media has the potential to contribute to Sustainable Development Goal (SDG) 4: Quality Education by promoting inclusive and equitable learning opportunities. Through the integration of Google Sites, students are encouraged to engage in independent learning, making education more accessible and adaptable to diverse learning needs.

Keywords: *4D, Concept understanding, Instructional media, Web*

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INTRODUCTION

Education plays a key role as the main foundation for national development (Yunizar et al., 2024). The ultimate goal is to enhance the quality of human resources, not only by strengthening character but also by improving global competitiveness. One of the key strategies to achieve this is through the integration of technology-based learning tools. This approach aligns with the Sustainable Development Goals (SDGs), particularly SDG 4: Quality Education, which focuses on ensuring inclusive, equitable, and high-quality education for all learners. (Syahputra, 2025).

The development of educational systems through instructional media plays a vital role in shaping the learning process in today's digital era. It not only supports more effective knowledge delivery but also encourages interactive and engaging learning experiences for students. (Permana et al., 2024). In line with the government's efforts to improve the quality of education, Government Regulation Number 19 of 2005 Article 20 states that teachers are expected to develop their own learning materials. By creating and utilizing appropriate teaching resources, teachers can better support students in achieving their learning objectives (Jiwa, 2022).

One of the challenges in education is the limited availability of instructional media that fully align with the current curriculum. This gap often occurs because curriculum changes are not always followed by comprehensive and timely updates to learning materials and textbooks. (Aisyah et al., 2020). Meanwhile, teaching materials in instructional media have a significant impact on high school students' understanding of physics concepts (Mulyana et al., 2021). In addition, the type of teaching media used also plays an important role in determining how flexible learning time can be, which in turn affects how effectively physics learning objectives are achieved. (Romadhan, 2023). Therefore, it is necessary to develop instructional media to initiate learning that is in line with learning objectives, especially in physics material.

Research results (Atmaja & Samsudin, 2025) show that the lack of understanding of physics concepts in Indonesian regions on the subject of momentum and impulse leads to significant misconceptions. Based on the international PISA (Programme for International Student Assessment) survey, there has been a noticeable decline in students' science performance among those randomly selected by the OECD. (OECD, 2023) in 2022. Around 66% of students in Indonesia are still below the minimum competency standard in science literacy. This means only about 34% of students have reached or surpassed level 2 on the PISA science proficiency scale. These numbers highlight that nearly half of the students possess only a basic understanding of scientific concepts. Interestingly, about 65% of students reported having high learning motivation, indicating that while interest and engagement are present, they are not yet fully translated into stronger academic performance. (OECD, 2023). The data indicate that despite students' motivation, challenges related to their well-being remain significant and can impact their academic performance. Key factors that influence student well-being include the physical school environment, social relationships within the school community, and students' sense of self-fulfillment at school. However, Indonesia's ranking remains relatively low compared to other countries. Data indicate that the quality of teacher training is still a major challenge. Although efforts have been made to enhance professional development, PISA results reveal that the quality of teaching is still uneven. One of the key issues is the limited improvement in teaching media and learning approaches, which continue to be predominantly teacher-centered. (Lestari et al., 2023).

In implementing digital learning in schools, the challenges teachers face in developing digital instructional media are not solely due to age factors. Other factors, such as low interest in learning information technology (IT) and limited skills in designing digital instructional media, also play a significant role. As a result, the underutilization of media in the teaching process can negatively affect students, as less effective teaching methods may make it harder for them to fully grasp the material. As a result, the learning process becomes monotonous and less interesting (Permatasari et al., 2022).

Through interviews, the researchers identified that the instructional media available in schools are still limited, especially in terms of interactive digital media and teaching resources. Additionally, students in each class only have access to five mobile phones, which further restricts the use of digital learning tools. Although there are teaching media based on Google Sites that have been developed previously by Lativa et al. (2024), there are no features for simulations, discussion groups, contextual videos, and other media sources. Instructional media that use simulations can improve student performance in learning physics (Fiscarelli et al., 2013). At present, the use of Google Sites in learning is still quite limited, mainly serving as a platform for e-books and practice exercises with less engaging visuals. This lack of interactive and appealing design means the platform has not been used to its full potential and remains poorly integrated with technology. As a result, students' motivation and learning outcomes remain relatively low.

Therefore, using Google Sites as a learning medium is considered an effective solution because it is easy to create, highly accessible, and allows for interactive features. Through this platform, researchers can integrate various elements such as interactive simulations, discussion forums, contextual videos, learning evaluations, and more. The use of interactive digital instructional media like this can help create a more engaging and active learning environment for students. (Handika et al., 2025). In physics learning, as researched by (Alves Do Nascimento et al., 2022) several digital teaching materials applied in the study, one of which is Google Sites, make physics learning more enjoyable because they offer multimedia features to support the learning process. Furthermore, learning using Google Sites can help students in independent learning, especially in physics learning, by providing visual learning for abstract and interactive concepts (Bueno et al., 2022). Thus, the development of visual and interactive instructional media is not only intended to enhance students' understanding of momentum and impulse concepts, but also represents a strategic effort to support the Sustainable Development Goals (SDGs), particularly SDG 4: Quality Education. Through inclusive, equitable, and high-quality digital learning, this initiative contributes to improving the overall quality of education in the modern era.

METHOD

This study uses the Research and Development method with a 4D development model consisting of several stages, namely: Define, Design, Develop, and Disseminate (Thiagarajan et al., 1974). The 4D model is most commonly used in the field of education, especially for curriculum design and the development of teaching materials. Its use outside the education sector, however, remains relatively limited (Indaryanti et al., 2025). Therefore, the selection of this development model is appropriate for the research conducted.

Define

At this stage, researchers identified students' learning needs, characteristics, and learning objectives, as well as potential challenges that could influence the media design process. They also gathered data to gain a deeper understanding of existing problems or gaps in students' knowledge and skills. This information was obtained through interviews with physics teachers and several students at the school.

Front-end analysis

The researchers began by analyzing the challenges in physics teaching through a pre-analysis process, which involved identifying and examining the obstacles faced by both teachers and students. This was done through in-depth interviews with teachers. The initial analysis focused on identifying concepts that students found difficult to grasp, serving as the foundation for aligning learning standards with creative approaches in developing appropriate and effective instructional media. The Google Sites-based media developed by Lativa et al. (2024) does not yet have a simulation function and is still limited to e-books and exercises, so its use is not yet optimal and is not fully integrated with technology, which is reflected in low student motivation and unsatisfactory learning outcomes.

Learner analysis

The main goal of this activity is to gather in-depth information about students' individual characteristics through direct interviews. To achieve this, researchers asked educators to analyze student characteristics in several ways: (1) examining students' personalities and (2) asking them to describe aspects of themselves. These aspects include their preferred learning styles, prior knowledge, learning challenges, and motivation for studying physics, particularly topics related to momentum and impulse.

Task analysis

This activity begins with a thorough review of the learning objectives and outcomes for the material to be taught. The process is guided by the Merdeka Curriculum, which emphasizes differentiated learning to accommodate each student's unique needs, interests, and learning styles. This strategy allows teachers to tailor the subject matter (content), delivery method (process), and form of assessment (product) to be more personalized and meaningful, avoiding a one-size-fits-all approach.

Concept Analysis

To identify and describe the core concepts in web-based teaching materials, a concept analysis was carried out. This step ensures that the learning materials are not only well-structured and informative but also aligned with the curriculum being implemented. In this study, the concept analysis centers on the topic of impulse and collisions, covering subtopics such as momentum, reflection, types of collisions, and the law of conservation of momentum. Mastery of these concepts plays a crucial role in supporting students' conceptual comprehension of physics in the second-grade curriculum.

Specifying Instructional Objectives

At this stage, researchers evaluate and analyze the available learning materials, set clear learning objectives, allocate appropriate learning time, and prepare supporting learning resources. The learning objectives are then formulated in a clear and structured way to guide the overall learning process effectively.

Design

Constructing Criterion-Referenced Test

The development of test guidelines acts as a bridge between the design and definition phases. This process is informed by interview findings that provide insights into students' characteristics and learning abilities. Based on this information, the test design is created to strengthen students' conceptual comprehension. Each assessment specification includes clear instructions and answer keys, and the questions are carefully adapted to match students' ability levels. The overall test concept is aligned with the learning objectives and students' learning capacities throughout the teaching process.

The concept comprehension test items in this study were developed based on the revised Bloom's Taxonomy by Anderson & Krathwohl (2001) This framework includes seven cognitive indicators: interpretation, exemplification, classification, generalization, inference, comparison, and explanation. Each indicator was developed into 14 descriptive questions covering the topics of momentum and impulse. The questions were designed to assess students' ability to grasp the meaning of concepts, identify examples and non-examples, classify phenomena, draw logical conclusions, compare concepts, and explain the relationships between physical variables. In addition, worksheets were used as supporting tools to help students visualize and better understand the learning material.

Media Selection

The selection of media is intended to identify teaching materials that match the characteristics of the subject matter while incorporating features that support the use of interactive visual elements. These features are designed to help students develop a deeper understanding of the concepts being taught. The chosen media components are carefully adjusted to meet specific learning needs. The selected media should have stimulating elements that encourage active student engagement during learning activities.

Format Selection

The selection of the format during the instructional media development stage is carefully based on the learning objectives and outcomes, relevant learning references, module design, and the materials that will be delivered.

Initial Design

This stage takes place before the trial phase and focuses on determining the media to be used. The learning media developed through Google Sites is designed with several main menus: Home, Learning Objectives, Materials, Videos, Simulations, Group Discussions, and Evaluations. Each menu is enriched with text, images, real-world phenomenon videos, and PhET simulations, allowing students to relate physics concepts to real-life situations. The Materials section applies the Discovery Learning approach to encourage active exploration and deeper understanding.

Develop

At this stage, feasibility tests are carried out for both the product and the test instruments. The process begins with developing an initial design and validating it through questionnaires involving subject matter, media, and language experts. Next, comprehension test instruments are created and reviewed by subject matter, construct, and language experts. Finally, the product is revised based on the feedback and recommendations provided by the experts to ensure its quality and effectiveness. Fourth, conducting small group testing on the finished product with 1 to 3 groups of students using 11 subjects. Fifth, revising the finished product based on suggestions from small group testing through the UEQ response questionnaire to measure media experience (Schrepp, 2023).

Disseminate

At this stage, the effectiveness of the product is evaluated. After conducting initial trials and making revisions based on user feedback, the product is finalized and prepared for broader use. Its effectiveness is tested in the field by comparing students' understanding before and after using the digital instructional media. The final product is implemented to second-grade students at an Islamic high school in South Tangerang. This stage is also carried out through the publication of journal articles (Saputri & Laksono., 2023). The purpose of this stage is to distribute the product and measure students' understanding of the concepts before and after using the instructional media.

In validating the instrument's feasibility, a set of questions was used to assess how well the test instrument reflected and measured the intended content, ensuring its overall content validity. The concept comprehension test instrument used is the concept comprehension developed by (Anderson & Krathwohl, 2001), which consists of seven aspects, namely interpretation, exemplification, classification, generalization, inference, comparison, and explanation. CVR is used to assess the level of suitability of test items based on expert assessment. In the assessment process, each item deemed relevant is given a score of 1, while items considered inappropriate receive a score of 0. For media feasibility validation, a 1–5 rating scale is used, covering several key aspects of instructional media development: self-instruction, self-contained content, adaptability, digital media components, media design, the use of clear and interactive language, and language consistency (Depdiknas, 2008).

The assessment of instructional media suitability is categorized into five levels based on the percentage score obtained. The "Highly feasible" category is given if the percentage is in the range of more than 80 to 100. The "feasible" category is assigned to percentage values between 60% and 80%. Meanwhile, percentages ranging from above 40% to 60% fall into the "Moderately Feasible" category. If the results are between 20% and 40%, they are categorized as "Less Feasible." Meanwhile, the "Unfeasible" category is assigned to percentages in the range of 0 to 20 (Sugiyono, 2013). CVI effectiveness test criteria: values in the range of 0.00–0.33 are classified as Less Feasible, values in the range of 0.34–0.67 are classified as feasible, and values in the range of 0.68–1.00 are classified as Highly Feasible (Allahyari et al., 2011).

The UEQ instrument includes six key scales: attractiveness, clarity, efficiency, accuracy, stimulation, and novelty, covering a total of 26 statement items. The average value of each item is converted into an index, and the results are then categorized into three assessment levels: positive if the index value is > 0.8, neutral if it is in the range of –0.8 to 0.8, and negative if the index value is < –0.8 (Schrepp, 2023). If the results of data processing with Microsoft Excel on the six aspects of the UEQ show a value above 0.8, then the digital teaching material can be categorized as very practical to use.

The effectiveness of the Google Sites–based interactive visual instructional media was evaluated using the N-Gain method, which measures the improvement between students' pre-test and post-test scores. The analysis revealed a noticeable increase in students' learning outcomes after engaging with the media (Wijaya et al., 2021). To determine the category of N-Gain score improvement, you can refer to the normalized Gain criteria. Based on the N-Gain criteria according to Sukarelawan et al. (2024), learning outcome improvement is categorized as high if the g value is ≥ 0.7, moderate if $0.3 \leq g < 0.7$, and low if $g < 0.3$. Meanwhile, the level of media effectiveness is assessed as ineffective at a percentage < 40%, less effective at 40–55%, quite effective at 56–75%, and effective if the result is > 76%.

RESULT AND DISCUSSION

Define

At this stage, a needs analysis was conducted to identify problems in physics learning, particularly in the material on momentum and impulse. Interviews with teachers and students revealed that many students struggled to grasp the material because of its abstract nature and the limited use of interactive instructional media. Teachers also explained that physics lessons in partner schools are still mostly teacher-centered, with minimal use of interactive technology. As a result, students often struggle to understand abstract concepts such as momentum and impulse.

Based on observations, classroom teaching is still dominated by verbal explanations, which often leaves students passive during the learning process. This finding highlights the need for visual and interactive digital-based instructional media, which enable students to understand abstract concepts more concretely through simulations and visualizations. Next, the media content must be aligned with the learning outcomes and learning objectives. Through concept analysis, they develop a concept map that illustrates the relationship between momentum, impulse, the law of conservation of momentum, and various types of collisions: perfectly elastic, imperfectly elastic, and inelastic. In the task analysis stage, learning activities are designed to provide students with opportunities to explore concepts through simulations, virtual experiments, and small-scale web-based exercises or assessments. Based on this, learning objectives are formulated: students are expected to be able to explain the concepts of momentum and impulse, interpret force-time graphs, and apply the law of conservation of momentum in various real-life contexts..

Design

This stage centers on developing Google Sites–based interactive visual instructional media along with the accompanying evaluation instruments. The design is guided by the discovery learning model, allowing students to actively explore concepts through structured stages, including stimulus, problem identification, and data collection (Nafiyanto & Pebriana, 2023). The media structure was created in accordance with the syntax of the learning model.

Each section is equipped with contextual videos, PhET simulations, and short quizzes. In addition, a concept comprehension test instrument is also compiled based on seven indicators according to Anderson & Krathwohl (2001), namely: interpretation, exemplification, classification, generalization, inference, comparison, and explanation. Each question is scored on a scale of 0-4: No Answer (NA), No Understanding (NU), Misunderstanding (MU), Partial Understanding (PU), and Full Understanding (FU) (Abraham et al., 1992). The flowchart outlines the entire learning process from the introduction to the final assessment ensuring that each page serves a clear and purposeful educational function

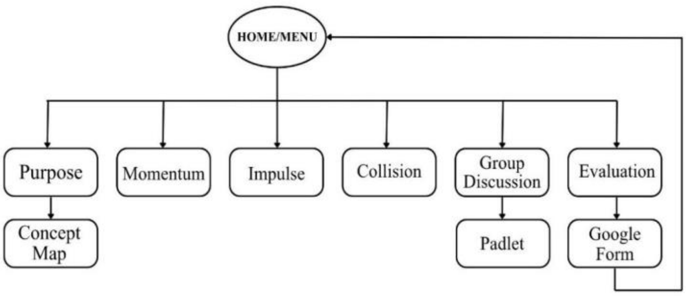

Figure 1. Flowchart

The developed product is enhanced with interactive features designed to deepen students' understanding of momentum and impulse concepts (Nurmarwaa et al., 2022). The media selected for use are YouTube for contextual videos, PhET Simulation for virtual experiments, Padlet for collaborative discussions, and Google Forms for automatic evaluation. The interactive visual design features a blend of appealing colors and a clean, simple layout, making it easy to access across various devices, including laptops and smartphones. The Google Sites-based learning media developed to enhance Grade 11 students' conceptual understanding of momentum and impulse consists of several key components

1) Menu. At the top of the menu, there is a panel that provides an overview of the menu components, along with a GIF logo, the application name, and a search bar. Just below it, a banner displays the title "Momentum and Impulse" with a GIF background illustrating a collision phenomenon, creating a dynamic and engaging visual. At the bottom of the page, copyright information is included to acknowledge the creation of the learning media.

2) Subject Matter. At the top of the page, there is a panel similar to the previous menu, followed by a series of contextual images. A stimulus video is provided to illustrate momentum phenomena in everyday life, accompanied by a short quiz designed to help students reflect on and summarize the concepts they observed.. Next, there is an interactive simulation to reinforce understanding of the concept, followed by an evaluation quiz to assess student learning outcomes. The final section features a contextual video, accompanied by a written explanation of the material. After engaging with the content, students are guided to complete a final virtual simulation, accompanied by step-by-step instructions to help them utilize the student worksheet effectively during the learning activity.

3) Group Discussion. In the discussion group section, there is a Padlet menu that serves as a forum for students to exchange

ideas and collaborate. The Padlet is divided into five groups, matching the group assignments given by the teacher. Below it, worksheets are provided for each group to support their discussions and activities.

4) Evaluation. The evaluation menu features questions that relate to the simulations and material covered during the lesson. It also includes buttons that allow users to return to the home page or navigate back to the previous section.

Figure 2. Menu display

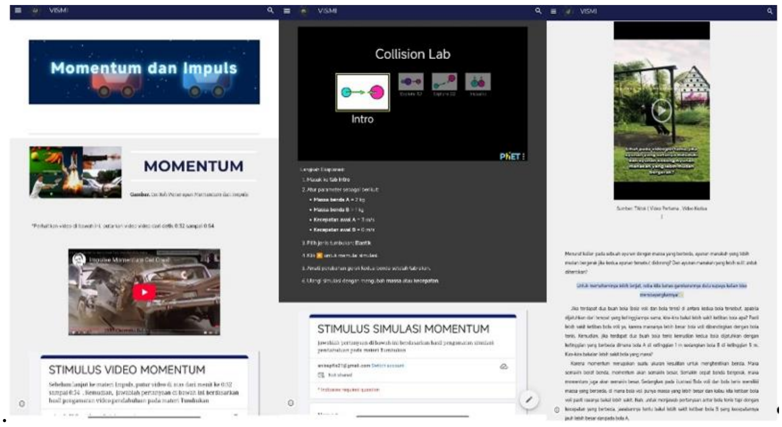

Figure 3. Material display

Figure 4. Group discussion display

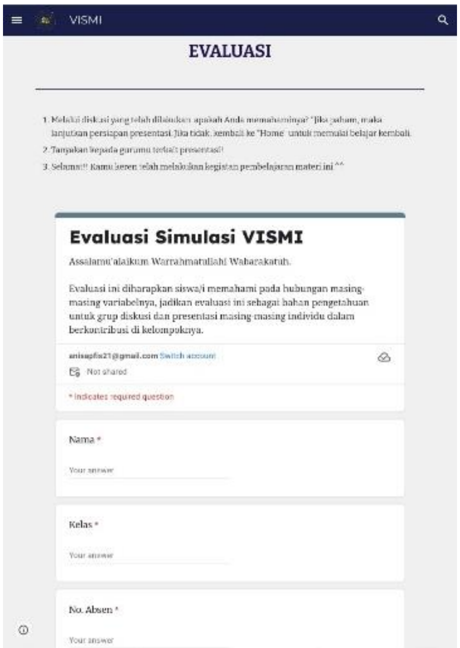

Figure 5. Evaluation display

Develop

The assessment of the instructional media's suitability was carried out through expert validation involving material, media, and language evaluations. The panel consisted of four experts: three university lecturers and one high school physics teacher. For the material validation, three key aspects were assessed, as presented in Table 1.

Table 1. Material expert validation calculations

Aspect	Score	Maximal	Percentage	Category
Self instruction	137	140	97,86%	Highly Feasible
Self contained	19	20	95%	Highly Feasible
Adaptive	18	20	90%	Highly Feasible

The validation results from four subject matter experts show that the material feasibility (94.29%) and adaptability (90%) aspects are categorized as "Highly Feasible," demonstrating their strong alignment with current developments in science and technology. The self-contained aspect scored 95%, indicating that the material is presented completely and coherently within a single competency. Meanwhile, the self-instruction aspect received the highest score at 97.86%, showing that the content strongly supports independent learning. Overall, these results confirm that the material is designed to enable students to learn autonomously through a systematic and contextual presentation (Norhafizah, 2025).

Table 2. Media expert validation calculations

Aspect	Score	Maximal	Percentage	Category
Digital teaching media design	218	220	99,09%	Highly Feasible
Digital teaching media components	117	120	97,50%	Highly Feasible

Based on the validation results from four media experts, the total score reached 335 out of a maximum of 340, with a feasibility percentage of 98.30%. This places the product in the "Highly Feasible" category, indicating that the developed digital instructional media can be implemented without major revisions. These findings also show that the product meets quality standards in both design and content, and has strong potential to make a positive contribution to the learning process.

Table 3. Language expert validation valculations

Aspect	Score	Maximal	Percentage	Category
Use of communicative and interactive language	76	80	95%	Highly Feasible
Discrepancies with the Indonesian language	79	80	98,75%	Highly Feasible

Based on the table above, it can be seen that the aspect of communicative and interactive language use scored 76 out of 80 (95%), which is classified as very good. This shows that the language used in the teaching materials is well aligned with the learning objectives, conveying information clearly and concisely while also encouraging student interaction. In terms of adherence to the Indonesian language, the material scored 79 out of 80 (98.75%), categorized as “Highly feasible.” This reflects strong spelling accuracy, clear sentence structure, and precise meaning, minimizing the risk of misinterpretation. Overall, the language expert validation achieved a total score of 155 out of 160 (96.88%), placing it in the “Highly feasible” category.

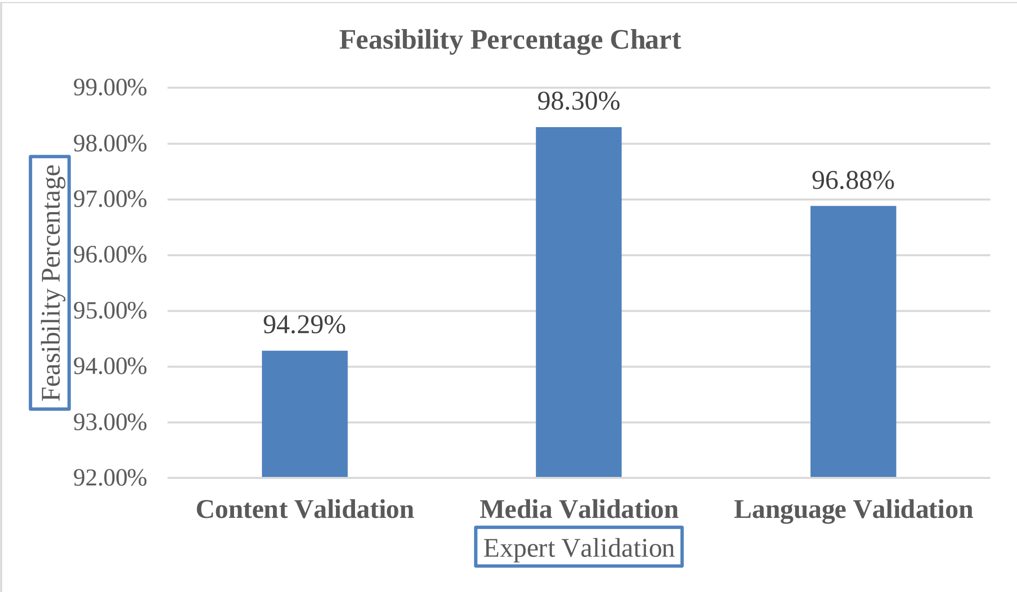

Figure 6. Media validation chart

Practicality was evaluated based on feedback from both teachers and students using a 6-point UEQ scale, which produced the following results.

Table 4. Small group test response result

Short UEQ Scales		Var	Comparison to the benchmark
Attractiveness	2,06	0,44107	Excellent
Clarity	1,63	0,82386	Excellent
Efficiency	2,04	0,39583	Excellent
Accuracy	1,48	0,26657	Excellent
Stimulation	1,98	0,30066	Excellent
Novelty	1,38	1,57386	Excellent

These criteria are used as a reference in assessing the quality of user experience with the instructional media being tested. From this, it can be seen that the instructional media developed has received positive evaluations, as it obtained a score of > 0.8, as in the study conducted by Darmawan et al. (2025). On the attractiveness scale (2.06) and efficiency scale (2.04), the media effectively support the learning process with minimal effort required from users. The clarity aspect (1.63) indicates that the navigation and material presentation are easy to follow, allowing students to access content smoothly. In terms of accuracy (1.48), the media is viewed as reliable and consistent in delivering information. The stimulation aspect (1.98) highlights its ability to create an engaging and motivating learning experience. Although the novelty aspect (1.38) scored slightly lower than the others, it still reflects innovative elements that bring added value to the learning process.

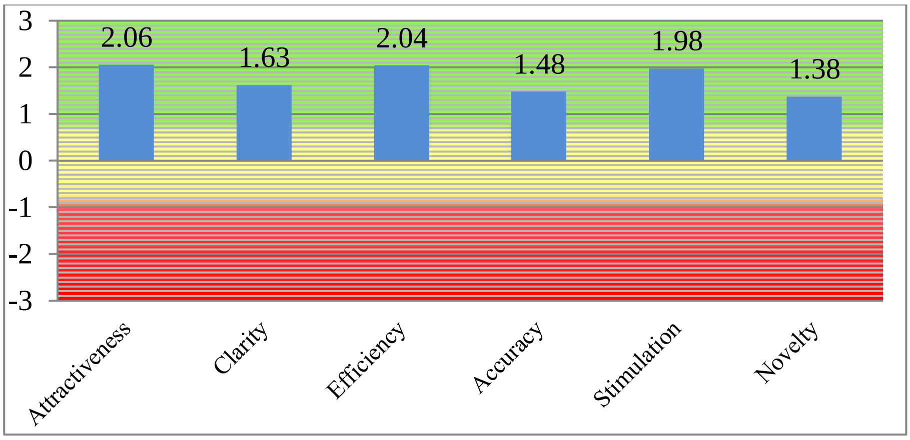

Figure 7. Graph of small group test result

Disseminate

At this stage, extensive field testing is carried out. After the product is proven to be feasible, practical, and effective based on previous trials, it is then finalized by refining its appearance and ensuring the completeness of the revised version. The finalized media is tested on a larger group of students to assess the consistency of its effectiveness in a broader learning context.

Table 5. Field test response results

Short UEQ Scales		Var	Comparison to the benchmark
Attractiveness	2,143	0,7584	Excellent
Clarity	1,764	1,31597	Excellent
Efficiency	2,136	0,78435	Excellent
Accuracy	1,886	0,76964	Excellent
Stimulation	2,150	1,05588	Excellent
Novelty	1,929	1,17489	Excellent

These criteria serve as a benchmark for evaluating the quality of the user experience with the instructional media being tested. The results show positive responses, indicating that the media provides a good user experience and is practical to use in the learning process. (Humairoh et al., 2025). From this, it can be seen that the instructional media developed received a positive evaluation because it obtained a score > 0.8. Based on the results, the interactive visual instructional media based on Google Sites received an Excellent rating in all assessment dimensions. The attractiveness aspect (2.143) indicates that the media is engaging, enjoyable, and capable of capturing students' interest. In terms of clarity (1.764), the media is easy to understand and features simple navigation, allowing students to use it without significant difficulties. The efficiency score (2.136) indicates that the media facilitates the achievement of learning objectives with minimal effort, while the accuracy aspect (1.886) reflects the consistent and reliable information that strengthens students' trust in the material. The stimulation aspect received the highest score (2.150), highlighting that the media offers a fun, motivating, and active learning experience. Lastly, the novelty score (1.929) suggests that the media introduces innovative elements that help reduce monotony in the learning process.

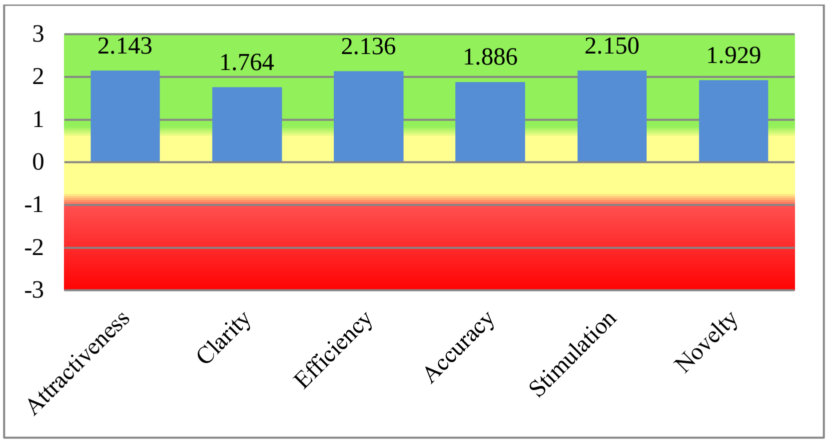

Figure 8. Graph of the field test result

The effectiveness of the developed instructional media can be evaluated by comparing students' pre-test and post-test scores after its implementation in the classroom. This was done to assess the extent of students' conceptual understanding after using the Google Sites instructional media.

Table 6. n-Gain results for small groups

Student	Pre-test Score	Post-test Score	N-Gain	Category
1	50,00	78,57	0,571428	Moderate
2	48,21	85,71	0,724137	High
3	32,14	75,00	0,631578	Moderate
4	46,43	76,79	0,566666	Moderate
5	23,21	62,50	0,511627	Moderate
6	51,79	87,50	0,740740	High
7	46,43	98,21	0,966666	High
8	46,43	76,79	0,566666	Moderate
9	35,71	73,21	0,583333	Moderate
10	39,29	82,14	0,705882	High
11	53,57	85,71	0,692307	Moderate

Based on the n-Gain calculation results for small group trials using Google Sites–based interactive visual instructional media, the average n-Gain score was 0.65, which falls into the moderate category. This indicates that the media effectively enhanced student learning outcomes, even though the improvement did not reach the highest level. When viewed individually, most students were in the moderate category. Students who obtained the high category showed a more optimal understanding of the material after using the instructional media, with the highest n-Gain score reaching 0.96. Meanwhile, students in the moderate category also showed positive progress, although their achievements were relatively more balanced. Overall, these results indicate that the media has strong potential to be effectively used in the learning process and can significantly enhance students' conceptual comprehension of momentum and impulse in physics.

Table 7. n-Gain field test results

Number of Students	Pre-test Scores	Post-test Scores	N-Gain
32	1466,07	2757,14	0,74459
Average	25,66	48,25	

The table presents the results of a limited trial involving 32 students. The improvement in student learning outcomes was further analyzed using the n-Gain method, which resulted in a score of 0.74459, indicating a substantial increase in students' understanding. Based on the n-Gain interpretation criteria, this score falls into the "High" category. These findings demonstrate that Google Sites–based visual-interactive instructional media is effective in enhancing students' understanding of momentum and impulse. Beyond enhancing learning achievements, this media also has a strong positive impact on students' conceptual grasp during limited field testing. It successfully helps students progress from a relatively low initial level of understanding to significantly better learning results.

Table 8. n-Gain descriptive

Variabel	Mean	Median	Min	Max	SD
N-Gain score	.7384	.7679	.46	.95	.1154
N-Gain Percentage	73.84%	76.79%	45.83%	95.00%	11.54

These findings indicate that the increase in students' understanding falls into the high category. In terms of n-Gain Percent, the average reached 73.84% with a median of 76.79% and a standard deviation of 11.54, indicating a relatively wide variation in student achievement. This value is also in the high category, reinforcing the finding that Google Sites web-based visual-interactive instructional media has a significant positive impact on student understanding. The gap between the lowest and highest scores reflects the variation in how much students' understanding improved, showing that some students experienced greater progress than others.

The development of this instructional media aligns with SDG 4 on Quality Education, which aims to provide inclusive and high-quality learning opportunities that foster lifelong learning. By utilizing Google Sites as a web-based platform, this media enhances science learning through engaging visual and interactive content, making the learning experience more effective and accessible for students (Ramadhan et al., 2025). This indicates that most students demonstrated significant conceptual improvement after using the developed instructional media. As in previous research (Fitroh et al., 2025), the use of Google Sites instructional media is effective in improving students' conceptual understanding. In conclusion, Google Sites instructional media has proven effective in helping students better understand the concepts of momentum and impulse, while also contributing to a significant improvement in their learning outcomes.

CONCLUSION

This study aims to evaluate the feasibility, practicality, and effectiveness of Google Sites–based interactive visual instructional media in enhancing students' conceptual comprehension of Momentum and Impulse. The expert validation results for content, media, and language indicated that the media falls into the "very feasible" category. Meanwhile, the practicality test, assessed through UEQ aspects: attractiveness, clarity, efficiency, accuracy, stimulation, and novelty, received an "excellent" rating. The effectiveness test revealed a meaningful improvement in student learning outcomes, reflected by a high n-Gain score. This result demonstrates that the media is effective in strengthening students' conceptual comprehension. Overall, the use of Google Sites-based instructional media plays an important role in enhancing the quality of physics education while supporting the achievement of SDG 4: Quality Education through inclusive, interactive, and sustainable digital learning.

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