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Interactive Articulate Storyline Media for Solar System Learning in Elementary Schools

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ABSTRACT

This study aimed to develop STAR-IPAS (Storyline Technology Augmented Resource – *Interaktif Pembelajaran Alam dan Sosial*), an interactive learning media developed with Articulate Storyline for Solar System content in Grade VI elementary science learning, and to examine its feasibility, practicality, and association with learning-score improvement. The study employed Research and Development using an integration of the ADDIE instructional design model and the Multimedia Development Life Cycle (MDLC). Feasibility was assessed through expert validation by one material expert, one instructional-design expert, and one media expert, yielding scores of 94%, 99%, and 91%, respectively, with an overall mean of 94.67% (very high category). Practicality was assessed through staged product trials, which produced scores of 88.89% in one-to-one evaluation, 89.00% in small-group evaluation, and 97.14% in field trial. Learning-score improvement was examined through a pretest-posttest design involving 30 Grade VI students of SD Negeri Cicewol, Sukabumi; the mean score increased from 68.02 to 93.53, with an N-Gain of 0.78 (high category) and an effectiveness interpretation of 78% (effective category); 22 students (73.33%) achieved a high N-Gain category, and 8 students (26.67%) achieved a moderate category. However, because the study did not include a control group and was conducted in a single school with a limited sample, the observed improvement cannot be interpreted as evidence of a causal effect of the media; the findings should be understood as an indication of association within the specific implementation context. These findings indicate that STAR-IPAS is feasible and practical for supporting students' understanding of abstract Solar System concepts, while further experimental research is needed to establish causal effectiveness. The study implies that integrating instructional design and multimedia production frameworks can enhance the quality of interactive learning media in elementary science.

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1. INTRODUCTION

Digital technology has an increasingly important role in elementary education because learning media can help students understand concepts that are difficult to observe directly. In science

learning, technology-supported media can make learning more interactive, contextual, and meaningful [1]. The Merdeka Curriculum also emphasizes critical, creative, and reflective thinking through contextual learning [2]. These principles are consistent with the national process standard that emphasizes learning which is conscious, meaningful, enjoyable, and holistic [3]. Furthermore, the integration of technology in elementary science education is expected to bridge the gap between abstract scientific concepts and students' concrete cognitive development [17].

Solar System content presents a particular challenge because several concepts, including celestial motion, Earth's rotation and revolution, and planetary characteristics, are abstract. Grade VI students are generally at the concrete operational stage, where understanding abstract phenomena requires concrete visual representations and guided interaction [9], [12]. The needs analysis at Grade VI of SD Negeri Cicewol found that learning was dominated by lectures and textbooks, students were relatively passive, and visual media or teaching aids were not available. Summative assessment data showed that 20 of 30 students (66%) had not reached the school's learning-target criterion. Diagnostic assessment also indicated students' stronger response to audiovisual learning, while school facilities included 15 laptops, one interactive flat panel, two projectors, and internet access. These conditions indicate a need for interactive media that can visualize abstract concepts while encouraging active participation.

Articulate Storyline provides authoring functions for combining text, images, animation, audio, video, simulation, and interactive assessment in one learning environment [4]. As an authoring tool, Articulate Storyline supports the creation of multimedia learning environments that align with Mayer's cognitive theory of multimedia learning, which emphasizes the integration of verbal and visual representations to reduce cognitive load and enhance understanding [15], [16]. Previous research has reported strong feasibility and positive learning effects of Articulate Storyline media for Solar System and elementary science learning. Ramadhan and Suprayitno [5], for example, reported media and material feasibility of 92% and 93%, respectively, with an N-Gain of 0.48. Other studies have also reported that Storyline-based media can provide more engaging experiences and improve learning outcomes [6], [7]. However, these studies have primarily focused on feasibility and learning outcomes without explicitly integrating instructional design frameworks with multimedia production frameworks. In addition, most previous studies have not systematically linked expert validation, staged product trials, and effectiveness testing within a single development procedure.

This study therefore developed STAR-IPAS (Storyline Technology Augmented Resource – Interaktif Pembelajaran Alam dan Sosial) as an interactive medium for Grade VI Solar System learning. The development integrates ADDIE as the instructional framework and MDLC as the technical multimedia-production framework. ADDIE provides a systematic instructional design process covering Analysis, Design, Development, Implementation, and Evaluation [13], while MDLC organizes multimedia production through Concept, Design, Material Collecting, Assembly, Testing, and Distribution [14]. The integration of these two frameworks is intended to maintain alignment between learning objectives, content, interaction, technical production, testing, and revision. This integration aligns with a growing body of R&D studies that combine instructional design models with multimedia development frameworks [22], [23], [24]. The present study contributes to this line of inquiry by applying the integrated framework to elementary science learning with Articulate Storyline, a context that remains underexplored in previous research.

The study addresses three objectives: (1) to describe the development procedure of STAR-IPAS using the integrated ADDIE-MDLC framework, (2) to determine media feasibility based on material, instructional-design, and media validation, and (3) to examine the effectiveness of the media in improving students' understanding of Solar System concepts. The study contributes a product-development procedure that links pedagogical design and multimedia production and provides evidence from expert validation and staged product trials. Practically, the findings are expected to provide a reference for teachers and educational developers in designing interactive learning media for abstract science concepts in elementary schools.

From an Islamic perspective, learning about the regularity of celestial phenomena can also support reflection on the signs of creation, as reflected in QS. Ali 'Imran 3:190-191 [20]. This verse encourages believers to observe and reflect upon the creation of the heavens and the earth, which

aligns with the goal of science learning not only toward conceptual mastery but also toward scientific curiosity and reflective awareness. Thus, the development of STAR-IPAS is also intended to support the cultivation of reflective and inquisitive attitudes in students.

Learning media development in educational technology involves translating instructional specifications into usable physical or digital products [8]. Interactive media can support active learning when learners are required to make choices, receive feedback, explore representations, and complete learning tasks. The multimedia features of Articulate Storyline are therefore relevant to Solar System learning because animation and simulation can represent processes that are difficult to experience directly. Theoretically, the development of this media is grounded in constructivist learning principles, which view learners as active constructors of knowledge through experience, interaction, problem solving, and reflection [9]–[11]. For Grade VI learners, concrete visual representations and guided interaction remain important because students benefit from meaningful representations connected with observable phenomena [12]. Therefore, the design of STAR-IPAS emphasizes learner-controlled navigation, animated representations, simulation, exercises, and immediate feedback to support active knowledge construction.

The diffusion of innovation perspective also supports the importance of this study. Rogers [18] emphasized that the adoption of an innovation is influenced by its relative advantage, compatibility, complexity, trialability, and observability. In the context of this study, STAR-IPAS is designed to offer relative advantage over conventional lecture-based instruction, to be compatible with the Merdeka Curriculum, to be easy to use for both teachers and students, to be trialable through staged product trials, and to be observable through improved learning outcomes. This perspective reinforces the rationale for developing an interactive learning medium that is not only feasible but also potentially adoptable in elementary school settings.

Based on the above rationale, this study is expected to contribute both theoretically and practically. Theoretically, it contributes to the integration of instructional design and multimedia development frameworks in educational technology research. Practically, it provides an alternative learning medium that can support students' understanding of abstract Solar System concepts. The following sections describe the method, results and discussion, and conclusion of the study.

2. METHOD

This study employed Research and Development (R&D) with a mixed-methods approach combining qualitative and quantitative data analysis [19], [21]. The R&D design was chosen because the study aimed to develop, validate, and evaluate a new educational product. The development process integrated the ADDIE instructional design model [13] and the Multimedia Development Life Cycle (MDLC) [14], [23] as described in Table 1. ADDIE provided the pedagogical framework covering Analysis, Design, Development, Implementation, and Evaluation, while MDLC organized the technical multimedia production through Concept, Design, Material Collecting, Assembly, Testing, and Distribution. This integration was intended to maintain alignment between learning objectives, content, interaction, technical production, testing, and revision.

Table 1. Integration of ADDIE and MDLC in STAR-IPAS development

ADDIE	MDLC	Main Activities
Analysis	—	Needs analysis, learner analysis, curriculum analysis, infrastructure analysis, and development-goal analysis.

Design	Concept + Design	Learning objectives, strategy, storyboard, interface, navigation, and assessment design.
Development	Material Collecting + Assembly + Testing	Collecting assets, building the media in Articulate Storyline 3, alpha validation, and product trials.
Implementation	Distribution	Packaging in HTML5/APK/exec and classroom use.
Evaluation	—	Formative and summative evaluation and product revision.

2.2 Research Setting and Participants

The study was conducted at SD Negeri Cicewol, Kecamatan Cicurug, Kabupaten Sukabumi, Indonesia. The research was carried out from December 2025 to June 2026. The participants of the study consisted of three groups: expert validators, product trial participants, and effectiveness test participants.

a. Expert Validators

Three expert validators were involved in the validation stage: one material expert (a lecturer in science education), one instructional-design expert (a lecturer in educational technology), and one media expert (a lecturer in multimedia or educational media). The experts were selected based on their expertise and experience in their respective fields. Each expert validated the product using a structured validation questionnaire.

b. Product Trial Participants

The product trials were conducted in three stages: one-to-one evaluation, small-group evaluation, and field trial. The one-to-one evaluation involved two Grade VI students and one teacher. The small-group evaluation involved 10 Grade VI students from outside the research school. The field trial involved 15 Grade VI students at SD Negeri Cicewol. The selection of participants was based on the criteria suggested by Dick and Carey and Borg and Gall [21], which emphasize the importance of representative users at each trial stage.

c. Effectiveness Test Participants

The effectiveness test involved all 30 Grade VI students of SD Negeri Cicewol. The participants were selected using a purposive sampling technique because the study focused on a specific grade level and a specific science topic. The participants had similar characteristics in terms of age, grade level, and prior knowledge of the Solar System topic.

2.3 Research Object

The research object was STAR-IPAS (Storyline Technology Augmented Resource – Interaktif Pembelajaran Alam dan Sosial), an interactive learning medium developed using Articulate Storyline 3 for Solar System content in Grade VI elementary science learning. The product was designed to support students' understanding of abstract concepts such as celestial motion, Earth's rotation and revolution, and planetary characteristics.

2.4 Data Collection Instruments

The study used both qualitative and quantitative instruments to collect data. The instruments were developed based on the research objectives and validated by experts before use.

a. Qualitative Instruments

1. Semi-structured teacher interview: used to explore teachers' perspectives on the learning needs, challenges, and expectations regarding Solar System learning.
2. Classroom observation: used to observe the teaching and learning process, student participation, and the availability of learning media.
3. Expert comments and suggestions: collected through validation questionnaires and used as the basis for product revision.

b. Quantitative Instruments

1. Expert validation questionnaires: used to assess the feasibility of the product from the perspectives of material, instructional design, and media. The questionnaire used a Likert scale with five response options (1 = very poor, 5 = very good).
2. Student and teacher response questionnaires: used to assess the practicality and acceptability of the product. The questionnaire used a Likert scale with five response options.
3. Pretest and posttest instruments: a 20-item multiple-choice test was used to measure students' understanding of Solar System concepts before and after the implementation of the media.

2.5 Instrument Validity and Reliability

Before the instruments were used, their validity and reliability were examined.

a. Content Validity

The pretest and posttest instruments were validated by two experts in science education and educational measurement. The validation covered content relevance, clarity, and alignment with learning objectives. The content validity index (CVI) was calculated, and items with a CVI below 0.80 were revised or removed.

b. Construct Validity

The expert validation questionnaires were validated by two experts in educational technology and instructional design. The validation covered the clarity of items, the relevance of indicators, and the appropriateness of the scale.

d. Reliability

The reliability of the pretest and posttest instruments was examined using the Kuder-Richardson Formula 20 (KR-20) because the items were dichotomous (correct/incorrect). The reliability coefficient was 0.85, which is categorized as high. The reliability of the expert validation and response questionnaires was examined using Cronbach's Alpha, and the coefficient was 0.88, which is categorized as high.

2.6 Data Analysis Techniques

The data were analyzed using both qualitative and quantitative techniques.

a. Qualitative Data Analysis

Qualitative data from interviews, observations, and expert comments were analyzed using the interactive model of Miles, Huberman, and Saldaña, which includes data reduction, data display, and conclusion drawing/verification. The results were used to describe the development process and to guide product revision.

b. Quantitative Data Analysis

Quantitative data from validation questionnaires, response questionnaires, and pretest-posttest were analyzed using descriptive and inferential statistics.

Feasibility analysis: The scores from the validation questionnaires were converted to percentages using the formula:

P = obtained score ideal maximum score × 100%

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The percentage scores were then categorized using the criteria presented in Table 2.

Table 2. Feasibility criteria

Percentage	Category
81% – 100%	Very high
61% – 80%	High
41% – 60%	Moderate
21% – 40%	Low
0% – 20%	Very low

Effectiveness analysis: The effectiveness of the media was examined using the N-Gain formula [25]:

$$G = \frac{\text{posttest score} - \text{pretest score}}{\text{ideal score} - \text{pretest scoce}}$$

The N-Gain scores were then categorized using the criteria presented in Table 3.

Table 3. N-Gain criteria

N-Gain	Category
$g \geq 0.70$	High
$0.30 \leq g < 0.70$	Moderate
$g < 0.30$	Low

Effectiveness interpretation: The effectiveness interpretation was calculated using the formula:

Effectiveness=N-Gain×100%

The effectiveness interpretation was then categorized using the criteria presented in Table 4.

Table 4. Effectiveness interpretation criteria

Percentage	Category
80% – 100%	Very effective
60% – 79%	Effective
40% – 59%	Moderately effective
20% – 39%	Less effective
0% – 19%	Not effective

Practicality analysis: The scores from the student and teacher response questionnaires were converted to percentages and categorized using the same criteria as the feasibility analysis.

2.7 Research Procedure

The research procedure followed the integrated ADDIE-MDLC framework and consisted of five stages:

a. Analysis

The analysis stage involved needs analysis, learner analysis, curriculum analysis, infrastructure analysis, and development-goal analysis. Data were collected through interviews, observations, and document analysis. The results of this stage were used to establish the development rationale and to identify the learning needs of Grade VI students.

c. Design

The design stage involved the formulation of learning objectives, the selection of learning strategies, the development of a storyboard, the design of the interface and navigation, and the design of the assessment. The design was aligned with the MDLC Concept and Design stages. The results of this stage were used as the blueprint for the development stage.

d. Development

The development stage involved collecting assets (text, images, animation, audio, video), assembling the media in Articulate Storyline 3, conducting alpha validation, and conducting product trials. The development was aligned with the MDLC Material Collecting, Assembly, and Testing stages. The results of this stage were used to produce the final product.

e. Implementation

The implementation stage involved packaging the media in HTML5/APK/exec format and using it in classroom learning. The implementation was aligned with the MDLC Distribution stage. The implementation was conducted in two classroom meetings through apperception, media orientation, individual exploration, discussion, interactive exercises, and reflection.

f. Evaluation

The evaluation stage involved formative and summative evaluation and product revision. Formative evaluation was conducted throughout the development process, while summative evaluation was conducted at the end of the study. The results of this stage were used to determine the feasibility and effectiveness of the product.

2.8 Ethical Considerations

The study was conducted in accordance with ethical principles of educational research. Informed consent was obtained from the principal, teachers, students, and parents of the students involved in the study. The participants were informed about the purpose of the study, the procedures, and their right to withdraw at any time. Data confidentiality and anonymity were maintained throughout the study.

3. RESULTS AND DISCUSSION

Results

3.1.1 Needs Analysis Results

The needs analysis established a clear development rationale. Classroom observation identified lecture-dominated instruction, limited student participation, and the absence of visual media. Assessment data showed that 66% of students (20 of 30) had not reached the school's learning-target criterion. Interviews indicated that students had difficulties in understanding rotation, revolution, and planetary characteristics, while diagnostic results showed stronger student

responsiveness to audiovisual materials. The availability of 15 laptops, one interactive flat panel, two projectors, and internet access supported the feasibility of implementing an interactive digital medium. These findings confirmed the need for a media product that could visualize abstract concepts while encouraging active participation.

3.1.2 Design and Development Results

The design stage translated the identified needs into learning objectives and a multimedia storyboard. The product used an educational-cartoon visual style, large navigation icons, 12 main screens with material submenus, planetary animation, and rotation-revolution simulation. The material addressed the Solar System, celestial objects, planetary characteristics, celestial motion, and Earth's rotation and revolution. Interactive learning was realized through learner-controlled navigation, animated representations, simulation, exercises, and immediate feedback rather than passive viewing alone.

During development, text, planetary images, animation, narration, and supporting video were collected and assembled in Articulate Storyline 3. The product included a student login page, motivational opening, navigation menu, interactive material, planetary-motion animation, rotation and revolution simulation, celestial-object explanations, and interactive quizzes with immediate feedback. Based on formative evaluation, revisions included adding a return-to-main-menu button, simplifying learning objectives into interactive points, adding a planet-size comparison infographic, and adding sound effects to quiz feedback.

Implementation was conducted in two classroom meetings through apperception, media orientation, individual exploration, discussion, interactive exercises, and reflection. This sequence positioned students as active users of the media and allowed the teacher to guide exploration rather than relying only on verbal explanation. The development process is consistent with the role of ADDIE in instructional alignment [13] and MDLC in technical multimedia production [14], [23].

3.1.3 Feasibility Results

The three expert validations produced high feasibility scores. The results are presented in Table 5.

Table 5. Expert validation results

Validator	Aspect	Score (%)	Category
Material expert	Content accuracy, currency, coverage, depth, references	94	Very high
Instructional-design expert	Learner characteristics, learning strategy, critical-thinking support, contextuality, relative advantage	99	Very high

Media expert	Narration, audio, video, animation, simulation, multimedia selection, packaging	91	Very high
Overall expert mean		94.67	Very high

The material expert score of 94% indicates that content accuracy, currency, coverage, depth, and references were considered appropriate. The instructional-design score of 99% indicates strong alignment with learner characteristics, learning strategy, critical-thinking support, contextuality, and relative advantage. The media score of 91% indicates that narration, audio, video, animation, simulation, multimedia selection, and packaging were considered appropriate. The overall mean of 94.67% places the product in the very-high feasibility category.

The staged product trials also showed consistently positive results, as presented in Table 6.

Table 6. Product trial results

Trial Stage	Participants	Score (%)	Category
One-to-one evaluation	2 students + 1 teacher	88.89	Very high
Small-group evaluation	10 students	89.00	Very high
Field trial	15 students	97.14	Very high

The results increased from 88.89% in one-to-one evaluation to 89.00% in small-group evaluation and 97.14% in field trial. The increase suggests that revisions made during the development process improved usability and classroom suitability. These findings strengthen previous reports of the feasibility of Articulate Storyline-based Solar System media [5]–[7], while the present product adds a combined instructional and multimedia-development procedure.

3.1.4 Effectiveness Results

The effectiveness test involved 30 Grade VI students. The pretest and posttest results are presented in Table 7.

Table 7. Pretest and posttest results

Measure	Pretest	Posttest
Mean	68.02	93.53
Minimum	55	80
Maximum	75	100

Standard deviation	5.42	4.87

The mean score increased by 25.51 points, from 68.02 to 93.53. The standard deviation decreased from 5.42 to 4.87, indicating that the spread of scores became narrower and student achievement became more homogeneous after the implementation of the media. The N-Gain of 0.78 was categorized as high, while the 78% effectiveness interpretation was categorized as effective according to the criteria used in the study. The distribution of N-Gain categories is presented in Table 8.

Table 8. Distribution of N-Gain categories

N-Gain Category	Frequency	Percentage (%)
High ($g \geq 0.70$)	22	73.33
Moderate ($0.30 \leq g < 0.70$)	8	26.67
Low ($g < 0.30$)	0	0.00
Total	30	100.00

Table 8 shows that 22 students (73.33%) achieved a high N-Gain category, while 8 students (26.67%) achieved a moderate category. No student was in the low category. This distribution indicates that the media was effective for the majority of students, although some students still required additional support. Student responses to the media are presented in Table 9.

Table 9. Student response results

Aspect	Score (%)	Category
Engagement	91	Very high
Comfort	87	Very high
Perceived effectiveness	87	Very high
Overall learning experience	92	Very high
Mean	89.25	Very high

Student responses indicated positive experiences across all aspects, with the overall learning experience obtaining the highest score (92%). These results indicate that the media supported both conceptual learning and active engagement.

Discussion

The findings of this study indicate that STAR-IPAS is a feasible and effective interactive learning medium for Solar System content in Grade VI elementary science learning. The discussion is organized around three main aspects: the development procedure, the feasibility of the product, and the effectiveness of the product.

3.2.1 Development Procedure

The integration of ADDIE and MDLC provided a coherent framework for developing STAR-IPAS. ADDIE ensured that the development process was grounded in instructional design principles, covering needs analysis, design, development, implementation, and evaluation [13]. MDLC ensured that the technical multimedia production followed a systematic process, covering concept, design, material collecting, assembly, testing, and distribution [14], [23]. The integration of these two frameworks addressed a gap in previous research, which often focused on either instructional design or multimedia production without explicitly linking the two.

The needs analysis revealed that lecture-dominated instruction and the absence of visual media were the main challenges in Solar System learning. This finding is consistent with the characteristics of Grade VI students, who are generally at the concrete operational stage and require concrete visual representations to understand abstract concepts [9], [12]. The design of STAR-IPAS therefore emphasized animated representations, simulation, and interactive exercises to support students' understanding of abstract phenomena such as celestial motion and Earth's rotation and revolution.

The formative evaluation conducted throughout the development process led to several revisions, including the addition of a return-to-main-menu button, the simplification of learning objectives into interactive points, the addition of a planet-size comparison infographic, and the addition of sound effects to quiz feedback. These revisions were based on expert comments and suggestions, as well as on student responses during the one-to-one and small-group evaluations. The increase in trial scores from 88.89% in one-to-one evaluation to 97.14% in field trial suggests that the revisions improved the usability and classroom suitability of the product.

3.2.2 Feasibility of the Product

The expert validation results showed that STAR-IPAS obtained an overall mean of 94.67%, which is categorized as very high. The material expert score of 94% indicates that the content of the media was accurate, current, comprehensive, and well-referenced. The instructional-design expert score of 99% indicates that the media was strongly aligned with learner characteristics, learning strategy, critical-thinking support, contextuality, and relative advantage. The media expert score of 91% indicates that the multimedia elements of the media, including narration, audio, video, animation, simulation, and packaging, were appropriate.

These findings are consistent with previous studies that reported high feasibility of Articulate Storyline-based media for elementary science learning [5]–[7]. Ramadhan and Suprayitno [5], for example, reported media and material feasibility of 92% and 93%, respectively. The present study obtained a slightly higher overall mean of 94.67%, which may be attributed to the integration of ADDIE and MDLC, which ensured that both instructional and technical aspects were systematically addressed.

The staged product trials also showed consistently positive results, with scores increasing from 88.89% in one-to-one evaluation to 97.14% in field trial. The high score in the field trial suggests that the product was well-received by students in a real classroom setting. This finding supports the diffusion of innovation perspective [18], which emphasizes that the adoption of an innovation is influenced by its relative advantage, compatibility, complexity, trialability, and observability. STAR-IPAS offered relative advantage over conventional lecture-based instruction, was compatible with the Merdeka Curriculum, was easy to use, was trialable through staged product trials, and was observable through improved learning outcomes.

3.2.3 Effectiveness of the Product

The effectiveness test showed that the mean score increased from 68.02 on the pretest to 93.53 on the posttest, with an N-Gain of 0.78, which is categorized as high. The effectiveness interpretation of 78% was categorized as effective. The distribution of N-Gain categories showed that 22 students (73.33%) achieved a high category, while 8 students (26.67%) achieved a moderate category. No student was in the low category.

The effectiveness result is higher than the N-Gain of 0.48 reported by Ramadhan and Suprayitno [5]. The difference should be interpreted cautiously because the studies differ in product features, development procedures, participants, and implementation conditions. Nevertheless, the present result suggests that a media product combining visualization, learner control, simulation, practice, and immediate feedback can be a useful approach for abstract Solar System concepts. The result also supports the role of multimedia representations in helping learners connect verbal information with visual representations [15], [16].

The high effectiveness of STAR-IPAS can be explained by several factors. First, the media provided animated representations and simulations that visualized abstract concepts such as celestial motion and Earth's rotation and revolution. This is consistent with Mayer's cognitive theory of multimedia learning, which emphasizes the integration of verbal and visual representations to reduce cognitive load and enhance understanding [15]. Second, the media provided learner-controlled navigation, which allowed students to explore the material at their own pace. This is consistent with constructivist learning principles, which view learners as active constructors of knowledge [9]–[11]. Third, the media provided interactive exercises with immediate feedback, which allowed students to monitor their understanding and correct misconceptions. This is consistent with the principles of effective e-learning [16].

The student response results also indicated positive experiences, with engagement obtaining 91%, comfort 87%, perceived effectiveness 87%, and overall learning experience 92%. These results indicate that the media supported both conceptual learning and active engagement. The high score on engagement is particularly important because active engagement is a key factor in effective learning [16].

3.2.4 Limitations and Implications

This study has several limitations. First, the study was conducted in a single school with a relatively small number of participants, which limits the generalizability of the findings. Second, the study did not include a control group, so the effectiveness of the media could not be compared with conventional instruction. Third, the study focused on a single topic (Solar System) and a single grade level (Grade VI), so the findings may not be directly applicable to other topics or grade levels. Fourth, the study did not examine the long-term retention of learning, so the durability of the learning effects is unknown.

Despite these limitations, the study has several implications. Theoretically, the study contributes to the integration of instructional design and multimedia development frameworks in educational technology research. The integration of ADDIE and MDLC provides a model that can be adapted for developing interactive learning media in other contexts. Practically, the study provides an alternative learning medium that can support students' understanding of abstract Solar System concepts. The findings suggest that teachers and educational developers should consider integrating visualization, learner control, simulation, practice, and immediate feedback in the design of interactive learning media.

For future research, it is recommended that the study be replicated with a larger and more diverse sample, with a control group, and with other topics and grade levels. It is also recommended that the long-term retention of learning be examined to determine the durability of the learning effects. Finally, it is recommended that the integration of ADDIE and MDLC be further examined in other contexts to determine its effectiveness and adaptability.

4. CONCLUSION

This study aimed to develop, determine the feasibility, and examine the effectiveness of STAR-IPAS, an interactive learning media developed with Articulate Storyline for Solar System content in Grade VI elementary science learning. The study successfully addressed three objectives.

First, the study described the development procedure of STAR-IPAS using an integrated ADDIE-MDLC framework. ADDIE provided the instructional design framework covering Analysis, Design, Development, Implementation, and Evaluation [13], while MDLC organized the technical multimedia production through Concept, Design, Material Collecting, Assembly, Testing, and Distribution [14], [23]. The integration of these two frameworks maintained alignment between learning objectives, content, interaction, technical production, testing, and revision. The development process produced a media product that included a student login page, motivational opening, navigation menu, interactive material, planetary-motion animation, rotation and revolution simulation, celestial-object explanations, and interactive quizzes with immediate feedback.

Second, the study determined the feasibility of STAR-IPAS based on expert validation and staged product trials. The expert validation results showed an overall mean of 94.67%, with 94% from the material expert, 99% from the instructional-design expert, and 91% from the media expert. These scores are categorized as very high. The staged product trials also showed consistently positive results, with 88.89% in one-to-one evaluation, 89.00% in small-group evaluation, and 97.14% in field trial. The increase in trial scores suggests that the revisions made during the development process improved the usability and classroom suitability of the product.

Third, the study examined the effectiveness of STAR-IPAS in improving students' understanding of Solar System concepts. The effectiveness test with 30 Grade VI students showed an increase in mean achievement from 68.02 on the pretest to 93.53 on the posttest, with an N-Gain of 0.78, which is categorized as high. The effectiveness interpretation of 78% was categorized as effective. The distribution of N-Gain categories showed that 22 students (73.33%) achieved a high category, while 8 students (26.67%) achieved a moderate category. No student was in the low category. Student responses were also positive across engagement (91%), comfort (87%), perceived effectiveness (87%), and overall learning experience (92%).

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