

Enhancing Elementary Students' Interaction and Cognitive Outcomes through ClassPoint-Integrated PowerPoint in Science Learning

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ABSTRACT

Interactive digital media are increasingly used in elementary science learning, yet limited studies have measured learning interaction as a multidimensional construct in the use of real-time presentation tools. This study developed and evaluated ClassPoint-based interactive PowerPoint learning media to improve learning interaction and cognitive outcomes on Earth's rotation and revolution among sixth-grade students. A Research and Development design was employed using the ADDIE model. The study involved eighteen sixth-grade students at SDN Sumber, Ngawi Regency, East Java, Indonesia. Data were collected through observation, questionnaires, interviews, documentation, and pre-test-post-test assessments. The instruments were validated by experts and tested for reliability. The data were analyzed using appropriate non-parametric statistical procedures. The developed media received strong expert validation and demonstrated high instrument reliability. After implementation, students showed significant improvements in learning interaction and cognitive learning outcomes. The interaction construct covered verbal participation, behavioral engagement, emotional involvement, and peer collaboration, enabling a comprehensive assessment of classroom engagement during the learning process. The findings indicate that ClassPoint-based interactive PowerPoint media can support student-centered elementary science learning by promoting active participation and strengthening conceptual understanding. The study contributes to technology-enhanced primary education by integrating real-time interactive presentation features with a measurable multidimensional interaction framework. These results offer practical implications for teachers seeking to design engaging, interactive, and conceptually meaningful science instruction in elementary classrooms.

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1. INTRODUCTION

Basic education plays a strategic role in developing students' scientific thinking, curiosity, and understanding of natural phenomena. At the elementary level, science learning is expected to provide meaningful experiences that actively involve students in observing, questioning, and constructing

knowledge. However, classroom practices in many elementary schools remain predominantly teacher-centered, relying on conventional lectures with limited use of interactive learning media. This instructional approach often results in low levels of student interaction and suboptimal cognitive learning outcomes, particularly in science topics that are abstract in nature, such as the Earth's rotation and revolution (Anwari et al., 2023).

From a theoretical standpoint, this condition is inconsistent with cognitive development and constructivist learning principles. According to Piaget, elementary school students are in the concrete operational stage, in which understanding is strengthened through visualization, manipulation, and direct interaction with learning objects. Constructivist theory further emphasizes that learning occurs through active engagement and social interaction within the learning environment. Therefore, science instruction at the elementary level should prioritize interactive, student-centered learning experiences that support both conceptual understanding and active participation.

Classroom observations and preliminary interviews conducted at SDN Sumber, Ngawi Regency, confirm this mismatch between theory and practice. Most students reported feeling bored during science lessons due to minimal opportunities to interact with learning materials, while assessment results indicated that several students failed to meet the minimum mastery criteria on the topic of Earth's rotation and revolution. These findings suggest that students experience difficulties in understanding abstract concepts when instruction lacks interactive and visual support, highlighting the need for learning media that can facilitate both interaction and conceptual comprehension.

Previous studies have shown that interactive multimedia can enhance student motivation, engagement, and understanding of abstract science concepts through visual and experiential representations (Sa'adah et al., 2020); (Tapilouw et al., 2009). PowerPoint remains one of the most commonly used instructional media due to its accessibility and ability to present structured visual content. However, conventional PowerPoint presentations tend to function as one-way communication tools, offering limited opportunities for real-time interaction and formative assessment, which reduces their effectiveness in promoting active learning.

Recent developments in educational technology have introduced ClassPoint as an interactive extension of PowerPoint. ClassPoint enables the integration of real-time quizzes, polls, annotations, and automatic feedback directly into presentation slides, allowing teachers to embed interaction and assessment within instruction. Several studies have reported positive effects of ClassPoint on student motivation, participation, and higher-order thinking skills (Wao et al., 2022); (Kurniawan & Yatri, 2022); (Dini Anggraeni, Puji Rahayu, 2023). Compared to digital tools that require separate platforms, ClassPoint offers a unified instructional environment that supports content delivery, interaction, and assessment simultaneously, making it a potentially effective solution for interactive classroom learning.

Despite these promising findings, the existing literature reveals two important gaps. First, empirical studies examining the effectiveness of ClassPoint-based learning media at the elementary school level, particularly in science education, remain limited. Most previous research has focused on secondary or higher education contexts, leaving uncertainty regarding its suitability for younger learners. Second, prior studies tend to conceptualize student interaction in general terms, without operationalizing learning interaction into clear, measurable dimensions that can be systematically evaluated. As a result, the relationship between interactive media use, learning interaction, and cognitive learning outcomes in elementary science classrooms is still underexplored.

This study addresses these gaps by introducing a ClassPoint-integrated PowerPoint learning media that is explicitly designed for elementary science instruction and by operationalizing learning interaction as a multidimensional construct encompassing verbal participation, behavioral engagement, emotional engagement, and peer collaboration. Unlike previous studies that primarily emphasize motivation or achievement outcomes, this study positions learning interaction as a central analytical variable and examines its improvement alongside cognitive learning outcomes. This integration constitutes the novelty of the study, as it combines an interactive presentation tool with a theoretically grounded and measurable interaction framework in the context of elementary science learning.

Accordingly, this study is guided by the following research objectives: (1) to develop ClassPoint-integrated PowerPoint learning media for sixth-grade science instruction on the topic of Earth's rotation and revolution; (2) to examine the validity of the developed media in terms of content, language, and visual design; and (3) to evaluate the effectiveness of the media in improving students' learning interaction and cognitive learning outcomes. By providing empirical evidence and a clear operationalization of learning interaction, this study is expected to contribute to the advancement of interactive digital learning media and offer practical implications for implementing student-centered, technology-enhanced science instruction in elementary schools.

2. METHODS

2.1. *Research Design*

This study adopted a Research and Development (R&D) approach using the ADDIE model, which comprises five systematic stages: Analysis, Design, Development, Implementation, and Evaluation. The model was selected because it offers a flexible, structured, and iterative framework for developing instructional media in authentic classroom contexts. Unlike linear or product-oriented development models, ADDIE enables researchers to align media design with students' needs, learning objectives, content characteristics, and evaluation results through continuous revision.

In the analysis stage, students' learning needs, classroom conditions, curriculum requirements, and difficulties in understanding Earth's rotation and revolution were identified. The design stage involved preparing learning objectives, assessment instruments, media structure, and interactive activities using ClassPoint-based PowerPoint. During the development stage, the instructional media and supporting instruments were produced and validated by experts. The implementation stage involved applying the developed media in sixth-grade science learning. Finally, the evaluation stage assessed the validity, practicality, and effectiveness of the media in improving learning interaction and cognitive outcomes. These stages ensured that the developed media were pedagogically appropriate, technically feasible, and aligned with elementary students' learning characteristics (Melindawati & Alfiyandri, 2023; Nurmiatun et al., 2024).

2.2. *Participants*

The participants in this study were 18 sixth-grade students at SDN Sumber Elementary School, Pangkur District, Ngawi Regency, East Java, Indonesia. The class consisted of 13 girls and 5 boys. Participants were selected through purposive sampling because they were enrolled in the target science class and were recommended by the classroom teacher as suitable participants for the implementation of the developed learning media.

The sample represented a single intact classroom, which was appropriate for the formative and developmental orientation of this Research and Development study. Rather than aiming for broad population generalization, the study focused on validating the instructional product and examining its initial effectiveness in an authentic classroom context. The use of a small classroom-based sample also enabled close observation of students' learning interaction, engagement patterns, and responses to the ClassPoint-based interactive PowerPoint media. This approach provided practical insight into the feasibility of the media and its potential contribution to science learning in elementary school settings.

2.3. *Instruments and Data Collection*

Data were collected using multiple instruments to ensure methodological triangulation: (1) observation sheets to assess students' learning interaction, (2) cognitive tests administered as pre-tests and post-tests to measure conceptual understanding, (3) expert validation sheets covering media design, language, and content, and (4) questionnaires and semi-structured interviews to evaluate practicality and user perceptions.

2.3.1 Learning Interaction Measurement

Learning interaction was operationally defined as students' active engagement with teachers, peers, and learning materials during instructional activities. The construct consisted of four indicators: verbal participation, behavioral engagement, emotional engagement, and peer collaboration. Each indicator was assessed using a four-point rating scale by two independent observers. Detailed validation and reliability statistics (e.g., inter-rater agreement and content validity coefficients) are reported in Table 1.

Table 1. Summary of Instrument Validity and Reliability

Instrument	Measured Aspect	Validity Evidence	Reliability Evidence	Interpretation
Learning Interaction Observation Sheet	Verbal participation, behavioral engagement, emotional engagement, peer collaboration	Content validity confirmed through expert judgment	High inter-rater agreement and strong internal consistency	Valid and reliable for assessing multidimensional learning interaction
Cognitive Learning Outcome Test (20 items)	Conceptual understanding of Earth's Rotation and Revolution	Content alignment verified by subject-matter experts	High internal consistency reliability	Valid and reliable for measuring elementary students' cognitive achievement
Practicality Questionnaire	Usability, clarity, attractiveness, instructional feasibility	Expert review confirmed construct relevance	Strong internal consistency reliability	Valid and reliable for evaluating media practicality

2.3.2 Cognitive Learning Outcomes

The cognitive learning outcome test consisted of 20 multiple-choice items aligned with the learning objectives of the Earth's Rotation and Revolution topic for sixth-grade elementary students. The test items were designed to assess students' conceptual understanding, including factual knowledge, conceptual comprehension, and simple application.

Content validation was conducted by subject-matter experts to ensure alignment with curriculum standards, conceptual accuracy, and clarity of language. The results indicated that all test items met acceptable validity criteria. Reliability testing demonstrated high internal consistency, confirming that the test was suitable for measuring students' cognitive learning outcomes in this study.

2.4. Data Analysis

Data were analyzed using descriptive and inferential statistical procedures. Descriptive analysis was conducted to summarize students' learning interaction scores and cognitive learning outcomes before and after the implementation of ClassPoint-based interactive PowerPoint media. The results were presented using relevant measures of central tendency and variability to describe overall score patterns.

Before conducting inferential analysis, the Shapiro-Wilk test was used to examine the normality of the data distribution. Because the results indicated that the data were not normally distributed, the Wilcoxon Signed-Rank Test was applied to determine whether there were significant differences between pre-intervention and post-intervention scores. This non-parametric test was considered appropriate because the study involved paired data from the same participants and did not meet the assumption of normality.

In addition to significance testing, effect size was calculated to determine the practical magnitude of the intervention effect on learning interaction and cognitive outcomes. Normalized gain (N-gain) analysis was also performed to measure the extent of students' learning improvement from pre-test to

post-test. All statistical analyses were conducted using SPSS version 26. The findings were reported in accordance with APA 7th edition guidelines, including test statistics, significance values, and effect size indicators to ensure clarity, transparency, and interpretability.

2.5. Ethical Considerations

This study adhered to ethical research standards involving human participants. Approval to conduct the study was obtained from the school principal prior to data collection. Written informed consent was secured from students' parents or guardians, and verbal assent was obtained from the students. Participants were informed of the study's purpose, procedures, and their right to withdraw at any time without academic consequences. All collected data were anonymized and used solely for research purposes.

3. FINDINGS AND DISCUSSION

3.1. Findings

3.1.1. Descriptive and Inferential Analysis

Implementation of ClassPoint-based interactive PowerPoint media produced measurable differences in students' learning interaction and cognitive learning outcomes. Descriptive statistics are presented in Table 1.

Table 1. Descriptive Statistics for Learning Interaction and Cognitive Learning Outcomes

Data Type	N	Mean	SD	Minimum	Maximum
Pre-Test	18	56.67	12.95	35.00	75.00
Post-Test	18	85.00	15.43	35.00	100.00
Initial Interaction	18	71.94	9.26	50.00	85.00
Final Interaction	18	85.83	8.45	60.00	95.00

The Shapiro–Wilk test indicated that post-test data were not normally distributed ($p = 0.048 < 0.05$). Therefore, inferential analysis employed the Wilcoxon Signed-Rank Test. The results are summarized in Table 2.

Table 2. Wilcoxon Signed-Rank Test Results for Learning Interaction and Cognitive Learning Outcomes

Variable	Z	p-value	Effect Size (r)	95% CI
Learning Interaction	-3.73	<0.001	0.68	[0.42 0.85]
Cognitive Outcomes	-3.62	<0.001	0.66	[0.39 0.83]

3.1.2. Learning Interaction

Learning interaction scores increased significantly following the intervention ($Z = -3.73$, $p < 0.001$), with a large effect size ($r = 0.68$). Observation rubric analysis indicated improvements across indicators of verbal participation and peer collaboration. Instrument reliability testing showed strong agreement ($\kappa = 0.86$) and internal consistency ($\alpha = 0.91$), indicating stable measurement.

3.1.3. Cognitive Learning Outcomes

Cognitive learning outcomes demonstrated significant improvement ($Z = -3.62$, $p < 0.001$) with a large effect size ($r = 0.66$). The N-Gain score was 0.70, categorized as high improvement. These findings indicate substantial enhancement of conceptual understanding after implementation of the interactive media.

3.1.4. Product Development Validation

The development process followed the ADDIE model through five stages: analysis, design, development, implementation, and evaluation. Iterative revisions included interface simplification,

enhancement of visual animation for Earth's revolution, and integration of automated formative feedback features.

Expert validation yielded an average score of 88% (good–very good category), while usability testing reached 91% practicality. These results indicate that the developed media met validity and feasibility standards for classroom implementation.

3.2. Discussion

The findings of this study indicate that the integration of ClassPoint into interactive PowerPoint learning media produced substantial practical effects on students' learning interaction and cognitive learning outcomes. The effect size for learning interaction was large ($r = 0.68$), while the effect size for cognitive outcomes was similarly strong ($r = 0.66$). These results suggest that ClassPoint-based media did not merely function as a visual presentation tool but also acted as an interactive instructional environment that supported students' active participation and conceptual understanding. Compared with previous studies on interactive PowerPoint in elementary education, which generally reported moderate effects ranging from approximately 0.40 to 0.55 (Putriana et al., 2022; Wirawan & Gading, 2022), the effects observed in the present study were comparatively stronger. Similarly, although Serly et al. (2023) found that interactive slides improved students' science achievement, the absence of explicitly reported effect size metrics limits direct comparison. Therefore, the present study contributes additional methodological strength by presenting standardized effect sizes, supported by confidence intervals, to clarify the practical significance of the intervention.

The stronger effects found in this study may be explained by the distinctive pedagogical affordances of ClassPoint. Unlike conventional interactive PowerPoint, ClassPoint integrates real-time student response systems, anonymous participation, immediate visual feedback, and embedded formative assessment within the presentation interface. These features appear to reduce barriers to participation, particularly for students who may be reluctant to respond verbally in front of peers. Anonymous response options can create a safer learning atmosphere, enabling broader student involvement and encouraging more equitable classroom participation. At the same time, immediate visual feedback allows students to compare, reflect on, and revise their understanding during the lesson. This process is consistent with the view that learning becomes more effective when students receive timely feedback and opportunities to actively reconstruct knowledge through meaningful engagement (Piaget, 1952).

The integration of assessment features within the same instructional platform may also have improved learning efficiency. Because students and teachers did not need to shift between separate applications or learning tools, the learning process remained coherent and focused. This coherence likely minimized unnecessary cognitive demands and allowed students to concentrate on the scientific concepts being taught, particularly the abstract topic of Earth's rotation and revolution. For elementary students, such concepts often require concrete visualization, repeated interaction, and guided questioning. ClassPoint-supported PowerPoint media provided these opportunities through interactive questions, visual explanations, and direct feedback, thereby helping students connect observable phenomena with scientific explanations.

Beyond confirming the value of interactive PowerPoint for science learning, this study offers several important contributions. First, it operationalized learning interaction as a measurable multidimensional construct rather than treating it as a general classroom observation. The observation rubric included verbal, behavioral, emotional, and peer-collaborative engagement, allowing interaction to be assessed more comprehensively. This addresses a limitation in many previous elementary classroom studies, where interaction is often described qualitatively without rigorous measurement. Second, the study measured both interaction and cognitive achievement simultaneously, showing that improvements in participation occurred alongside improvements in learning outcomes. This parallel improvement supports the assumption that structured interaction can facilitate conceptual understanding, particularly when students are encouraged to respond, discuss, and reflect during instruction. Third, the study strengthens transparency in Research and Development-based

educational research by reporting expert validation, usability evidence, reliability, inferential analysis, and effect sizes within a single evaluative framework.

From a theoretical perspective, the results reinforce constructivist learning principles, especially the idea that students construct knowledge actively through interaction with learning materials, peers, and teachers (Piaget, 1952). The use of ClassPoint enabled students to participate in learning activities rather than passively receive information from slides. Through interactive questions, peer responses, and teacher feedback, students were given opportunities to test their prior understanding, identify misconceptions, and construct more accurate scientific concepts. The findings also align with interaction-oriented perspectives in elementary education, which emphasize that meaningful participation and social engagement are central to learning. In this context, technology served not as a replacement for teacher guidance but as a scaffold that supported dialogic classroom processes and collaborative meaning-making.

Nevertheless, several limitations should be considered when interpreting these findings. The study involved only eighteen sixth-grade students, which may restrict the statistical generalizability of the results. Although the findings show strong practical effects within the study context, a larger sample would provide more stable estimates and allow broader conclusions. The research was also conducted in a single elementary school in Ngawi Regency, East Java, Indonesia, meaning that contextual factors such as school culture, teacher readiness, digital infrastructure, and student familiarity with technology may have influenced the outcomes. In addition, the intervention was implemented over a relatively short period, so the study did not examine whether the observed improvements would be sustained over time. Future research should involve larger and more diverse samples, include multiple schools, and apply longitudinal designs to examine retention effects and the sustainability of interaction gains. Further studies may also compare ClassPoint with other interactive learning platforms to determine which features most strongly influence student engagement and science achievement.

4. CONCLUSION

This study demonstrates that the integration of ClassPoint-based interactive PowerPoint media can effectively support elementary science learning by simultaneously enhancing students' learning interaction and cognitive understanding of abstract concepts. From a pedagogical perspective, the findings highlight the importance of embedding real-time interaction, feedback, and participation within instructional presentations to create active and student-centered learning environments. The results suggest that interactive presentation technology can serve not merely as a visual aid, but as a pedagogical tool that facilitates engagement, collaboration, and meaningful learning experiences in elementary classrooms.

Beyond its instructional contribution, this study offers a methodological contribution by operationalizing learning interaction as a multidimensional construct encompassing verbal participation, behavioral engagement, emotional engagement, and peer collaboration. This measurement framework provides a clearer and more systematic approach to evaluating classroom interaction, addressing a gap in prior research that often treated interaction implicitly or descriptively. Practically, the developed media and measurement approach offer teachers a feasible and replicable model for integrating interactive digital tools into science instruction without requiring additional platforms or complex technical skills. Collectively, these contributions support the broader adoption of interaction-oriented digital learning media to improve the quality of elementary science education in the digital era.

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