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Improving Primary Students' IPAS Learning Outcomes through Wordwall-Based Learning Media: A Classroom Action Research

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ABSTRACT

The integration of digital learning media has become increasingly important in improving students' engagement and learning outcomes in primary education. However, the implementation of interactive digital media in elementary science learning remains limited, particularly within the context of Indonesia's Merdeka Curriculum. This study aimed to investigate the effectiveness of Wordwall-based learning media in improving fourth-grade students' learning outcomes in *Ilmu Pengetahuan Alam dan Sosial* (IPAS). The study employed Classroom Action Research following the Kurt Lewin model, consisting of three iterative cycles of planning, action, observation, and reflection. The research was conducted in a fourth-grade classroom at SD Negeri Lembang, Sumedang Regency, involving 30 students. Data were collected through classroom observations, learning achievement tests, and documentation, and were analyzed using descriptive qualitative and quantitative approaches. The findings revealed continuous improvements in both the learning process and students' academic achievement throughout the three research cycles. Teacher activity improved from 75% in Cycle I to 90% in Cycle III, while student learning activity increased from 70% to 85%. The percentage of students achieving the Minimum Mastery Criterion also increased from 63% in Cycle I to 70% in Cycle II and reached 83% in Cycle III, accompanied by an increase in the mean learning score from 67.1 to 75.2. These findings indicate that Wordwall-based learning media effectively promoted active participation, strengthened students' conceptual understanding, and improved learning achievement in IPAS. This study contributes to the growing body of knowledge on technology-enhanced learning by providing empirical evidence that integrating interactive digital media with Classroom Action Research offers an effective approach for improving instructional quality and students' learning outcomes in authentic primary school classrooms.

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1 INTRODUCTION

Science education plays a fundamental role in equipping primary school students with scientific literacy, critical thinking, creativity, and problem-solving skills that are essential for lifelong learning and sustainable development. In the twenty-first century, educational systems worldwide are expected to develop students who are capable of understanding scientific concepts, applying knowledge to authentic situations, and adapting to rapid technological change. However, international large-scale assessments continue to indicate that students' scientific achievement remains below the expected level in many countries, including Indonesia. The results of the Programme for International Student Assessment (PISA) 2022 reveal that Indonesian students continue to experience difficulties in scientific reasoning, conceptual understanding, and the application of knowledge to everyday contexts, highlighting the urgent need for more effective and engaging instructional practices in primary education [1]. Likewise, UNESCO emphasizes that integrating digital technology into teaching and learning should not merely replace conventional instruction but should promote active participation, collaboration, and meaningful learning experiences that improve educational quality [2].

In response to these global challenges, the implementation of Indonesia's Merdeka Curriculum emphasizes student-centered learning that promotes inquiry, collaboration, creativity, and the meaningful application of knowledge. Within this curriculum, Ilmu Pengetahuan Alam dan Sosial (IPAS) integrates natural and social sciences to encourage students to investigate real-world phenomena through observation, exploration, experimentation, and discussion. Consequently, teachers are expected to employ innovative instructional strategies supported by digital learning technologies that actively engage students throughout the learning process. Nevertheless, classroom implementation often remains dominated by teacher-centered instruction, limiting

opportunities for students to interact, investigate scientific problems, and construct knowledge independently. Such instructional conditions frequently result in low learning motivation, limited classroom participation, and unsatisfactory academic achievement [2].

Recent advances in educational technology have demonstrated that digital learning media can substantially improve students' engagement and learning outcomes when integrated appropriately into classroom instruction. Interactive digital platforms allow students to participate actively through quizzes, educational games, collaborative activities, and immediate formative feedback, creating learning environments that are more motivating than traditional lecture-based approaches. Research in educational technology consistently reports that game-based learning environments improve conceptual understanding, student motivation, and classroom engagement because learners actively construct knowledge while interacting with meaningful learning tasks [3], [4]. Moreover, digital learning environments that provide immediate feedback and adaptive learning experiences encourage greater participation and facilitate deeper conceptual understanding among elementary school students [5], [6].

One digital platform that has become increasingly popular in primary education is Wordwall. The platform enables teachers to create interactive quizzes, matching exercises, puzzles, games, and formative assessment activities that transform conventional classroom instruction into enjoyable and engaging learning experiences. Unlike static presentation media, Wordwall encourages students to participate directly in learning activities while receiving immediate feedback on their performance. Such interactive features are consistent with contemporary theories of active learning and educational technology, which emphasize that meaningful learning occurs when students actively engage with instructional content rather than passively receiving information [3], [5]. Consequently, Wordwall has considerable potential to improve students' motivation, participation, and conceptual understanding in elementary science learning.

Previous studies have consistently demonstrated the educational benefits of digital game-based learning. Ding and Yu reported that serious game-based learning significantly improved students' science learning outcomes by increasing active participation and conceptual understanding [3]. Similarly, Alotaibi's systematic review concluded that game-based learning positively influences students' motivation, engagement, and academic achievement across various educational settings [4]. Other studies have also shown that interactive digital learning environments providing immediate feedback enhance students' attention, participation, and learning performance during classroom instruction [5]–[7]. Collectively, these findings suggest that educational technologies integrating game elements can create meaningful learning experiences that support both cognitive and motivational development.

Despite these promising findings, an important research gap remains. Existing studies have primarily investigated digital game-based learning using experimental or quasi-experimental designs that evaluate learning effectiveness under relatively controlled conditions [3]–[7]. Comparatively few studies have examined how interactive digital learning media such as Wordwall can be implemented through Classroom Action Research, where instructional improvements are continuously refined through cycles of planning, implementation, observation, and reflection. Furthermore, empirical evidence regarding the application of Wordwall in IPAS learning within the implementation of the Merdeka Curriculum remains limited. Consequently, further investigation is required to understand how iterative instructional improvement supported by interactive digital learning media contributes to enhancing both classroom participation and students' science learning outcomes in authentic elementary school settings.

A preliminary observation conducted in a fourth-grade classroom at SD Negeri Lembang, Sumedang Regency, identified several instructional challenges. Classroom instruction was still predominantly teacher-centered, learning media were rarely varied, and students demonstrated relatively low participation during IPAS learning activities. As a consequence, learning achievement remained unsatisfactory. Of the 30 students in the class, 23 students (approximately 76%) obtained scores below the school's Minimum Mastery Criterion (MMC) of 65 on the topic Forces Around Us. These findings indicate that students experienced difficulties in understanding scientific concepts through conventional instructional approaches and suggest the need for more interactive learning media capable of increasing classroom engagement and improving learning outcomes.

The novelty of this study lies in integrating Wordwall-based interactive digital learning media within a Classroom Action Research framework to improve elementary students' IPAS learning outcomes under the implementation of the Merdeka Curriculum. Unlike previous studies that mainly focused on measuring the effectiveness of digital learning media through experimental designs, this study demonstrates how continuous instructional reflection and iterative classroom improvement contribute to enhancing students' participation and academic achievement in authentic learning environments. Therefore, the study provides both theoretical and practical contributions to the growing body of research on digital learning in primary education by illustrating how interactive educational technology can support meaningful science learning through reflective classroom practice.

Accordingly, this study aims to investigate the implementation of Wordwall-based learning media in improving fourth-grade students' IPAS learning outcomes through Classroom Action Research. Specifically, the study examines the improvement of classroom participation, evaluates students' learning outcomes across three action research cycles, and analyzes the contribution of interactive digital learning media to creating more engaging, student-centered, and meaningful learning experiences in primary education.

2 RESEARCH METHOD

Research Design

This study employed Classroom Action Research (CAR) using the Kurt Lewin model, which consists of four iterative stages: planning, action, observation, and reflection. Classroom Action Research was selected because it enables teachers to systematically improve instructional practices while simultaneously addressing learning problems encountered in authentic classroom settings. The intervention was implemented through three action cycles, with each cycle designed to evaluate and refine the use of Wordwall-based learning media in improving students' IPAS learning outcomes. The cyclical nature of the research allowed continuous instructional improvement based on the findings obtained from each preceding cycle [10]–[12].

Participants and Research Setting

The research was conducted at SD Negeri Lembang, Sumedang Regency, Indonesia, during the implementation of the Merdeka Curriculum. The participants consisted of 30 fourth-grade students, including 15 male and 15 female students. The participants were selected because classroom observations identified low learning achievement in IPAS, particularly in the topic Forces Around Us, where most students had not achieved the school's Minimum Mastery Criterion (MMC).

Research Procedure

The research was implemented through three consecutive action cycles following the Kurt Lewin Classroom Action Research model. Each cycle consisted of four stages:

1. Planning, including preparing lesson plans, designing Wordwall-based learning activities, preparing observation sheets, and developing learning outcome tests.
2. Action, involving the implementation of IPAS learning using interactive Wordwall media during classroom instruction.
3. Observation, during which teacher performance, students' learning activities, and classroom interactions were systematically observed.
4. Reflection, where the outcomes of each cycle were analyzed to identify instructional strengths and weaknesses and to determine improvements for the following cycle.

The instructional improvements implemented in each cycle focused on increasing students' classroom participation, strengthening conceptual understanding, and improving learning achievement through interactive digital learning activities.

Research Instruments

Data were collected using classroom observations, learning achievement tests, and documentation. Observation sheets were used to evaluate teacher performance and students' learning activities throughout the implementation of Wordwall-based instruction. Learning outcome tests assessed students' achievement across the cognitive, affective, and psychomotor domains, while documentation supported the interpretation and verification of classroom activities conducted during each action cycle.

Table 1. Research Instruments

Instrument	Purpose	Data Type
Observation sheet	Evaluate teacher performance	Qualitative
Observation sheet	Evaluate students' learning activities	Qualitative
Learning achievement test	Assess cognitive, affective, and psychomotor learning outcomes	Quantitative
Documentation	Support classroom observation and research evidence	Qualitative

Data Analysis

The collected data were analyzed using both qualitative and quantitative approaches. Qualitative data obtained from classroom observations and documentation were analyzed descriptively through the stages of data reduction, data display, and conclusion drawing to evaluate the implementation of Wordwall-based learning media throughout the research cycles. Quantitative data obtained from students' learning achievement tests were analyzed using descriptive statistics, including mean scores and the percentage of students achieving the predetermined Minimum Mastery Criterion (MMC). The effectiveness of the intervention was determined by comparing students' learning outcomes across Cycle I, Cycle II, and Cycle III. The intervention was considered successful when at least 75% of students achieved the Minimum Mastery Criterion of 65, in accordance with the school's learning achievement polic

3 RESULTS AND DISCUSSION

3.1 Cycle I: Implementation of Wordwall-Based Learning Media

The first cycle was conducted to introduce Wordwall-based learning media during IPAS instruction on the topic "Forces Around Us." The learning activities followed the Classroom Action Research procedure consisting of planning, action, observation, and reflection. During the planning stage, the teacher prepared lesson plans, Wordwall interactive learning activities, observation sheets, and learning achievement tests. The instructional activities were designed to encourage students to actively participate through interactive quizzes and game-based exercises that supported concept reinforcement.

During the implementation stage, students showed considerable enthusiasm toward the use of Wordwall because the learning activities differed from the conventional teacher-centered instruction they usually experienced. The interactive games successfully attracted students' attention and encouraged them to participate in answering questions, discussing concepts with classmates, and completing learning tasks. However, several students were still unfamiliar with the platform and required additional guidance from the teacher before they could independently operate the learning activities. Classroom observations

also indicated that classroom management remained challenging because some students focused more on the game elements than on understanding the scientific concepts being studied. These findings suggest that although students responded positively to the new learning media, further instructional refinement was still necessary to maximize learning effectiveness.

The observation results indicated that teacher performance during Cycle I reached 75%, reflecting that most planned instructional activities were implemented appropriately despite several aspects requiring improvement. Students' learning activity reached 70%, indicating that a considerable proportion of students actively participated in classroom discussions and interactive learning activities, although classroom participation had not yet reached the expected level. The learning achievement test further showed that 19 of the 30 students (63%) successfully achieved the Minimum Mastery Criterion (MMC), while the remaining students still experienced difficulties in mastering several IPAS concepts. The class mean score was 67.1, which was slightly above the minimum criterion but had not yet fulfilled the predetermined indicator of classical learning mastery.

The reflection stage identified several issues that required improvement before the second cycle. Some students needed clearer instructions when using the Wordwall platform, while others required additional opportunities for collaborative discussion to strengthen their conceptual understanding before completing the interactive exercises. Furthermore, classroom time management and teacher facilitation during game-based activities needed refinement to ensure that students remained focused on achieving the intended learning objectives rather than merely completing the games. These reflections became the basis for revising the instructional strategy implemented in Cycle II

3.2 Cycle II: Improvement of Learning Process and Students' Learning Outcomes

Cycle II was implemented by revising the instructional strategy based on the reflection results obtained in Cycle I. The teacher provided clearer guidance on the use of the Wordwall platform, strengthened classroom facilitation, and encouraged greater student participation through collaborative discussion before students completed the interactive learning activities. These improvements created a more organized learning environment and enabled students to participate more confidently during the learning process.

The classroom observation results indicated improvements in both teacher performance and student participation. Teacher activity increased from 75% in Cycle I to 80% in Cycle II, while student learning activity improved from 70% to 75%. Furthermore, students demonstrated greater confidence in answering questions, participating in discussions, and completing Wordwall-based activities independently.

Table 3. Observation Results in Cycle II

Indicator	Cycle I	Cycle II	Improvement
Teacher Activity	75%	80%	+5%
Student Activity	70%	75%	+5%

The improvement in classroom participation was accompanied by better learning achievement. The average learning score increased from 67.1 in Cycle I to 70.2 in Cycle II. Likewise, the percentage of students achieving the Minimum Mastery Criterion (MMC) increased from 63% to 70%, indicating that the instructional improvements implemented during Cycle II contributed positively to students' understanding of the IPAS concepts.

Table 4. Students' Learning Outcomes in Cycle II

Indicator	Cycle I	Cycle II
Mean Score	67.1	70.2
Students Achieving MMC	19	21
Learning Mastery	63%	70%

Although learning outcomes improved compared with the previous cycle, the predetermined indicator of classical mastery had not yet been achieved. Reflection results showed that several students still required additional guidance when applying scientific concepts independently. Therefore, further instructional refinement was planned for Cycle III by strengthening teacher feedback, increasing collaborative learning opportunities, and providing more structured guidance during Wordwall-based activities

3.3 Cycle III: Optimization of Wordwall-Based Learning and Students' Learning Achievement

Cycle III was implemented after evaluating the strengths and limitations identified in Cycle II. The instructional improvements focused on optimizing teacher facilitation, providing more structured guidance during collaborative learning activities, and encouraging students to explain scientific concepts before completing the Wordwall-based exercises. The teacher also increased the intensity of formative feedback to ensure that students not only participated in the interactive activities but also understood the underlying scientific concepts. These improvements were intended to maximize students' engagement and achieve the predetermined indicator of learning success.

The implementation of these refinements resulted in a more effective and student-centered learning environment. Students demonstrated greater confidence in using the Wordwall platform, actively participated in classroom discussions, and were able to complete learning activities with minimal teacher assistance. Most students showed increased enthusiasm during interactive learning sessions and demonstrated better collaboration when solving problems related to the topic Forces Around Us. Classroom

observations indicated that students were more focused on understanding scientific concepts rather than merely completing the game-based activities.

The observation results revealed substantial improvements in both teacher and student performance. Teacher activity increased from 80% in Cycle II to **90%** in Cycle III, while student learning activity improved from **75%** to **85%**, indicating that the learning process had become increasingly interactive and effective.

Table 5. Observation Results in Cycle III

Indicator	Cycle II	Cycle III	Improvement
Teacher Activity	80%	90%	+10%
Student Activity	75%	85%	+10%

The improvement in classroom activities was accompanied by significant gains in students' learning outcomes. The average learning score increased from 70.2 in Cycle II to 75.2 in Cycle III. Likewise, the number of students achieving the Minimum Mastery Criterion (MMC) increased from 21 students (70%) to 25 students (83%), indicating that the predetermined indicator of classical learning mastery had been successfully achieved.

Table 6. Students' Learning Outcomes in Cycle III

Indicator	Cycle II	Cycle III
Mean Score	70.2	75.2
Students Achieving MMC	21	25
Learning Mastery	70%	83%

Overall, the findings of Cycle III demonstrate that the instructional improvements implemented throughout the Classroom Action Research cycles successfully enhanced both the quality of the learning process and students' IPAS learning outcomes. The increased teacher performance, higher levels of student participation, and improved academic achievement indicate that Wordwall-based learning media effectively supported a more engaging and interactive learning environment. Consequently, the success indicators established at the beginning of the study were achieved, and no additional action cycle was considered necessary.

3.4 Overall Improvement in Students' Learning Outcomes

The implementation of Wordwall-based learning media across the three Classroom Action Research cycles demonstrated continuous improvements in both the learning process and students' IPAS learning outcomes. Each instructional revision implemented following the reflection stage contributed to better classroom participation, more effective teacher facilitation, and higher academic achievement. The progressive increase observed throughout the research indicates that iterative instructional improvement combined with interactive digital learning media successfully enhanced the quality of classroom learning.

Table 7. Overall Improvement Across the Three Research Cycles

Indicator	Cycle I	Cycle II	Cycle III
Teacher Activity	75%	80%	90%
Student Activity	70%	75%	85%
Mean Learning Score	67.1	70.2	75.2
Students Achieving MMC	19	21	25
Classical Learning Mastery	63%	70%	83%

Table 7 shows a consistent upward trend in all observed indicators. Teacher activity improved by 15 percentage points, increasing from 75% in Cycle I to 90% in Cycle III. Similarly, student learning activity increased from 70% to 85%, indicating that the learning environment became progressively more interactive and student-centered. These improvements suggest that students became increasingly familiar with the Wordwall platform and participated more actively in classroom discussions and learning activities throughout the intervention.

Students' learning achievement also demonstrated continuous improvement during the research. The class mean score increased from 67.1 in Cycle I to 70.2 in Cycle II and further increased to 75.2 in Cycle III. Likewise, the percentage of students achieving the Minimum Mastery Criterion (MMC) increased steadily from 63% in Cycle I to 70% in Cycle II and reached 83% in the final cycle. These findings indicate that the iterative implementation of Wordwall-based learning media effectively improved both classroom engagement and students' academic achievement in IPAS learning.

Overall, the results demonstrate that continuous instructional refinement through Classroom Action Research, supported by interactive Wordwall-based learning activities, contributed to meaningful improvements in teacher performance, student participation, and learning outcomes. The achievement of the predetermined success indicators in Cycle III confirms the effectiveness of the intervention and provides empirical evidence supporting the integration of digital learning media into primary science education.

3.4 Discussion

The findings of this study indicate that Wordwall-based learning media contributed to continuous improvements in students' IPAS learning outcomes across the three action research cycles. The improvement suggests that interactive digital

media can transform classroom learning from teacher-centered instruction into a more participatory and engaging learning experience. This result is consistent with previous research showing that serious games and game-based learning environments can improve students' learning achievement, motivation, and retention when they are integrated with meaningful instructional activities [13], [16].

The increase in student participation throughout the cycles can be explained by the characteristics of Wordwall as a gamified learning platform. Wordwall provides interactive quizzes, immediate feedback, and game-like activities that encourage students to become more actively involved in the learning process. This finding aligns with meta-analytic evidence showing that gamification has positive effects on cognitive, motivational, and behavioral learning outcomes [14]. Similarly, previous systematic review findings indicate that gamification supports learner engagement by increasing motivation, participation, and interaction during learning activities [15].

The findings also show that students' learning achievement improved when Wordwall was implemented through continuous instructional refinement. This suggests that the effectiveness of digital learning media does not depend only on the technology itself, but also on how teachers design, facilitate, and reflect on learning activities. Game-based learning is more effective when it is connected to clear learning objectives, structured classroom guidance, and meaningful feedback [13], [16]. Therefore, the teacher's role remained essential in ensuring that students did not merely focus on playing games but also understood the IPAS concepts being learned.

The improvement in students' learning outcomes is also consistent with studies on game-based learning in early and primary education. Alotaibi reported that game-based learning can support children's engagement, motivation, and learning performance when implemented appropriately in classroom contexts [17]. In the present study, Wordwall helped create a more enjoyable and participatory classroom atmosphere, which encouraged students to pay attention, answer questions, and complete learning tasks more actively. This condition supports the view that students' interest and curiosity are important factors in sustaining learning engagement and improving academic achievement [18].

From the perspective of instructional effectiveness, the gradual improvement across cycles indicates that Wordwall-based learning provided opportunities for active practice and formative reinforcement. Students could interact with learning materials repeatedly through quizzes and game-based exercises, while the teacher could identify students' difficulties and provide feedback. This finding is in line with Hattie's argument that feedback, active engagement, and visible learning processes are among the factors that strongly influence student achievement [19].

Another important finding is that the improvement was achieved through the Classroom Action Research process. Each cycle allowed the teacher to evaluate weaknesses, improve classroom management, refine the use of Wordwall, and provide better guidance for students. This confirms that reflective teaching practice is important in improving classroom instruction. Action research enables teachers to solve practical classroom problems through systematic planning, action, observation, and reflection [20].

The study has practical implications for IPAS learning in elementary schools. Wordwall can be used as an accessible digital learning medium to support the Merdeka Curriculum, especially because it encourages active participation, formative assessment, and student-centered learning. Teachers may use Wordwall not only as an evaluation tool but also as a medium for concept reinforcement, collaborative learning, and classroom interaction. However, successful implementation requires careful instructional planning so that the use of digital media remains aligned with learning objectives.

Despite these positive findings, this study has several limitations. The research was conducted in one fourth-grade classroom and focused only on the IPAS topic "Forces Around Us," which limits the generalizability of the findings. In addition, the Classroom Action Research design was intended to improve classroom practice rather than establish causal effects. Future studies are recommended to use quasi-experimental or mixed-methods designs involving larger samples, different grade levels, and various IPAS topics. Further research may also examine the long-term impact of Wordwall on students' conceptual understanding, motivation, digital literacy, and higher-order thinking skills.

Overall, this study contributes to the literature on technology-enhanced learning in primary education by demonstrating that Wordwall-based learning media can improve students' IPAS learning outcomes when implemented through systematic classroom reflection. The novelty of this study lies in showing how interactive digital media and Classroom Action Research can be combined to enhance elementary students' learning participation and achievement in an authentic classroom context.

4 CONCLUSION

This study demonstrates that the implementation of Wordwall-based learning media through Classroom Action Research effectively improved the quality of the learning process and students' IPAS learning outcomes in a fourth-grade elementary classroom. Continuous instructional improvements implemented across the three action research cycles resulted in higher teacher performance, increased student participation, and better academic achievement. The percentage of students achieving the Minimum Mastery Criterion increased progressively from 63% in Cycle I to 70% in Cycle II and reached 83% in Cycle III, indicating that the predetermined success indicator was successfully achieved. These findings confirm that integrating interactive

digital learning media with reflective teaching practices can create more engaging, student-centered, and meaningful learning experiences in primary science education.

This study contributes both theoretically and practically to the field of technology-enhanced learning in primary education. Theoretically, it extends the growing body of evidence that game-based digital learning media improve students' engagement and learning achievement when supported by systematic instructional reflection. Practically, the study provides an evidence-based example of how Wordwall can be integrated into IPAS instruction under the Merdeka Curriculum to promote active participation, formative assessment, and meaningful concept reinforcement. The novelty of this research lies in demonstrating that the combination of interactive digital media and Classroom Action Research offers an effective approach for continuously improving teaching quality and students' learning outcomes in authentic elementary school classrooms.

Despite these positive findings, several limitations should be acknowledged. The study was conducted in a single fourth-grade classroom at one elementary school and focused on one IPAS learning topic, limiting the generalizability of the findings to broader educational contexts. Furthermore, the Classroom Action Research design emphasizes instructional improvement rather than causal inference. Future research is therefore recommended to employ quasi-experimental or mixed-methods designs involving larger samples, multiple schools, and different science topics to examine the long-term effects of Wordwall on students' conceptual understanding, scientific literacy, learning motivation, and higher-order thinking skills. Such investigations would provide more comprehensive evidence regarding the effectiveness of interactive digital learning media in primary education.

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6 DECLARATIONS

AI USAGE STATEMENT

During the preparation of this manuscript, the authors used ChatGPT (OpenAI) to assist in improving the language quality, grammar, readability, and academic writing style of the manuscript. The tool was also used to support the organization of the manuscript structure and refine academic expressions. All AI-generated outputs were carefully reviewed, verified, revised, and edited by the authors. The authors take full responsibility for the originality, accuracy, integrity, and scientific content of this publication.

AUTHOR CONTRIBUTIONS

Author 1: Conceptualization, Investigation, Methodology, Data Collection, Data Curation, Formal Analysis, Visualization, Writing – Original Draft Preparation.

Author 2: Methodology, Validation, Formal Analysis, Supervision, Writing – Review & Editing.

Author 3: Methodology Consultation, International Academic Review, Critical Revision of the Manuscript, Validation, Writing – Review & Editing.

All authors have read and approved the final version of the manuscript and agree to be accountable for all aspects of the work.

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COMPETING INTERESTS

The authors declare that they have no known competing financial interests, professional relationships, or personal relationships that could have appeared to influence the work reported in this manuscript.

ETHICAL APPROVAL

This study was conducted in accordance with the ethical principles of educational research involving human participants. Ethical permission to conduct the study was obtained from the Principal of SD Negeri Lembang, Sumedang Regency, Indonesia, prior to data collection. Participation was voluntary, and informed consent was obtained from the school administration, classroom teacher, and the parents or legal guardians of the participating students where required. All participant data were anonymized, and confidentiality was maintained throughout the research process. The study complied with institutional and national ethical guidelines for educational research.

CONSENT TO PARTICIPATE

Informed consent was obtained from the school administration and the parents or legal guardians of the participating students prior to the implementation of the research. Participation was entirely voluntary, and participants were informed that the collected data would be used solely for research purposes.

CONSENT FOR PUBLICATION

All authors have reviewed and approved the final version of the manuscript and consent to its publication. The manuscript has not been published previously and is not under consideration for publication elsewhere.

DATA AVAILABILITY STATEMENT

The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request. Data will be shared for academic and research purposes while maintaining participant confidentiality.

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