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Improving Learning Outcomes and Student Activity through Experimental Method in Science

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Abstrak

Pembelajaran Ilmu Pengetahuan Alam dan Sosial (IPAS) di sekolah dasar masih didominasi pendekatan yang berpusat pada guru, berhenti di teori dan hanya sebatas hafalan semata, sehingga aktivitas dan hasil belajar murid rendah. Penelitian ini bertujuan untuk meningkatkan hasil belajar dan aktivitas murid melalui penerapan metode eksperimen pada materi Gaya Magnet. Penelitian Tindakan Kelas (PTK) model Kemmis & McTaggart ini dilaksanakan dalam dua siklus dengan tahapan perencanaan, pelaksanaan, observasi, dan refleksi. Subjek penelitian meliputi 24 murid kelas IV SD Negeri Kaliwadas 01 Tahun Pelajaran 2024/2025. Data dikumpulkan melalui tes hasil belajar dan lembar observasi aktivitas, kemudian dianalisis secara deskriptif komparatif. Hasil penelitian menunjukkan peningkatan ketuntasan belajar dari 50% pada pra-siklus menjadi 79,17% pada siklus I, dan mencapai 100% pada siklus II. Rata-rata nilai belajar meningkat dari 79,95 menjadi 94,00. Aktivitas murid juga naik dari 45,83% menjadi 87,50%. Temuan ini menegaskan efektivitas metode eksperimen dalam meningkatkan pemahaman konsep, keterampilan ilmiah, berpikir kritis dan motivasi belajar. Secara teoritis, penelitian ini memperkuat implementasi pendekatan konstruktivistik, sedangkan secara praktis memberikan alternatif strategi PAIKEM untuk meningkatkan kualitas pembelajaran IPAS di sekolah dasar.

Kata Kunci: metode eksperimen, hasil belajar, aktivitas belajar, IPAS, gaya magnet

Abstract

Science and Social Studies (IPAS) learning in elementary schools is still dominated by teacher-centered approaches that focus on theory and memorization, resulting in low student engagement and achievement. This study aims to improve learning outcomes and student engagement by applying the experimental method to the magnetic force. The research employed Classroom Action Research (CAR) using the Kemmis & McTaggart model, conducted in two cycles: planning, implementation, observation, and reflection. The subjects were 24 fourth-grade students at SD Negeri Kaliwadas 01 in the 2024/2025 academic year. Data were collected through learning outcome tests and observation sheets, then analyzed descriptively and comparatively. The findings showed an increase in mastery learning from 50% in the pre-cycle to 79.17% in cycle I and 100% in cycle II. The average score improved from 79.95 to 94.00, while student activity rose from 45.83% to 87.50%. These results confirm the effectiveness of the experimental method in enhancing conceptual understanding, scientific skills, critical thinking, and learning motivation. Theoretically, this study reinforces the implementation of constructivist approaches, while practically, it provides an alternative PAIKEM strategy to improve the quality of IPAS learning in elementary schools.

Keywords: *Experimental methods, learning outcomes, learning activities, IPAS, magnetic force*

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INTRODUCTION

Basic education plays a key role in nurturing a generation that is intelligent, critical, and adaptable to the development of science and technology. One subject that plays a strategic role in developing scientific thinking skills from an early age is Science and Social Studies (IPAS). Ideally, IPAS learning should emphasise pupils' active involvement in the process of observation, exploration, and discovery of concepts through direct experience. In line with Labibah et al. (2025) views, the 21st Century demands not only academic achievement, but also the development of critical thinking, creativity, communication, and collaboration skills. However, in practice, IPAS learning tends to be teacher-centred, focusing on theoretical explanations and rote learning. This leads to poor learning outcomes and limited scientific understanding among students.

Observasi di SD Negeri Kaliwadas 01 menunjukkan bahwa hanya 50% murid kelas IV yang mencapai Kriteria Ketuntasan Tujuan Pembelajaran (KKTP), yaitu nilai 80. This phenomenon indicates a gap between the active learning principles recommended in the curriculum and the conventional teaching practices that are still dominant. This gap highlights the urgent need for teaching strategies that integrate scientific activities, hands-on experience, and student engagement in independently discovering concepts. The implementation of active, innovative teaching strategies is becoming increasingly crucial for equipping students with 4C skills. Active learning involves students in the learning process. In contrast, innovative learning focuses on using new methods and technologies to create meaningful, contextually relevant learning experiences that reflect daily life. (Labibah et al., 2025).

Theoretically, IPAS learning based on experimentation is rooted in the constructivist paradigm, which emphasises that knowledge is constructed through active learning experiences (Piaget, 1970). This theory aligns with the view of Wilani & Marjo (2025) that scientific activities such as observation, measurement, and experimentation encourage students to think inductively and construct meaning through direct interaction with natural phenomena, thereby impacting their ability to be creative, argue, and express opinions based on experimental results. Experiment-based learning also supports a student-centred learning approach, in which the teacher acts as a facilitator, helping students to discover concepts through the investigative process (Haudi, 2021).

Previous research has shown that the experimental method can improve primary school students' learning outcomes and scientific process skills (Ali et al., 2023; Khalida & Astawan, 2021; Kurniawan et al., 2022; Susilowati, 2023). However, most of these studies have focused on cognitive aspects and have not extensively explored the relationship between implementing the experimental method and sustained enhancement of students' scientific activities, particularly in the context of abstract topics such as magnetism (Arif & Fatah, 2024). Therefore, a teaching model is needed that not only emphasises learning outcomes, but also scientific processes and reflective collaboration between students.

Based on this review, a research gap was identified in integrating experimental methods with a reflective, collaborative approach in the context of IPAS teaching in primary schools. Previous research has not examined in depth how experiments can be adapted into a cyclical and reflective model of Classroom Action Research (PTK). Therefore, this study offers something new by applying the experimental method through two PTK cycles, which not only improve learning outcomes but also develop scientific activity, collaboration, and reflection among pupils.

From an academic perspective, this study is important because it fills a gap in the literature on integrating experimental methods and collaborative reflection in constructivist-based IPAS learning. This approach broadens the theoretical framework on how experiential learning can optimise pupils' scientific thinking skills from a young age.

In practice, the study contributes to improving the quality of IPAS learning in primary schools by offering an alternative PAIKEM strategy (active, innovative, creative, effective, and enjoyable). By implementing experiments across two PTK cycles, this study helps teachers develop contextualised, participatory, and student-centred learning activities that can ultimately enhance students' learning outcomes and scientific activity.

Thus, this study not only replicates previous findings but also expands our understanding of how experimental methods can be implemented collaboratively and reflectively to improve the quality of IPAS learning at the primary school level.

METHOD

This research method is Classroom Action Research (CAR), which aims to improve the quality of the classroom learning process through repeated reflective actions. The model used refers to Kemmis and McTaggart, which consists of four stages, namely: (1) planning, (2) acting, (3) observing, and (4) reflecting (Machali, 2022). This research was conducted in two cycles, where each cycle reflected a series of IPAS learning activities with the application of the experimental method on the subject of Magnetic Force.

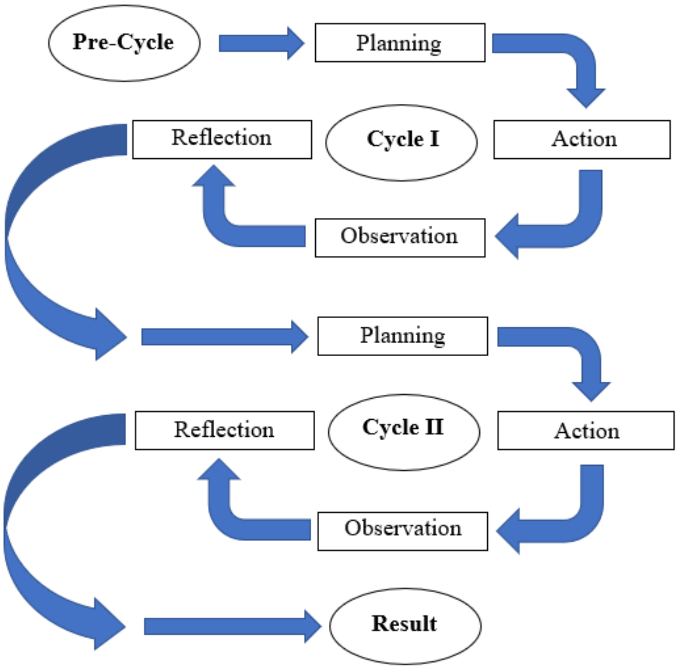

Figure 1. Classroom Action Research Model

Subject and Setting of the Research

The study subjects were 24 Year 4 pupils at SD Negeri Kaliwadas 01 in the 2024/25 academic year. The subjects were selected using the purposive sampling technique, based on similarities in academic ability and learning engagement. The study was conducted in Class IV, focusing on the 'Magnetic Forces' topic in the IPAS curriculum.

Design Action

Each cycle consists of four main stages:

1. Planning: The teacher prepares the Lesson Plan (RPP) using the experimental method, as well as the Group Work Sheet (LKK), the Activity Observation Sheet, and the Learning Outcomes Test.
2. Implementation (Action): The teacher carries out the lesson by involving the pupils actively in experimental activities using simple equipment and materials (such as bar magnets, nails, paper clips, and other metal objects).
3. Observasi (Observation): The activities of the pupils and teacher are observed using an observation instrument that has been prepared. Two observers conduct the observation to ensure objectivity.

4. Reflection: The results of the observations and tests are analysed together by the teacher and researcher to determine the success of the action and plan improvements for the next cycle.

Research instruments

The instruments used in this study consist of:

1. Test results, consisting of 10 objective questions, five short-answer questions, and three essay questions, are designed to assess understanding of the concept of magnetic force. The test outline was compiled based on the IPAS fundamental competency indicators and underwent content validity testing by two peers with a background in Science Education. The test's reliability was examined using Cronbach's alpha, yielding a value of 0.82, indicating high reliability.
2. The Student Activity Observation Sheet contains 10 indicators of scientific activity, such as observing, questioning, experimenting, discussing, and concluding. The validity of the observation sheet was established through expert judgement from two experienced primary school science teachers.
3. The Teacher Performance Observation Sheet is used to evaluate the implementation of experimental learning and its alignment with the RPP.
4. Documentation in the form of photos of activities, field notes, and teacher reflections to reinforce qualitative data.

Data collection techniques

Data is collected through three main techniques:

1. Use the results of the learning test to measure the pupils' increased understanding of the concept in each cycle, before and after the intervention.
2. Observing learning activities to evaluate increased student engagement and participation during the learning process.
3. Documentation and reflection notes to support the interpretation of quantitative data in the context of classroom activities.

Data Analysis Technique

Data analysis is carried out both quantitatively and qualitatively.

1. Quantitative analysis
   The students' learning outcomes are analysed by comparing the mean value and the percentage of students who have achieved the Learning Outcomes Criteria (KKTP = 80). The increase is calculated based on the formula:

   $$P = \frac{(X_2 - X_1)}{X_1} \times 100\%$$

   Here is the pre-cycle average, and here is the average for each cycle. Student activity was assessed by scoring an observation sheet on a 1–4 scale and converting the score to a percentage of engagement.
2. Qualitative analysis
   The data from observations, field notes, and teacher reflections were analyzed using the Miles & Huberman (1994) interactive analysis model, which includes data reduction, data presentation, and conclusion drawing. This analysis was used to understand the dynamics of changes in student learning behavior and the effectiveness of learning strategies in each cycle.

Data Validation and Validity

Data validity is maintained by applying triangulation techniques, which include four forms:

1. Source Triangulation, comparing data from teachers, observers, and students to obtain an objective view of the implementation of actions.

2. Technique Triangulation, using several data collection methods, namely learning outcome tests, observation, and documentation, to ensure consistency between results.
3. Time Triangulation, collecting data in the pre-cycle, cycle I, and cycle II to verify the sustainability of changes in learning outcomes and student activities.
4. Audit Trail, storing all research documents such as lesson plans, test results, observation sheets, teacher reflections, and activity documentation as objective and transparent evidence of the research process.

Success Indicators

The research is considered successful if:

1. Student learning outcomes reach a minimum average of 80 with a classical completeness of ≥ 80%.
2. Student activity in learning reaches a percentage of ≥ 80%.
3. Teacher reflections show an improvement in the quality of the learning process from cycle to cycle.

RESULT AND DISCUSSION

Improvement in Learning Outcomes

The learning outcomes of students in the magnetic force subject in science significantly improved from cycle I to cycle II. This is shown in the table below.

Table 1. Increase in KKTP students' achievement in each cycle.

Cycle	Total Students ≥ 80	Total Students < 80	Percentage (%)	Average
Pre-Cycle	12	12	50%	79,95
Cycle I	19	5	79,17%	84,54
Cycle II	24	0	100%	94,00

Source: Researcher data analysis for 2024.

Based on Table 1, the percentage of KKTP achievement in student learning outcomes increased in each cycle. The pre-cycle showed that only 12 students were enrolled, meaning that only 50% had achieved KKTP ≥ 80. Furthermore, in cycle I, it increased to 19 students with an achievement percentage of 79.17%, and in cycle II, 100% of students had achieved KKTP. This indicates the success of the experimental method applied in class IV at Kaliwadas 01 Public Elementary School in increasing students' achievement in KKTP.

The following is a comparison of learning outcome scores across cycles.

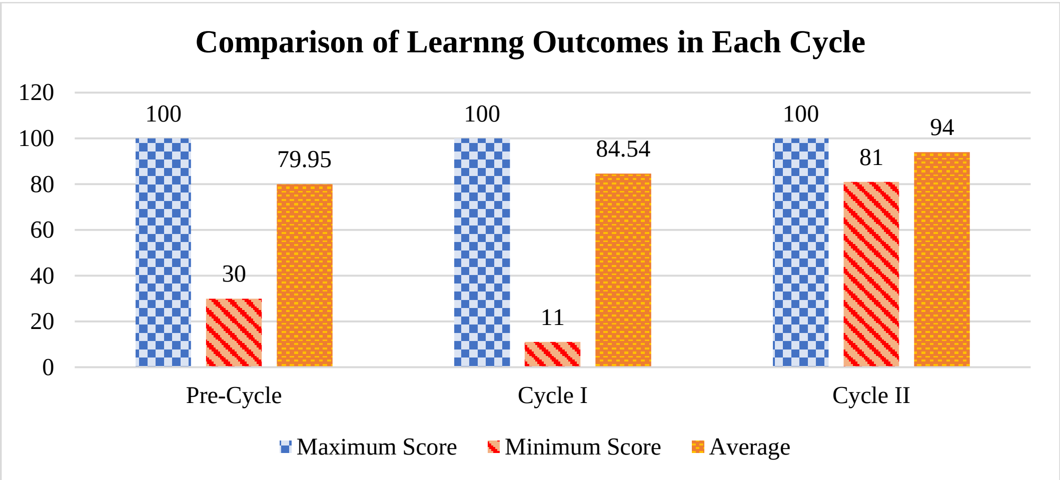

Figure 2. Bar chart comparing student learning outcomes for each cycle

Based on Figure 2, the data show that although each cycle achieved a score of 100, there were differences in the lowest and average scores. In the pre-cycle, the lowest score was 30; in cycle I, it decreased to 11; and in cycle II, it increased to 81. Looking at the average data, it can be seen that the average score of students in each cycle increased significantly, from 79.95 to 84.54 and finally to 94. This increase occurred after the experimental method was implemented in teaching magnetic force. It can be interpreted that, based on the average scores, student learning outcomes improved in each cycle after being taught using the experimental method.

Based on the analysis of the data, learning completeness increased from 50% to 100%. The average student score increased by 14.05 points from the pre-cycle to cycle II. This shows that the experimental activities made it easier for students to understand the concept of magnetic force because they were directly involved in scientific proof. These results align with the research by Laelandi & Robandi (2021), which found that experiment-based learning can improve science learning outcomes in elementary schools by increasing students' active involvement.

Learning Activity

The implementation of experimental methods in teaching IPAS material on magnetic force received positive responses from students. This is evident in the graph below, which shows the increase in student activity.

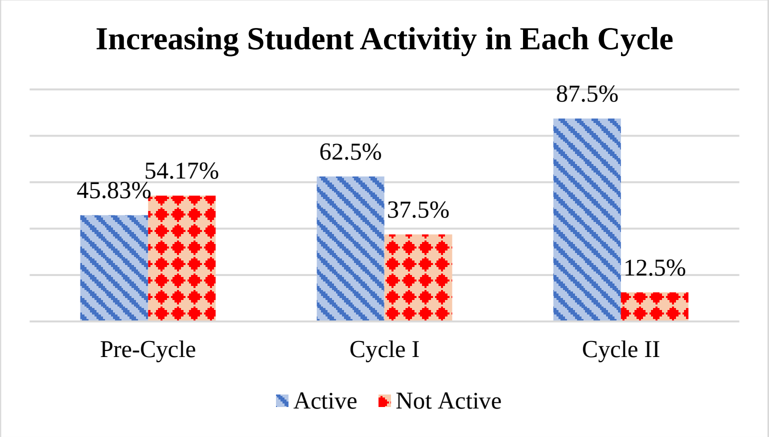

Figure 3. Line diagram showing the increase in student activity

Based on Figure 3, it can be interpreted that student learning activities increased in each cycle. Before applying the experimental method, learning was conducted solely through the conventional teacher model, which did not fully engage students. In fact, the percentage was still below 50%, at only 45.83%. This indicated that improvements in learning were needed. However, after implementing the experimental method in two cycles, there was a very significant increase. In cycle I, student activity increased from 45.83% to 62.5%. Meanwhile, in cycle II, student learning activity increased by 25% from 62.5% to 87.5%.

A comparison of student learning activities across cycles shows that in the pre-cycle, only 11 students were active. In cycle I, this increased to 15 students; in cycle II, it increased to 21 students actively learning. Based on observations of student activity, the experimental method increased students' active role and made them the subjects of learning. The experimental method applied enabled students to construct their knowledge independently and actively.

Discussion

The implementation of this classroom action research consisted of two cycles, each of which was carried out through four stages, namely (1) planning, (2) implementation of actions, (3) observation, and (4) reflection. Each stage is carried out sequentially to improve and enhance the quality of IPAS learning, particularly in the subject of Magnetic Force. The discussion of the research results describes the dynamics of each cycle, the improvement in student learning outcomes and activities, and their relevance to the concept of experiment-based science learning and to previous relevant research.

Cycle I

1. Planning

   At this stage, teachers prepare learning tools, such as Lesson Plans (RPP), using an experimental approach. The material focuses on the understanding of magnetic force and the properties of magnets. In addition, student worksheets (LKS), activity observation instruments, and formative tests to measure learning outcomes are also prepared.
2. Implementation Action

   The teacher began the lesson by introducing the topic and motivating the students, then gave a brief explanation of magnetic force and examples of its application. The students were divided into several groups to conduct simple experiments using magnetic and non-magnetic objects. The teacher acted as a facilitator, while the students actively tried out the experiments and discussed the results.
3. Observation

   During the observation stage, observers recorded students' activities during the learning process. The data showed that in cycle I, 15 of 24 students (62.5%) were active in the experiment, while 9 (37.5%) remained passive. Quantitatively, the formative test results show that 19 students (79.17%) have achieved a minimum passing grade of $\geq$ 80, with the class average score increasing to 84.54.
4. Reflection

   Based on observations and discussions with observers, it was found that some students still had difficulty understanding the concept of magnetic force due to limited experimental time and suboptimal group cooperation. This reflection was used to design improvements for cycle II, namely by reducing the size of the experiment groups, clarifying instructions, and adding variety to the learning media.

Cycle II

1. Planning

   The results of the reflection from cycle I were used to improve the learning design. Teachers developed new lesson plans with more diverse experimental activities and included small-group interactions (4–5 students). The media used were supplemented with bar magnets, nails, clips, and PowerPoint images to reinforce visual concepts.
2. Implementation Action

   The teacher began the lesson by briefly reviewing the concept of magnetic force through a question-and-answer session. Students then conducted further experiments to predict and prove which objects have magnetic properties. Each group documented its observations and presented its findings to the class.
3. Observation

   The observation results showed a significant increase in student engagement. A total of 21 students (87.5%) showed high learning activity, enthusiastically asking questions, discussing, and conducting independent experiments. Meanwhile, the formative test results showed that all students (100%) had achieved scores above the minimum passing grade with an average of 94.00.
4. Reflection

   Reflections at the end of cycle II showed that learning had achieved the predetermined success indicators. Students were more active, confident, and enthusiastic in understanding the material through direct experience. Teachers also showed improvement in their ability to manage experiment-based learning effectively.

Effectiveness of Experimental Methods on Learning Outcomes

The results of the study indicate that the application of experimental methods in teaching magnetic force significantly improves student learning outcomes and scientific activity. This improvement is not only quantitative but also reflects students' active involvement in the scientific cycle: observation, hypothesis

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formulation, experimentation, and reflection. These findings align with the constructivist theories of Piaget (1970) and Vygotsky (1978), which emphasize that knowledge cannot be transferred directly from teacher to student but must be constructed through active learning experiences. When students conduct magnetic experiments, they not only remember facts but also construct concepts of magnetic force through direct interaction with natural phenomena (Sembiring et al., 2024).

According to Brunner (1966), effective learning occurs when students engage in discovery learning, namely, the process of discovering concepts through exploratory activities. In the context of this study, simple experiments, such as testing magnetic and non-magnetic objects, provide students with opportunities to hypothesize, observe, and draw conclusions independently. This activity strengthens memory and conceptual understanding Hikon et al. (2025). Conceptually, the experimental method is effective for magnetic force material because its abstract nature is challenging to understand through lectures alone. By manipulating magnetic objects, students gain concrete experiences that bridge the abstraction to real understanding (Yulidar, 2020).

This study also confirms the findings of Widodi et al. (2023) that the experimental method improves science comprehension by engaging cognitive, affective, and psychomotor aspects simultaneously. Cognitively, students understand the relationship between magnetic force and everyday phenomena. Affectively, they show interest and curiosity. Psychomotorically, students are skilled at conducting experiments and recording the results carefully. Similar research by Syahrul et al. (2023) also shows that experimental activities improve science process skills such as observing, classifying, and concluding. This occurs because experiential activities provide students with opportunities to learn through real experiences (learning by doing), as emphasized in Kolb's Experiential Learning theory.

In addition, the results of this study reinforce the view Rukinem (2018) that experiment-based learning can improve learning outcomes by linking theory with practice, thereby deepening understanding of abstract concepts in science. The findings of this study are also consistent with those of Tindan & Anaba (2024), who found that hands-on inquiry-based learning improves long-term retention of science topics by engaging multisensory experiences. Their study on active learning showed that experimental strategies produced higher normalized gains than traditional lecture learning.

The increase in learning activity from 45.83% to 87.50% shows that the experimental method can transform passive learning into active, constructive learning. These findings support the results of research Awansyah (2022), which proves that simple experiments increase student participation and scientific curiosity. In theoretical terms, this increase can be explained by Vygotsky's (1978) concept of the Zone of Proximal Development (ZPD), in which effective learning occurs when students are given opportunities to collaborate and experiment with teacher-guided scaffolding. Teachers in this study acted as facilitators rather than the primary source of information, in accordance with the student-centered learning paradigm.

These findings are also consistent with a study by Wilani & Marjo (2025), which showed that students' scientific activities increased because experimental learning provided space for collaborative skills and scientific communication. Meanwhile, Luthfi & Rosmi (2024) emphasized that experimental-based science learning improved critical thinking skills through direct observation.

Overall, this study builds on the findings of Kurniawan et al. (2022), Mutia & Adri (2025), Nuryanto & Kausar (2025), and Warsiki (2018), which emphasize improved learning outcomes. However, this study makes an additional contribution by emphasizing continuous scientific activity and collaborative reflection, which have not been widely studied previously. This study also aligns with international views, such as those of Freeman et al., which affirm that active learning through experiments can improve academic achievement and student engagement in science.

Theoretical and Practical Implications

Theoretically, the results of this study reinforce the relevance of constructivist theory (Piaget, Vygotsky, Bruner) and experiential learning (Kolb, 1984) in Indonesian primary education. The application of the experimental method to magnetic force material shows that scientific knowledge can be actively constructed through direct interaction with physical phenomena. In practice, this study shows that applying the experimental method across two cycles of action research effectively improves students' science process skills, learning outcomes, and scientific activities. This model can be adapted by elementary school teachers in science and mathematics learning to develop active, collaborative, and reflective learning based on PAIKEM.

CONCLUSION

The implementation of the experimental method proved effective in improving student learning outcomes in IPAS learning on magnetic force materials in grade IV at SD Negeri Kaliwadas 01. The results of this study have important implications for the development of learning practices in elementary schools. Teachers are advised to combine the experimental method with an inquiry approach, project-based learning, or STEAM (Science, Technology, Engineering, Art, and Mathematics)- based learning models to optimize student learning outcomes and activities. This combination can enrich the learning experience, integrate cognitive and affective aspects, and foster 21st-century skills such as critical thinking, collaboration, and creativity. In addition, further research can expand the focus on students' science process skills and scientific attitudes to obtain a more comprehensive picture of the effectiveness of the experimental method in the context of IPAS learning at the elementary level.

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