

## **The Effect of Hands-On Minds-On Activity-Based Experiential Learning Model on Science Process Skills and Learning Motivation of Elementary School Students**

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### **ABSTRACT**

This study examined the effect of an experiential learning model integrated with hands-on and minds-on activities on elementary school students' science process skills and learning motivation in Natural and Social Sciences (IPAS) lessons on changes in the state of matter. A quantitative approach using a quasi-experimental method with a nonequivalent control group design was employed. The participants were 66 fourth-grade students, consisting of 35 students from SDN Sukaraja II as the experimental group and 31 students from SDN Cikapek as the control group. Data were collected through an essay test, a Likert-scale questionnaire, and observation sheets, and were analyzed using descriptive statistics, the Kolmogorov-Smirnov normality test, Levene's test of homogeneity, and the independent samples t-test at a significance level of 0.05. The results showed that the model significantly improved students' science process skills (Sig. = 0.002) and learning motivation (Sig. = 0.003). The mean science process skills score of the experimental group increased by 26.61%, while its mean learning motivation score increased by 22.24%, with 97.14% of the students reaching the high motivation category. These findings indicate that integrating experiential learning with practical and cognitive activities effectively enhances science process skills and learning motivation among elementary school students.

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## Introduction

Science process skills (SPS) are scientific abilities that help students acquire, develop, and apply knowledge through a series of systematic investigative activities (Gizaw & Sota, 2023). Mastery of these skills enables students not only to receive information as objects of learning but also to engage actively in observing phenomena, solving problems, and developing critical, logical, and analytical thinking skills (Yunaini et al., 2025). In the teaching of Natural and Social Sciences (IPAS) in elementary school, SPS is one of the competencies that need to be developed early, in accordance with the cognitive developmental characteristics of students who are still in the concrete operational stage (Aini et al., 2025). Therefore, the learning process must provide meaningful learning experiences through basic scientific activities, such as observing, classifying, measuring, predicting, drawing conclusions, and communicating the results of observations (Fitriyeni et al., 2026; Gizaw & Sota, 2023).

In addition to SPS, learning motivation is also a factor that determines students' success in the learning process. Learning motivation is an internal drive that directs, propels, and sustains learning behavior (Ryan & Deci, 2020), thereby encouraging students to achieve the expected learning objectives. A high level of motivation influences students' dedication to studying the material, their ability to maintain focus during learning, and their capacity to overcome various difficulties that arise when understanding abstract concepts (Yulfita & Afrita, 2024). According to Keller's theory of motivation, motivation can be reflected through students' active engagement, high levels of curiosity, and perseverance in completing the academic tasks assigned during the learning process (Rosmayati et al., 2020).

Although SPS and learning motivation play an important role in IPAS learning, their implementation in elementary schools still faces various challenges. Preliminary observations, supported by a review of the literature, indicate that students' SPS remain at a low level (Astuti et al., 2025). Weaknesses in processing and analyzing information as well as in evaluating and reflecting on investigation results have even been found among prospective elementary school teachers (Fitriyeni et al., 2026), which indicates that these skills need to be cultivated from the early grades. This is influenced by a learning process that has not yet systematically integrated SPS; consequently, learning activities are still dominated by lecture-based (*teacher-centered*) methods, with minimal inquiry-based activities, and interactive learning media are not yet utilized optimally (Permatasari & Nurita, 2023). These conditions cause students to experience difficulties in designing experiments, taking accurate measurements, and communicating their investigation results both orally and in writing (Dani et al., 2024). These issues not only result in low SPS but also affect students' motivation to learn. Low self-confidence, a lack of curiosity, and the perception that science material is difficult to understand are some of the intrinsic factors that influence students' motivation (Sari et al., 2025). On the other hand, external factors such as monotonous instruction, limited experimental facilities, and the suboptimal implementation of innovative learning models further exacerbate this situation (Azzahra et al., 2026; Fahima & Julianto, 2022). As a result, students tend to show low enthusiasm for learning, lack focus during lessons, and do not yet participate actively in learning activities (Sinuhaji et al., 2023).

To address these issues, a learning model is needed that can actively engage students in both physical activities and the thinking process. Recent studies have shown that innovative learning designs and resources for elementary school, such as science

literacy-based electronic student worksheets (e-LKPD), TPACK-based e-textbooks, and engaging visual media, improve students' conceptual understanding and skills when they are built around active and meaningful learning experiences (Sumirat et al., 2024; Sundari & Bintoro, 2025; Sundari et al., 2025). One model considered suitable is Experiential Learning combined with the Hands-on Minds-on Activity approach. According to Kolb's Experiential Learning Theory (ELT), learning is a continuous process in which knowledge is constructed through the transformation of experience. This process encompasses four interrelated stages: *Concrete Experience*, *Reflective Observation*, *Abstract Conceptualization*, and *Active Experimentation* (Gummelt et al., 2025; Hasanah & Ningsih, 2026; Villarroel Henríquez et al., 2025).

Integrating the hands-on and minds-on activity approaches into the experiential learning cycle gives students the opportunity to build understanding through a balanced combination of physical and cognitive engagement. *Hands-on* activities encourage students to interact directly with tools, materials, and learning objects through practical exercises or experiments (Purnomo et al., 2021). Meanwhile, *minds-on* activities guide students to observe, analyze, and interpret data, reflect on results, and formulate scientific concepts based on their experiences (Alvina et al., 2025). Thus, the learning process is oriented not only toward conducting practical activities but also toward students' ability to connect these concrete experiences meaningfully with scientific reasoning (Aini et al., 2025).

Various previous studies have shown that experiential learning and hands-on, minds-on activities make a positive contribution to science learning. Permatasari and Nurita (2023) and Jannah and Shofiyah (2024) reported that implementing experiential learning can improve students' SPS. Furthermore, Rukhsana et al. (2021) and Tania and Dianti (2026) found that experiential learning has a positive effect on learning motivation. Hasanah and Ningsih (2026) reported that an IPAS learning model based on the four stages of experiential learning improved elementary students' conceptual understanding, and other studies indicate that experiential and hands-on, minds-on activities can enhance students' engagement and motivation (Alvina et al., 2025; Kong, 2021). However, hands-on activity alone did not always produce a significant difference in final SPS between experimental and control classes in elementary school (Purnomo et al., 2021). Moreover, these studies generally examined the approaches separately. Research that integrates Experiential Learning with Hands-on Minds-on Activities while analyzing their impact on both SPS and learning motivation in elementary school science education, particularly on the topic of changes in the state of matter, remains limited.

Based on the problem statement, the results of previous studies, and the research gaps outlined above, this study aims to analyze the effect of implementing an Experiential Learning model based on Hands-on Minds-on Activities on elementary school students' SPS and learning motivation. Specifically, the study examines whether fourth-grade students taught with this model on the IPAS topic of changes in the state of matter achieve higher SPS than students who receive conventional instruction, and whether the model also leads to higher learning motivation.

## Method

This study employed a quantitative approach using a quasi-experimental method. The research design was the Nonequivalent Control Group Design, which involved an experimental group and a control group without individual randomization because class assignments were predetermined by the school (Sugiyono, 2022). The experimental group

received instruction using the Experiential Learning model based on hands-on minds-on activities across five treatment sessions, whereas the control group continued with the instruction usually applied in its school.

The study population comprised all fourth-grade elementary school students in the second semester of the 2025/2026 academic year at the study sites. The sample was determined using a non-probability sampling technique, namely saturation sampling, given that the population size was relatively limited and met the necessary characteristics for the study (Husin et al., 2025). The sample consisted of 66 students, comprising 35 fourth-grade students from SDN Sukaraja II as the experimental group and 31 fourth-grade students from SDN Cikapek as the control group. Both schools had relatively comparable characteristics in terms of the implementation of the Merdeka Curriculum, learning facilities, and student backgrounds.

Data were collected using both test and non-test techniques. The SPS test consisted of 12 essay questions that measured six basic SPS indicators, namely observing, classifying, predicting, measuring, drawing conclusions, and communicating, based on the IPAS material on changes in the state of matter. Each question was accompanied by a scoring rubric ranging from 0 to 4. Learning motivation was measured using a closed-ended questionnaire with a 4-point Likert scale (strongly agree, agree, disagree, and strongly disagree) consisting of 15 positive and negative statements. The statements covered six indicators of learning motivation according to Uno (Sinuhaji et al., 2023): desire and willingness to learn, motivation and need to learn, hopes and aspirations, recognition, engaging learning activities, and a supportive learning environment. In addition, a learning motivation observation sheet, a Guttman-scale checklist (yes = 1, no = 0) consisting of 15 items, was used to assess students' actual engagement behaviors during the five treatment sessions as supporting data for the questionnaire.

Before being used in the study, all instruments were pilot-tested in a class outside the sample ( $df = 28$ ,  $r\text{-table} = 0.361$  at  $\alpha = 0.05$ ). The Product Moment validity test showed that 10 SPS questions and 12 questionnaire items met the validity criteria, while items with insufficient validity were revised based on expert input. The Cronbach's Alpha reliability test yielded  $r = 0.839$  (very high category) for the SPS test and  $r = 0.668$  (reliable category) for the learning motivation questionnaire. The discriminating power analysis of the SPS items showed that the majority fell within the "good" to "very good" range ( $DP = 0.40\text{--}0.84$ ).

The data were analyzed in three stages. Descriptive statistics were first used to calculate the minimum, maximum, range, mean, variance, and standard deviation. Prerequisite analyses were then carried out, consisting of the Kolmogorov–Smirnov normality test and Levene's homogeneity test at a significance level of 0.05 using IBM SPSS Statistics 26. Finally, hypothesis testing was conducted using an independent samples t-test to determine significant differences in posttest mean scores between the experimental and control groups (Sugiyono, 2022).

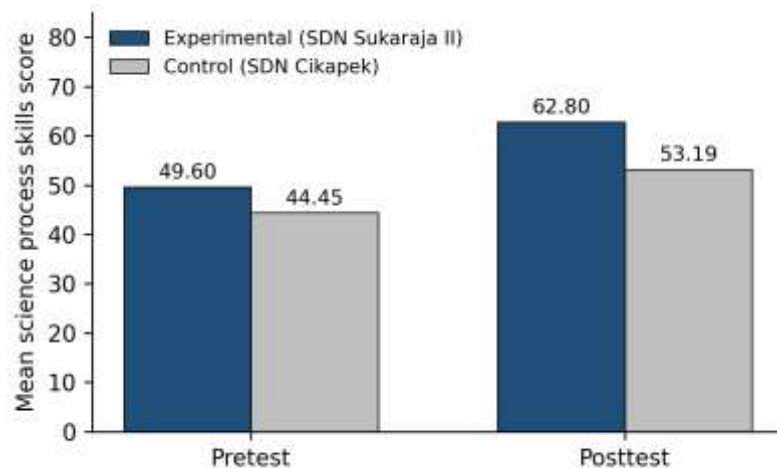
## Results and Discussion

Students' SPS and learning motivation in the experimental group (SDN Sukaraja II) and the control group (SDN Cikapek) were analyzed descriptively and inferentially. A summary of the descriptive statistics of the SPS scores before (pretest) and after (posttest) the treatment is presented in Table 1.

**Table 1.** Descriptive Statistics of Students' Science Process Skills Scores

| Statistic          | Experimental Pretest | Experimental Posttest | Control Pretest | Control Posttest |
|--------------------|----------------------|-----------------------|-----------------|------------------|
| Minimum score      | 22                   | 41                    | 20              | 33               |
| Maximum score      | 81                   | 89                    | 72              | 77               |
| Range              | 59                   | 48                    | 52              | 44               |
| Variance           | 203.30               | 156.40                | 170.92          | 144.56           |
| Standard deviation | 14.25                | 12.50                 | 13.07           | 12.02            |
| Mean               | 49.60                | 62.80                 | 44.45           | 53.19            |

Table 1 shows that the mean SPS score of the experimental group increased from 49.60 on the pretest to 62.80 on the posttest, an increase of 26.61%. In the control group, the mean score rose from 44.45 to 53.19, an increase of 19.66%. The mean posttest score of the experimental group was 9.61 points higher than that of the control group. These changes are visualized in Figure 1.

**Figure 1.** Mean Science Process Skills Scores of the Experimental and Control Groups Before and After the Treatment

The measurement results of students' learning motivation in the experimental and control groups before and after the treatment are summarized in Table 2.

**Table 2.** Descriptive Statistics of Students' Learning Motivation Scores

| Statistic          | Experimental Pretest | Experimental Posttest | Control Pretest | Control Posttest |
|--------------------|----------------------|-----------------------|-----------------|------------------|
| Minimum score      | 29                   | 43                    | 25              | 32               |
| Maximum score      | 54                   | 59                    | 54              | 57               |
| Range              | 25                   | 16                    | 29              | 25               |
| Variance           | 50.29                | 19.08                 | 53.38           | 36.06            |
| Standard deviation | 7.09                 | 4.37                  | 7.31            | 6.01             |
| Mean               | 42.94                | 52.49                 | 43.42           | 48.45            |

Table 2 shows that the mean learning motivation score of the experimental class increased from 42.94 (moderate category) to 52.49 (high category) after the treatment, an increase of 22.24%, with 97.14% of the students (34 of 35) reaching the high motivation category. Meanwhile, the mean score of the control class rose from 43.42 to 48.45, an increase of approximately 11.58%, as shown in Figure 2.

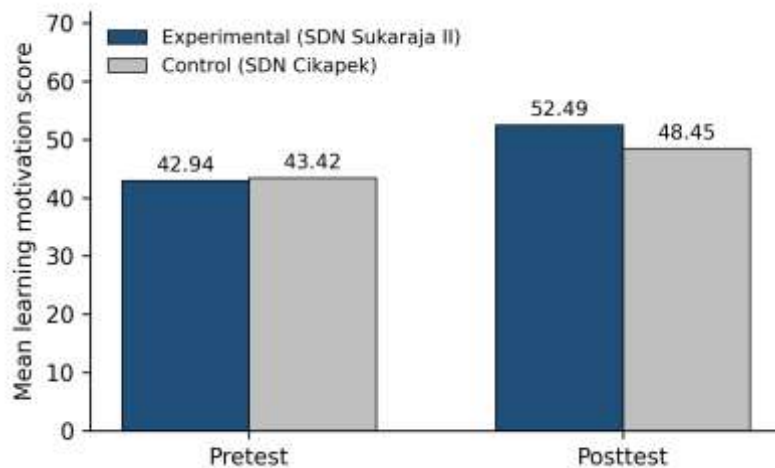


**Figure 2.** Mean Learning Motivation Scores of the Experimental and Control Groups Before and After the Treatment

Before hypothesis testing, the Kolmogorov–Smirnov test showed that the posttest SPS data were normally distributed in both classes (Sig. = 0.200 > 0.05), and Levene’s test showed homogeneous variances for the SPS data (Sig. = 0.881) and the learning motivation data (Sig. = 0.198). Hypothesis testing was then conducted using a parametric independent samples t-test on the posttest data of both groups, and the results are summarized in Table 3.

**Table 3.** Summary of Hypothesis Testing Results (Independent Samples t-test)

| Dependent Variable     | t-value | df | Sig. (2-tailed) | $\alpha$ | Decision                                         |
|------------------------|---------|----|-----------------|----------|--------------------------------------------------|
| Science process skills | 3.171   | 64 | 0.002           | 0.05     | H <sub>0</sub> rejected, H <sub>1</sub> accepted |
| Learning motivation    | 3.146   | 64 | 0.003           | 0.05     | H <sub>0</sub> rejected, H <sub>2</sub> accepted |

Table 3 shows that both Sig. (2-tailed) values were below 0.05 (0.002 for SPS and 0.003 for learning motivation), so H<sub>0</sub> is rejected and H<sub>1</sub> and H<sub>2</sub> are accepted. In other words, implementing the experiential learning model based on hands-on minds-on activities had a positive and significant effect on both the SPS and the learning motivation of elementary school students.

The findings show that the improvement in students’ SPS and learning motivation is closely related to their active involvement in the experiential learning cycle and in hands-on, minds-on activities. Other variables that were not examined in this study, such as teachers’ competence, students’ prior knowledge, and the availability of learning facilities, may also have contributed to the remaining variation in the results.

SPS are complex abilities formed through active learning experiences, in which students acquire knowledge and skills directly through the learning process. When students are given the opportunity to interact directly with concrete objects and engage in reflective

thinking (minds-on), they are more likely to develop scientific reasoning and to retain concepts in the long term. One way to improve SPS and motivation is to stimulate students' awareness and interest through contextual experiments (Villarroel Henríquez et al., 2025). This is particularly relevant for fourth-grade students in the concrete operational stage, who learn best when abstract concepts are bridged through hands-on experiences (Aini et al., 2025). The result is consistent with the findings of Permatasari and Nurita (2023) and Jannah and Shofiyah (2024) that experiential learning improves SPS, with Hasanah and Ningsih (2026), who found that experiential learning stages improved elementary students' understanding of IPAS concepts, and with Alvina et al. (2025), who reported that hands-on, minds-on experiments effectively developed students' hands-on scientific competencies.

The finding differs, however, from that of Purnomo et al. (2021), who found no significant difference in final SPS between third-grade students taught with hands-on activity and those taught conventionally, although their observation data showed a larger improvement in the hands-on group. A possible explanation is that the present model combined hands-on activities with the reflective and conceptual stages of Kolb's cycle, which engage students cognitively (minds-on) after the practical work. Differences in grade level, topic, and school context may also have contributed to this discrepancy.

Effective IPAS instruction emphasizes conceptual understanding and psychomotor skills, focusing on why a phenomenon occurs rather than merely knowing information, thereby fostering scientific thinking (Villarroel Henríquez et al., 2025). The Experiential Learning model based on hands-on minds-on activities integrates Kolb's four main stages, namely Concrete Experience, Reflective Observation, Abstract Conceptualization, and Active Experimentation, and it involves students' physical and mental engagement through sensory interactions, reflective group discussions, scientific inference, and the application of concepts (Jannah & Shofiyah, 2024). As illustrated in Figure 3, these stages are directly related to the SPS indicators and learning motivation indicators. In the Concrete Experience stage, students conduct hands-on experiments, such as observing ice cubes melting and water evaporating, which develops the "observing" indicator (22.50%) and stimulates curiosity. In the Reflective Observation stage, students discuss their findings in groups and record their observations on the worksheet, which hones the "classifying" indicator (10.75%) and fosters mental engagement. In the Abstract Conceptualization stage, students connect their findings with scientific concepts and formulate conclusions, which reinforces the "drawing conclusions" indicator (6.25%). Finally, in the Active Experimentation stage, students present their work to the class and apply their knowledge in new contexts, which enhances the "communicating" indicator (23.25%) and the "engaging learning activities" motivation indicator (18.00%). The comparatively small gain in the "drawing conclusions" indicator suggests that inferential skills require more guided practice, which is in line with Fitriyeni et al. (2026), who identified processing, analyzing, evaluating, and reflecting as the weakest science process skills.

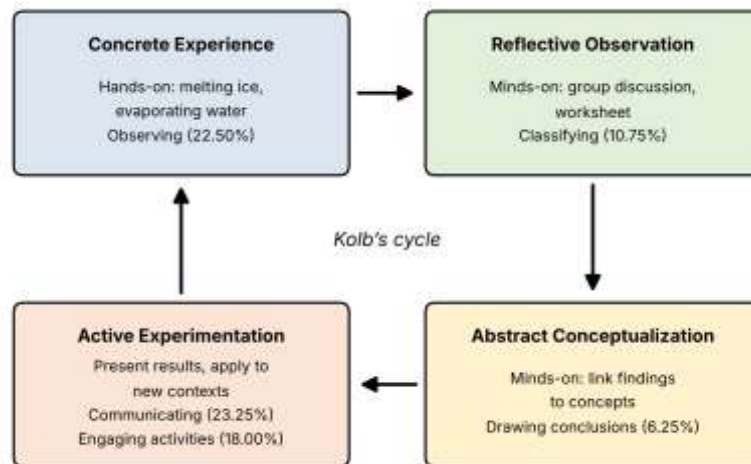


**Figure 3.** Relationship Between the Stages of the Experiential Learning Cycle Based on Hands-on Minds-on Activities and the Science Process Skills and Motivation Indicators

The significant improvement in learning motivation can be explained by the nature of the learning activities. Direct experiments, group discussions, and class presentations give students opportunities to feel competent and connected to their peers, which according to self-determination theory sustains motivation and engagement (Ryan & Deci, 2020). This is consistent with the review by Kong (2021), which highlights the contribution of experiential learning to students' classroom engagement and motivation, and with the findings of Rukhsana et al. (2021) and Tania and Dianti (2026) that experiential learning has a positive effect on students' motivation. The fact that 97.14% of the students in the experimental class reached the high motivation category also suggests that the hands-on and minds-on activities addressed the intrinsic factors that were previously found to lower motivation, such as low curiosity and the perception that science is difficult (Sari et al., 2025).

These findings suggest that teachers can use the experiential learning model based on hands-on minds-on activities as an alternative to lecture-based instruction in IPAS lessons, provided that simple experimental materials and sufficient time for reflection and discussion are available, because limited experimental facilities and unsupportive classroom conditions have been reported to hinder motivation (Azzahra et al., 2026; Fahima & Julianto, 2022). Teachers may also strengthen the reflective and conceptualization stages by using science literacy-based worksheets or e-LKPD and TPACK-based digital learning resources, which have been shown to support elementary students' conceptual understanding (Sundari & Bintoro, 2025; Sundari et al., 2025). The results should nevertheless be interpreted with caution. The study involved a relatively small sample from two schools and intact classes, the two groups differed in their pretest means, and the hypothesis test was conducted on posttest data only. Future studies are therefore encouraged to use designs that statistically control for initial differences and to involve more schools.

## Conclusion

The results indicate that the implementation of the Experiential Learning model based on Hands-on Minds-on Activities had a positive and significant effect on elementary school students' science process skills and learning motivation in IPAS lessons on changes in the state of matter, as shown by the independent samples t-test with significance values of 0.002 for science process skills and 0.003 for learning motivation, both smaller than 0.05. The mean science process skills score of the experimental group increased by 26.61% and its mean learning motivation score by 22.24%, with 97.14% of the students reaching the high motivation category. These findings show that integrating direct learning experiences through the stages of concrete experience, reflective observation, abstract conceptualization, and active experimentation with hands-on and minds-on activities can develop science process skills while simultaneously enhancing learning motivation, so the model can serve as an effective alternative to improve the quality of IPAS instruction in elementary schools. Future research is recommended to apply the model to other science topics, involve larger and more diverse samples, and use designs that control for students' initial differences.

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## Author Contributions

Conceptualization: SR, HH; Methodology: SR, AN, HH; Formal analysis: NHD, DPN, AN; Investigation: SR; Writing – original draft: HH; Writing – review & editing: NHD, AN, DPN; Supervision: SR, HH.

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## Declaration of Competing Interest

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

## Use of Artificial Intelligence

The authors used ChatGPT and Gemini for language editing and grammar improvement. The authors reviewed and verified all AI-assisted revisions and take full responsibility for the final content.

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