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Vol. 14 No. 5 (2025): October
http://dx.doi.org/10.33578/jpfkip.v14i5.p616-626

The effect of deep Learning-based practicum with simple tools on improving the science process skills of prospective teacher students

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1 **Article info** | **Abstract**

Keywords:
deep learning; practicum; simple tools; science process skills

The study aims to determine the effect of deep learning-based practical work using simple tools on improving students' science process skills. The research method employs a quasi-experimental design with a one-shot case study approach. The sample consisted of 43 PGSD FKIP UIR students, with research instruments as observation sheets and questionnaires. The data obtained were analysed using prerequisite tests, specifically normality and hypothesis tests, including the t-test with a significance level 0.05. The normality test results showed that the data were normally distributed with a Sig value of 0.2 > 0.05. The hypothesis test results yielded a Sig value of 0.000 < 0.05, so H0 was rejected and H1 was accepted. The results show a significant improvement in science process skills, including observing, classifying, measuring, and communicating. In conclusion, students' science process skills improve when applying the deep learning-based practical method using simple tools. These findings indicate practical potential that can be used to support effective science learning for prospective teacher students.

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DOI: http://dx.doi.org/10.33578/jpfkip.v14i5.p616-626
Received 23 June 2025; Received in revised form 29 August 2025; Accepted 09 September 2025
Available online 05 October 2025
e-ISSN 2598-5949 | p-ISSN 2303-1514

Vol. 14 No. 5 (2025): October | http://dx.doi.org/10.33578/jpfkip.v14i5.p616-626
Dea Mustika et al.

1. Introduction

Education is an effort to humanise humans, which is vital to human survival. Education is not only a process of transferring knowledge, theory, and academics, but also a process of freeing individuals from ignorance, incompetence, powerlessness, untruthfulness, and dishonesty (Hajian, 2019). Science education at the elementary school level is vital in establishing the foundation for scientific understanding and critical thinking skills among students.

Prospective elementary school teachers, specifically PGSD students, must possess conceptual understanding and strong scientific thinking skills. Scientific process skills encompass six abilities: observing, classifying, predicting, measuring, concluding, and communicating (Gizaw & Sota, 2023; Kurniawati, 2021). These foundational abilities must be developed through continuous practice to build skills naturally inherent within individuals. However, previous research findings show that sometimes problems arise in the learning process due to a lack of innovation on the part of lecturers in stimulating students' interest in participating in the learning process, which ultimately can have an impact on the lack of training in scientific process skills (Amrulloh & Galushasti, 2022). Moreover, learning involving practical activities is considered difficult to implement due to limitations in space, tools, and materials.

In line with the results of observations of lectures in the Elementary Science Education course in the PGSD program at FKIP UIR, it was observed that one of the objectives of the Elementary Science Education course is for students to be able to design and carry out experiments in accordance with the science material taught in elementary schools. However, in reality, this objective has not been fully achieved because the course system is dominated by discussion-based learning and focuses solely on reviewing the science curriculum taught in elementary schools. The cause is the limited availability of laboratory facilities that students can use. As a result, students struggle to understand the concepts being taught and have difficulty developing and applying scientific concepts. This indicates a lack of training in scientific process skills among students.

It is necessary to follow up on students' abilities so that they not only focus on strengthening their cognitive abilities but also train their scientific process skills to achieve the planned learning objectives. Efforts that can be made to develop scientific process skills are by applying appropriate learning methods. Learning methods are ways used to establish relationships with students during the learning process. The application of teaching methods should align with the subject matter's nature and type (Sund & Gericke, 2020). This is intended to ensure that learning objectives are achieved effectively and efficiently. The appropriate application of learning methods can train students to discover facts, collect data, control variables, and solve problems practically (Kertati et al., 2023; Mustika, 2022).

One of the learning methods that can be used is the practicum method. The practicum method is a learning method that provides students with the opportunity to conduct experiments (Rini & Aldila, 2023). In the practicum method, learning is presented by conducting experiments on a particular subject, observing the process, recording the experimental results, and presenting the results for evaluation (Kusmawan, 2024). Practical work consists of three main stages: (1) the preparation (setting objectives, determining tools and materials, and designing activities); (2) the implementation; and (3) the follow-up stage (discussing activity results) (Ersin & Mede, 2020; Lestari et al., 2023).

Vol. 14 No. 5 (2025): October | http://dx.doi.org/10.33578/jpfkip.v14i5.p616-626
Dea Mustika et al.

In this study, to create a more meaningful learning experience, practical work was implemented using deep learning activities. Deep learning in the context of education is not merely about artificial intelligence technology but encompasses a learning approach that encourages deep conceptual understanding, critical thinking, and the ability to relate knowledge to real-world contexts (Perrotta & Selwyn, 2020). The deep learning approach can be applied to project-based learning, inquiry-based learning, case studies, or simulations to strengthen critical thinking and analytical skills (Austin, 2025; Miller & Krajcik, 2019).

Deep learning differs from surface learning. In deep learning, students connect new concepts with existing knowledge, seek meaning, and build understanding that can be applied to real-life situations (Weng et al., 2023). Constructivist theory aligns with this, asserting that real learning experiences actively construct knowledge (Kovač et al., 2025).

In the context of science education, deep learning is believed to be closely related to active and inquiry-based learning. Active learning encourages direct involvement in activities that promote critical thinking, discussion, and reflection (Chen & Chen, 2025; Urdanivia Alarcon et al., 2023). Meanwhile, inquiry-based learning emphasises student involvement in asking questions, designing experiments, collecting data, analysing data, and drawing conclusions (Ambarwati et al., 2025). Zepke's research results indicate that there is cognitive involvement of students through reflective and investigative activities in deep learning (Ješková et al., 2022). In addition, (Rahimi & Sevilla-Pavón, 2024) state that the deep learning approach can improve higher-order thinking skills. This means that deep learning not only plays a role in cognitive aspects but can also foster scientific attitudes and practical skills.

Integrating practical work with a deep learning approach can create more effective and meaningful science learning. Students perform experimental activities procedurally and are guided to analyse, reflect on, and connect experimental results with relevant scientific concepts. This aligns with the goals of 21st-century education, which emphasizes learning focused on developing critical thinking, creativity, communication, and collaboration skills (Susilowati et al., 2025; Thornhill-Miller et al., 2023).

In addition, to overcome the limitations of practical facilities, learning is also designed to utilize simple tools and materials easily accessible to students. It is hoped that practical knowledge based on deep learning with the help of simple tools can help improve students' scientific process skills, especially in finding facts, collecting data, controlling variables, and solving real-world problems. This is the basis for researchers to apply experimental methods with simple tools to improve students' process skills. The research objective is to determine whether there is an effect of the experimental method using a deep learning approach with simple tools on students' scientific process skills.

2. Method

4 The type of research used is quantitative research with an experimental research method. An experimental research method is a research method used to find the effect of a particular treatment on another under controlled conditions (Ngalim, 2020). The research design used is pre-experimental in the form of a one-shot case study. The research only involves one experimental class, conducted without a control class and without a pre-test. The design pattern is described as follows.

X	O

Figure 1. One-shot case study design pattern
Explanation: X = Treatment (independent variable), O = Observation (dependent variable)

[e-**ISSN** **2598-5949** | p-**ISSN** **2303-1514**]

Vol. 14 No. 5 (2025): October | http://dx.doi.org/10.33578/jpfkip.v14i5.p616-626
Dea Mustika et al.

The research sample was taken using purposive sampling, which is sampling according to research needs. The research sample consisted of 43 students in class IVB, comprising three male and 40 female students. The independent variable was the experimental method using simple tools, while the dependent variable was the students' science process skills. Data collection techniques included observation and questionnaires, with the research instruments being observation sheets and questionnaire sheets. The observation sheets were used to assess the implementation of learning using the experimental method conducted by the lecturer. After using the experimental procedure, the questionnaire sheets evaluated the improvement in students' science process skills.

Before the research was conducted, the questionnaire instrument that had been developed was first tested on 20 randomly selected students. The instrument test was intended to obtain valid and reliable statements before distributing the questionnaire to the research sample. The questionnaire was developed with four aspects of scientific process skills: observing, classifying, measuring, and communicating. These aspects of scientific process skills are part of the basic abilities required by students to use science. The questionnaire items for scientific process skills are in the following Table 1.

Table 1. Grid for science process skills questionnaire instrument

No	Aspects	Descriptors	Statement Numbers
1	Observing	Responding to events using the five senses	1,2,3,4,5,6
2	Classify	Classifying types of groups	7,8,9,10,11
3	Measuring	Compare with measurement units	12,13,14,15,16
4	Communicating	Stating the facts	17,18,19,20,21,22

Table 1 shows the initial science process skills questionnaire was designed with 22 statements. The questionnaire validation process includes content validity and construct validity. Content validity involves a science education expert and an educational evaluation expert. The expert assessment results were obtained through an expert judgment sheet. In addition, construct validity is conducted by testing the instrument on 20 students outside the research sample. After testing on 20 students, the validity test data are calculated using SPSS for Windows. A statement item is considered valid if the calculated r > r table. Since the sample size (N) is 20 people, the r table was 0.444. The validity test results concluded that of the 22 statement items, there are invalid statement items. The invalid statement items are discarded, leaving only 20 items classified as valid and could be tested on the actual research sample.

Descriptive statistical analysis is intended to describe the improvement in students' science process skills after applying the experimental method with simple tools. Inferential statistical analysis is meant to obtain final-stage data analysis. The prerequisite test is a normality test using the Kolmogorov-Smirnov formula and a hypothesis test using the t-test. Data processing was performed using SPSS for Windows software applications. The hypothesis in this study is:

H_1 : There is an effect of experimental methods with a deep learning approach, aided by simple tools, on improving students' science process skills.

H_0 : There is no effect of the experimental method using a deep learning approach aided by simple tools on improving students' science process skills.

Vol. 14 No. 5 (2025): October | http://dx.doi.org/10.33578/jpfkip.v14i5.p616-626
Dea Mustika et al.

Determining the conclusion of the hypothesis test with the provision is that if the probability (Sig) < 0.05, then H_0 is rejected and H_1 is accepted, or if the probability (Sig) > 0.05, then H_0 is accepted and H_1 is rejected.

3. Results

The research began with preparing lecture plans using an experimental method with a deep learning approach aided by simple tools. The experimental method focused on three stages: preparation, implementation, and follow-up. The deep learning approach includes understanding, applying, and reflecting. The simple tools used are easily found in the surrounding environment and are appropriate for the science material. Simple tools include spoons, plastic, modelling clay, butter, matches, and glasses. An overview of the learning activities can be seen in Table 2.

Table 2. Application of deep learning-based practicum with simple tools

Phase	Component	Lecturer Activities	Student Activities
Preparation (Understanding)	a. Introduction to science topics related to experiments, namely changes in the form of objects, force and energy, refraction and reflection of light, electricity and magnetism. b. Introduction and explanation of examples of simple tools that can be utilised	a. Convey learning objectives b. Explain science concepts in context c. Demonstrate simple tools and examples of how to use them	a. Understand the learning objectives b. Take notes and ask questions about concepts that are not yet understood c. Observe demonstrations of how to use simple tools d. Analyse simple tools that can be used for experimental activities
Implementation (Application)	a. Application of practical work using simple tools b. Discussion of results	a. Guiding group practicum activities b. Asking critical questions c. Guiding students in compiling activity reports d. Facilitating group discussions	a. Sit in groups b. Carry out the planned experiments in group c. Discuss the results of the experiments d. Compile a report on the results of the activities e. Hold a class discussion f. Respond to exploratory questions that arise
Follow-up (Reflecting)	a. Reflection on learning activities b. Expansion of understanding in the context of elementary school c. Feedback	a. Reinforcement and conclusions on activity reports and discussions b. Asking critical reflection questions c. Follow-up assignments in the form of developing practical learning with simple tools for elementary school students	a. Understand reinforcement and conclude together b. Respond to reflective questions c. Design learning scenarios using simple tool-assisted practical methods for elementary school learning d. Collect assignments through Google Classroom

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Vol. 14 No. 5 (2025): October | http://dx.doi.org/10.33578/jpfkip.v14i5.p616-626
Dea Mustika et al.

The implementation of learning activities was assessed using observation sheets filled out by peers. The analysis of the observation sheets showed an average score of 3.9, which falls within the interval range of 3.00 < x < 4.00, meaning that it is categorised as very well implemented. This is because the practice-based learning activities help create a more focused learning process, where learning is conducted through discussions and involves active student participation in every activity.

The learning was conducted in four sessions, and at the end of the teaching, the researcher distributed a questionnaire to 43 students. The questionnaire consisted of 20 valid statements and was used to obtain data on students' science process skills. The results of the recapitulation of the questionnaire data on students' science process skills can be seen in Table 3 below.

Table 3. Recapitulation of the science process skills questionnaire

No	Interval	F	%	Criteria
1	85 – 100	23	53.4	Very High
2	72 – 84	18	41.8	High
3	59 -71	2	4.8	Enough
4	46 – 58	-	-	Low
5	33 – 45	-	-	Very Low
Total		**43**	**100**	
Average			**84.65**	

Based on the data above from the student science process skills questionnaire shown in Table 3, it can be summarised that 53.4% of students achieve very high scores, 41.8% achieve high scores, and 4.8% achieve moderate scores. These results indicate that students' science process skills fall within the mild to very high range, with an overall average of 84.65. This may be attributed to students' active engagement during learning activities. The higher the level of student activity during the learning process, the higher the science process skill scores they achieve, and vice versa.

Furthermore, before testing the hypothesis, researchers must ensure the data is generally distributed by conducting a normality test. The normality test uses the Kolmogorov-Smirnov calculation in the SPSS for Windows application program. Table 4 shows the results of the normality test for the science process skills questionnaire can be seen in Table 4.

Table 4. Normality test results

	Kolmogorov-Smirnov[a]		
	Statistic	**df**	**Sig.**
KPS	.099	43	.200*

Data are normally distributed if the sig. value is> 0.05. Table 4 shows the results of analysing the science process skills questionnaire scores after applying the experimental method with simple tools, indicating a Sig. Value in the Kolmogorov-Smirnov column, or P-value > α, 0.2 > 0.005. This means that the science process skills questionnaire results are normally distributed. After determining that the data are normally distributed, the hypothesis is subsequently tested using the t-test. The final results of the hypothesis test can be seen in Table 5 below.

[e-**ISSN 2598-5949** | p-**ISSN 2303-1514**]

Vol. 14 No. 5 (2025): October | http://dx.doi.org/10.33578/jpfkip.v14i5.p616-626
Dea Mustika et al.

Table 5. Hypothesis testing

	Test Value = 75					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
KPS	5.3	85	.000	4.58	2.87	6.28

Table 5 presents that the calculated t-value is 5.3 with 85 degrees of freedom and a Sig (2-tailed) value of 0.000. The t-table value with a significance level of 0.05 is 1.65. Thus, it is found that the calculated t-value of 5.3 > t-table 1.65, so the decision is to reject H0 and accept H1. Additionally, looking at the p-value (Sig) in Table 5, it is proven that Sig (2-tailed) is 0.000 < 0.05, so the null hypothesis (H0) is rejected and the alternative hypothesis (H1) is accepted. Implementing a practical exercise based on deep learning using simple tools can enhance students' scientific process skills.

4. Discussion

Based on the study's results, it is known that implementing deep learning-based practical work can improve students' science process skills. This is evident from the results of the student science process skills questionnaire, which scored 95.2, falling into the very high and high categories. The t-test results also indicated a significant improvement after the intervention. These findings demonstrate that deep learning-based laboratory exercises can allow students to directly experience the scientific process, such as formulating problems, designing experiments, observing, and drawing conclusions.

Through practical work, students can discover concepts for themselves through empirical experience, thereby significantly improving their scientific process skills. This view is reinforced by (Judijanto et al., 2025), who state that practical activities provide students with opportunities to be actively and concretely involved in learning, thereby developing their scientific thinking and conceptual understanding. In line with (Haerani et al., 2023), laboratory experiments that involve active student participation have been proven to enhance observational skills, data interpretation, and critical thinking abilities. Thus, laboratory experiments can train students to know a concept and experience, feel, and understand it firsthand by observing various scientific phenomena.

Practical activities based on deep learning also play an essential role in encouraging students to understand the material in depth rather than just memorising it. Through deep learning activities, students can apply knowledge in new contexts, reflect on the learning process, and evaluate learning outcomes. Biggs and Tang (as cited in (Lersundi Perez et al., 2025) state that deep learning requires cognitive and affective engagement from students in connecting new knowledge with existing mental structures, as well as constructing meaning from reflective learning experiences. Learning with a deep learning approach can enhance students' metacognitive and reflective abilities in science laboratory activities (Zayed, 2024).

The practical learning activities are designed in three main stages: preparation, implementation, and follow-up, which are then aligned with the deep learning experience of understanding, applying, and reflecting. The preparation stage is intended to build a sense of basic concepts by introducing simple tools that can be used for experimental activities. The implementation stage is designed to provide opportunities for students in groups to conduct experiments directly and discuss the application of concepts. The follow-up stage will enable students to reflect on their learning and design science-based experimental learning activities for

Vol. 14 No. 5 (2025): October | http://dx.doi.org/10.33578/jpfkip.v14i5.p616-626
Dea Mustika et al.

elementary school levels. This learning activity creates a structured and systematic learning process and has been proven to encourage students to think critically and scientifically. Additionally, learning conducted through exploration and reflection stages is known to enhance conceptual understanding and process skills (Idris et al., 2022).

The use of simple tools is also an essential aspect of learning effectiveness. Some simple tools used, such as experiments on the change of state of matter using metal spoons, candles, matches, and melted butter, bring science concepts closer to everyday phenomena and strengthen students' observation and inference skills. Research (Ni'mah et al., 2023) indicates that using simple tools in science experiments can facilitate understanding, increase student active participation, and promote more contextual learning. Additionally, simple tools in science education provide concrete experiences that impact learning retention (Rossi et al., 2021).

Active student involvement in every stage of learning has a direct impact on scientific process skills. According to (Agustina & Abidin, 2022; Susilowati et al., 2025), the higher the level of active student participation in learning, the higher the achievement of thinking and scientific skills. In this context, students are not merely information recipients but actively involved in knowledge construction. Active student participation in project-based learning can develop analytical thinking and problem-solving skills (Sutaryani et al., 2024).

The findings have practical implications for improving the science process skills of prospective teachers but also contribute to the development of science learning at the university level. The results show that combining practical work with in-depth learning aided by simple tools can encourage students to carry out experimental procedures, relate their observations to scientific concepts, engage in critical reflection, and develop problem-solving strategies.

Theoretically, deep learning involves students actively constructing knowledge rather than merely memorising (surface learning), which is closely related to higher-order cognition, such as analysis, synthesis, and evaluation (Murphy et al., 2025; Weng et al., 2023). Students are also involved in formulating hypotheses, planning experiments, and interpreting data, which are forms of metacognitive processes such as the ability to observe, evaluate, and organise strategies (Morris, 2025). The study's results reinforce active learning by emphasising students' direct involvement in meaningful learning activities. Thus, students are not only physically active but also cognitively and metacognitively active.

Implementing meaningful learning-based practicums using simple tools has been proven to improve the science process skills of PGSD students. It is hoped that this learning will positively impact science teaching practices at the elementary school level because prospective teachers have been trained in scientific thinking and pedagogy skills. Practicums are not merely a means of demonstrating scientific phenomena but also a vehicle for developing higher-order thinking skills realised in elementary school learning practices.

Although the study's results show a positive effect of deep learning-based practicums using simple tools, the study has limitations that need to be considered. These limitations include the research design, which uses a pre-experimental one-shot case study without a control group; the limited sample size; and the measurement of science process skills through questionnaires and observations, which means that the study results cannot be explored in greater depth. These limitations provide opportunities for future researchers to conduct further research so that the results can provide a more comprehensive picture of the effectiveness of deep learning in science learning for prospective elementary school teachers.

[e-**ISSN** **2598-5949** | p-**ISSN** **2303-1514**]

Vol. 14 No. 5 (2025): October | http://dx.doi.org/10.33578/jpfkip.v14i5.p616-626

5. Conclusion and Implications

Deep learning-based practicums using simple tools have been proven effective in improving students' scientific process skills. This can be seen during the learning process, where students are actively involved in designing and carrying out practical activities using simple tools and materials. Observations indicate that the learning process is in the excellent category. Survey results and statistical tests imply a significant improvement in scientific process skills, particularly in observing, classifying, measuring, and communicating. These findings indicate that deep learning-based practicums using simple tools can be a relevant alternative for prospective elementary school teachers. These findings imply the importance of integrating deep learning in science education, including at the university level. This approach can strengthen the competence of prospective teachers so that they not only master the material but also have meaningful learning experiences. The research results are not only valid in the context of elementary school teacher education programs. Still, they can also provide direction for developing student-centred science learning practices in elementary schools that are relevant to real life.

Declaration of competing interest

The author declares that she has no competing personal or financial interests that may influence the work presented in this paper.

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[e-**ISSN** **2598-5949** | p-**ISSN** **2303-1514**]