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An Analysis of Chemistry Practical Obstacles in Supporting Deep Learning at SMAN 5 Tangerang Selatan

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Abstract

Chemistry laboratory activities are essential for supporting deep learning through hands-on experiences, reflection, and contextual problem-solving. However, limited evidence exists regarding the obstacles that hinder their implementation in secondary chemistry education. Understanding these obstacles is important to improve chemistry practicum implementation and optimize deep learning in chemistry education. This study aims to analyze the implementation of chemistry practicum and identify the obstacles encountered in supporting deep learning at SMAN 5 Tangerang Selatan. This study employed a quantitative descriptive method using questionnaires, observations, and interviews. The participants were selected through purposive sampling, consisting of 89 eleventh-grade students and chemistry teachers involved in chemistry practicum activities. The analyzed aspects included laboratory facilities and infrastructure, students' interest in practicum, practicum implementation time, preparation and implementation of practicum activities, practicum reports, teachers' ability to explain practicum activities, practicum topics, and the characteristics of deep learning-based practicum modules. The results showed that the overall implementation of chemistry practicum in supporting deep learning was in the good category. The highest percentage was found in the teacher's ability to explain practicum activities (82.47%). Meanwhile, the lowest percentage was found in laboratory facilities and infrastructure (57.41%). The interview findings revealed that chemistry practicum supported mindful, meaningful, and joyful learning through students' active participation in experimentation, discussion, and reflection activities. Nevertheless, limited laboratory facilities, low practicum intensity, and insufficiently contextual practicum modules gave significant challenges. These findings suggest the need to improve the laboratory facilities and develop more contextual practicum modules to optimize the implementation of deep learning in chemistry education.

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1. INTRODUCTION

Learning chemistry at the Senior High School (SMA) level not only requires theoretical mastery of concepts but also an in-depth understanding through empirical experience. This is important because chemistry is a subject that is based largely on abstract concepts, so it is often difficult for students to understand, especially when they have to understand phenomena that cannot be observed directly. In addition, chemical material has a complex level of representation, from macroscopic to microscopic and symbolic, which are interconnected with each other. This condition causes students' understanding of chemical concepts to be insufficient only through theoretical learning. Therefore, concrete, contextual, and meaningful learning experiences are needed so that the learning process can run more optimally in the digital era (Refelita et al., 2023).

The development of learning in the digital era demands the implementation of a more meaningful and contextual learning process. Meaningful learning does not just emphasize conveying information, but also connecting learning material with real experiences that are close and relevant to students' lives Through a contextual approach, students can understand and apply knowledge in various situations so that they are better prepared to face complex problems. Contextual learning can also increase student involvement because the material studied is closer to everyday life. Therefore, teachers need to innovate in learning strategies so that the learning process and outcomes achieved can be more optimal (Fatihah & Wiji, 2025). One learning innovation that can be applied to support the creation of meaningful learning is the deep learning approach.

Obviously, deep learning is a learning method that emphasizes in-depth conceptual understanding, rather than simply memorizing or quickly recognizing facts (Haryanti,2024). Furthermore, according to Fitriani & Santiani (2025) deep learning is a learning method that provides students with hands-on experience. Students are not simply immersed in theory; the deep learning approach helps them understand knowledge in a more realistic context. The theories taught to students can be applied in everyday life. The application of deep learning in education is not a new concept. This approach has been used in various European countries and has even pioneered efforts to improve the quality of learning. In Indonesia, the application of deep learning is expected to make a positive contribution to improving the quality of the learning process and student learning outcomes. One of the advantages of deep learning in education is its ability to adapt learning methods according to the nature and character of each student (Albani, 2025). Meanwhile, Wafi et al. (2025) explains that the deep learning approach consists of three main parts: meaningful learning, attentive learning, and enjoyable learning. These three components interact to create a comprehensive learning process so that students not only understand theory but also can apply chemical concepts in real-world situations through practical activities.

Although practical activities play a crucial role in supporting deep learning in chemistry, their implementation in schools still faces various obstacles. Limited laboratory facilities and infrastructure, such as a lack of equipment and chemicals, are one of the main obstacles preventing practicals from being implemented optimally. Research Nkurunziza et al. (2023)indicates that obstacles to practical implementation include limited laboratory facilities, a shortage of chemicals, and the high cost of procuring equipment and materials. These conditions result in a low frequency of practicals, resulting in many chemistry experiments not being carried out optimally. As a result, students miss out on opportunities to develop science process skills, critical thinking, and problem-solving abilities through hands-on learning experiences. Yet, student engagement in practical activities is a crucial factor in developing a deep and meaningful understanding of concepts. Therefore, further study of the various obstacles to implementing chemistry practicals is needed to find appropriate solutions to support the optimal implementation of deep learning.

The implementation of chemistry practicums in schools is still not optimal, with only a small portion of the topics planned by teachers being realized in the practicum activities. Furthermore, practicums are generally conducted in groups with direct teacher guidance, resulting in limited individual student involvement in the experimental process. The success of practicums is influenced by various factors, such as teacher and student readiness, the availability of adequate laboratory facilities, completeness of tools and materials, allocation of learning time, and support from laboratory staff. On the other hand, difficulties in learning chemistry experienced by students also contribute to obstacles in implementing practicums, both originating from internal factors, such as low learning motivation, lack of interest, limited understanding of concepts, and low calculation skills, as well as external factors, such as suboptimal learning methods, ineffective learning management strategies, peer influence, and limited learning time. This condition indicates that obstacles in chemistry practicums are not only related to the facility aspect but also include the readiness of human resources and the overall learning process, which ultimately can hinder the achievement of deep learning (Kurniawati & Rahmawati, 2024)

Several previous studies have shown that the implementation of practicums in schools still faces various obstacles that can hinder the implementation of deep learning. Research Muis et al. (2023) shows that the implementation of practicums in Sulawesi State Senior High Schools is included in the good category with an average of 72.26%. However, some practicums cannot be implemented due to limited laboratory equipment, lack of time, and the unavailability of practicum objects. In

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addition (Rahmah et al., 2021) found that obstacles to practicums include inadequate laboratory facilities and infrastructure, limited practicum materials, lack of implementation time, and minimal training for teachers and laboratory assistants. Research Riyanto et al. (2023) also shows that the low implementation of practicums is influenced by limited laboratory facilities, lack of teacher skills, a lack of laboratory staff, and low teacher participation in laboratory training. These various studies indicate that obstacles to practicums remain a common problem in schools and have the potential to hinder the creation of meaningful learning and the development of students' higher-order thinking skills.

However, previous studies mainly focused on identifying obstacles in practicum implementation, such as laboratory facilities, materials, and management issues. Limited studies have examined how these obstacles influence the implementation of deep learning in chemistry education, particularly in relation to mindful, meaningful, and joyful learning. Therefore, this study addresses the research gap by analyzing chemistry practicum obstacles from the perspective of deep learning implementation. The novelty of this study lies in integrating the analysis of chemistry practicum constraints with the deep learning framework. Rather than merely identifying the barriers to chemistry practicum implementation, this study also examines their implications for students' learning experiences, including conceptual understanding, active engagement, reflection, and contextual learning. Theoretically, this research contributes to the advancement of deep learning implementation in chemistry education by emphasizing the role of laboratory-based learning. Practically, the findings provide valuable insights for teachers and schools to improve practicum management, enhance laboratory facilities, and develop contextual practicum modules that support meaningful learning experiences.

Based on these conditions, the main problem addressed in this study is that the implementation of chemistry practicum as a learning activity to support deep learning has not been fully optimized due to various internal and external constraints, including laboratory facilities, practicum implementation processes, student involvement, teacher support, and practicum module characteristics. These constraints may limit students' opportunities to experience meaningful, mindful, and joyful learning through laboratory activities. Therefore, this study aims to analyze the implementation of chemistry practicum and identify the obstacles encountered in supporting deep learning at SMAN 5 Tangerang Selatan. The findings of this study are expected to provide an understanding of factors that need to be improved to optimize chemistry practicum implementation and support the development of deep learning in chemistry education.

2. METHOD

a. Research Design and Location

This study used a quantitative descriptive approach. Quantitative descriptive research is a research design that uses numerical data to systematically describe, explain, and analyze a phenomenon based on facts found in the field. This approach aims to obtain a picture of a situation or phenomenon as it is and draw conclusions based on the data obtained (Putra et al., 2025) This approach was used to describe in depth the various obstacles in implementing chemistry practicums to support deep learning. The study was conducted during the even semester of the 2025/2026 academic year at SMAN 5 Tangerang Selatan. The selection of the research location was based on the implementation of chemistry practicum activities in the school's learning process.

b. Object and Subject of Research

The object of this study was the constraints in implementing chemistry practicums to support deep learning. The research subjects consisted of eleventh-grade students and chemistry teachers at SMAN 5 Tangerang Selatan. The sample is part of the number and characteristics of the population. Sampling must be carried out appropriately to represent the research population as a whole (Sugiyono, 2019). The population of this study consisted of 124 eleventh-grade science students. The sample was determined using the Isaac and Michael table with a 10% error rate, resulting in a sample size of 89 students.

The sampling technique used was proportional random sampling, in which three classes from the eleventh-grade science program were selected proportionally according to the number of students in each class. The determination of the number of samples for each class was calculated using the proportional allocation formula according to Sugiyono, (2019) as shown in Formula 1.

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$$ni = \frac{Ni}{N} \times n \quad (1)$$

Description:

ni : Number of samples in each class

Ni : Total population in each class

n : Total number of samples

N : Total population

Before conducting the research, the researcher obtained permission from SMAN 5 Tangerang Selatan and coordinated with the chemistry teacher and related parties. All participants were informed about the purpose and procedures of the study, and their participation was voluntary. The researcher ensured the confidentiality of participants' identities and personal information by not including identifiable data in the research report. The collected data were used only for academic research purposes.

c. Instruments and Data Collection Techniques

The instruments used in this study were observation sheets to determine laboratory conditions, laboratory facilities and infrastructure, and the implementation of chemistry laboratory activities in schools. The interview guides were conducted with chemistry teachers to obtain more in-depth information regarding the obstacles encountered in implementing the laboratory. Furthermore, the questionnaires were administered to the students to determine their perceptions regarding the implementation of chemistry laboratory activities in supporting deep learning. The data were collected through observation, interviews, and questionnaires.

The questionnaire instrument developed in this study employed a Likert scale. Sugiyono (2019) stated that the Likert scale is a measurement method used to assess individuals' or groups' attitudes, opinions, and perceptions toward a specific phenomenon. In this research, the measured phenomenon refers to students' perceptions of chemistry practicum implementation in supporting deep learning. The Likert scale was applied because it provides a systematic approach to measure and quantify respondents' perceptions through a range of response categories. This study used a five-point Likert scale, consisting of five response categories from strongly agree to strongly disagree. The response categories and scoring criteria are presented in Table 1.

Table 1. Questionnaire assessment guidelines

Statement	Favorable Score	Unfavorable Score
Strongly Agree	5	1
Agree	4	2
Undecided	3	3
Disagree	2	4
Strongly Disagree	1	5

(Sugiyono, 2019)

d. Data Analysis Technique

The data were analyzed using descriptive analysis with percentage calculations. Before being used in the research, the questionnaire instrument was first tested for validity and reliability. The validity test was conducted through expert judgment to evaluate the suitability of the instrument based on content, construct, and language aspects. Furthermore, the questionnaire was tested on grade XII students who met the criteria, namely having studied chemistry materials in grade XI. The results of the questionnaire validity and reliability tests were then analyzed using SPSS version 25 and are presented in Table 2.

Table 2. Result of questionnaire instrument validity test

Number Item	R_{table}	R_{value}	Decription
1	0,355	0,676	Valid
2	0,355	0,599	Valid
3	0,355	0,743	Valid
4	0,355	0,545	Valid
5	0,355	0,538	Valid
6	0,355	0,728	Valid
7	0,355	0,603	Valid
8	0,355	0,639	Valid
9	0,355	0,446	Valid
10	0,355	0,315	Invalid
11	0,355	0,771	Valid
12	0,355	0,743	Valid
13	0,355	0,207	Invalid
14	0,355	0,719	Valid
15	0,355	0,717	Valid
16	0,355	0,552	Valid
17	0,355	0,763	Valid
18	0,355	0,400	Valid
19	0,355	0,363	Valid
20	0,355	0,619	Valid
21	0,355	0,817	Valid
22	0,355	0,210	Invalid
23	0,355	0,368	Valid
24	0,355	0,872	Valid
25	0,355	0,793	Valid
26	0,355	0,636	Valid
27	0,355	0,737	Valid
28	0,355	0,595	Valid
29	0,355	0,742	Valid
30	0,355	0,294	Invalid
31	0,355	0,602	Valid

Number Item	R_{table}	R_{value}	Decription
32	0,355	0,825	Valid
33	0,355	0,813	Valid
34	0,355	0,531	Valid
35	0,355	0,643	Valid
36	0,355	0,678	Valid
37	0,355	0,849	Valid
38	0,355	0,502	Valid
39	0,355	0,825	Valid
40	0,355	0,679	Valid
41	0,355	0,798	Valid
42	0,355	0,798	Valid
43	0,355	0,720	Valid
44	0,355	0,680	Valid
45	0,355	0,569	Valid
46	0,355	0,328	Invalid
47	0,355	0,777	Valid
48	0,355	0,698	Valid
49	0,355	0,561	Valid
50	0,355	0,706	Valid
51	0,355	0,691	Valid
52	0,355	0,727	Valid
53	0,355	0,767	Valid
54	0,355	0,563	Valid
55	0,355	0,455	Valid
56	0,355	0,523	Valid
57	0,355	0,180	Invalid
Number of Valid Item			**51 Item**
Number of Invalid Item			**6 Item**
Total Item			**57 Item**

The validity test was conducted to determine the extent to which the research instrument was able to measure the intended variables. According to Sugiyono (2019), a valid instrument indicates that the measurement tool can accurately measure what it is intended to measure. The validity test in this study was performed using the Pearson Product Moment correlation by comparing the r-count and r-table values at a significance level of 5%. An item was considered valid if the r-count value was greater than the r-table value, while an item was considered invalid if the r-count value was lower than the r-table value. Based on the validity test results of 57 questionnaire items, 52 items were categorized as valid, while 5 items were categorized as invalid. The valid items were used as research instruments, whereas the invalid items were excluded from further data analysis.

After the validity test was conducted, the questionnaire instrument was further tested for reliability to determine the consistency of the instrument in measuring the research variables. According toSugiyono (2019), reliability refers to the level of consistency and stability of an instrument in producing data when the instrument is used repeatedly to measure the same object. In this study, the reliability test was conducted using the Cronbach's Alpha coefficient. The questionnaire instrument was considered reliable if it met the predetermined reliability criteria. The results of the reliability test are presented in Table 3.

Table 3. Reliability test results of questionnaire instrument

Sample	Number Item	Cronbach's Alpha	Catogory
31	51	0,970	Very Good

Based on the results of the reliability test, the study involved 31 respondents with a total of 52 questionnaire items. The analysis showed a Cronbach's Alpha value of 0.971, which is categorized as very good. According to Sugiyono (2019), reliability refers to the consistency of an instrument in producing stable results when repeatedly used to measure the same construct, and an instrument is considered reliable when the Cronbach's Alpha value exceeds 0.60. Therefore, the obtained value of 0.970 indicates that the instrument has very high internal consistency, meaning that all items are reliable and suitable for use in data collection. Based on these results, it can be concluded that the instrument is feasible to be used in further data analysis.

Furthermore, the data from the interviews and observations were analyzed through the stages of data reduction, data presentation, and drawing conclusions to obtain an overview of the obstacles to implementing chemistry practicum. Meanwhile, the questionnaire data was analyzed by calculating the percentage for each research indicator. The results of the analysis were then presented in the form of tables and descriptive descriptions to make them easier to understand. The data analysis was carried out to obtain a systematic picture of the implementation of chemistry practicum in supporting deep learning at SMAN 5 Tangerang Selatan. To calculate the percentage from the student questionnaire and observation sheet for each item, use the following formula.

$$p=\frac{f}{n}\times 100\% \quad (2)$$

Description:

p = Percentage of practical implementation

f = Frequency of respondent responses

n = Maximum score

The observation scores for each aspect of chemistry practical implementation were then classified of obstacles to the chemistry practical implementation in Table 4.

Table 4. Percentage categories of obstacles to chemistry practical implementation

Interval	Category
86% - 100%	Very Good
71% - 85%	Good
56% - 70%	Fair
41% - 55%	Poor
≤ 40%	Very Poor

(Sembiring et al., 2023)

3. RESULT AND DISCUSSION

3.1. Result

Based on the analysis of the student response questionnaires regarding the implementation of chemistry practicums, the percentage data were obtained for each indicator that described the conditions under which chemistry practicums support deep learning. These data included the aspects of laboratory facilities and infrastructure, student interest in chemistry practicums, practicum time, preparation and implementation of practicums regarding the material, teacher ability to explain practicums, practicum topics or materials, and the characteristics of deep learning-based modules. The percentages for each indicator were then categorized based on achievement criteria to identify the indicators that had been implemented well and the indicators that remained obstacles to the implementation of chemistry practicums.The overall percentage results of the student response questionnaire indicators regarding the implementation of chemistry practicums are shown in the following table.

Table 5. Percentage of overall indicators of chemistry practicum obstacles in supporting deep learning

Indicator	Percentage	Criteria
Laboratory Facilities and Infrastructure (Condition, Equipment, Materials, and Safety)	57,41%	Fair
Student Interest in Chemistry Labs	81,59%	Good
Laboratory Time	71,10%	Good
Preparation and Implementation of Lab Materials	73,48%	Good
Laboratory Report	76,17%	Good
Teacher's Ability to Explain Labs	82,47%	Good
Laboratory Topics/Materials	81,72%	Good
Characteristics of Deep Learning-Based Modules	78,80%	Good

Based on Table 2, the overall percentage of chemistry practicum implementation indicators falls into a good category. The highest indicator was the teachers' ability to explain the practicum at 82.47%, while the lowest indicator was the laboratory facilities and infrastructure at 57.41%, in a moderate category. These results indicated that the chemistry practicum implementation had been going well, but the laboratory facilities still need to be improved.

a. Chemistry Laboratory Facilities and Infrastructure

To determine the condition of chemistry laboratory facilities and infrastructure to support the implementation of deep learning-based practicums, the results of the observation analysis are presented in the table below.

Table 6. Percentage of chemical laboratory observation indicators

Indicator	Percentage
Furniture	68,75%
Educational Equipment	46,25%
Educational Media	100%
Supporting Equipment	60%
Consumables	70%
Average	**69%**
Criteria	**Fair**

The data in Table 3 show that the average percentage of chemistry laboratory observations was 69%, in a moderate category. The educational equipment indicator received the lowest percentage, at 46.25%. It indicated that laboratory facilities and infrastructure still did not meet standards (Kementerian Pendidikan Nasional Republik Indonesia, 2007) such as student desks and chairs, chemical storage, and laboratory ventilation. To obtain a more in-depth overview, each sub-indicator in the questionnaire was analyzed based on the percentage of the respondents' answers and presented in tabular form.

Table 7. Percentage of sub-indicators of the chemistry laboratory facilities and infrastructure questionnaire

No.	Sub Indikator	Percentage	Category
1.	Laboratory Conditions	48,53%	Poor
2.	Ventilation and Lighting	41,34%	Poor

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No.	Sub Indikator	Percentage	Category
3.	Laboratory Facilities	69,43%	Fair
4.	Condition of Lab Equipment	56,17%	Fair
5.	Availability of Lab Equipment	33,48%	Very Poor
6.	Availability of Materials	69,21%	Fair
7.	Limited Materials	31,01%	Poor
8.	Safety Facilities	53,03%	Poor
9.	Laboratory Safety	50,56%	Poor
10.	Understanding of SOPs	84,71%	Good
11.	Understanding of Chemical Symbols	82,24%	Good
12.	Use of Personal Protective Equipment	56,85%	Fair

Based on the data in Table 4, the sub-indicators of the facilities and infrastructure questionnaire showed that the highest percentage was in the sub-indicator of understanding SOPs at 84.71%. It showed that the respondents had a good understanding of standard operating procedures. Meanwhile, the lowest percentage was found in the material limitations sub-indicator of 31.01. It showed that there were still obstacles in the availability of practical materials.

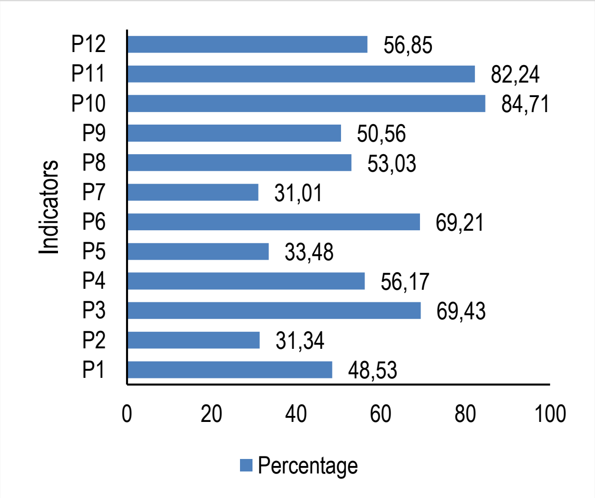

Figure 1. Facilities and infrastructure questionnaire indicator graph

In Figure 1, each statement is presented in the form of codes P1 to P12 to facilitate the presentation and reading of the graph. These codes represent statements 1 to 12, as listed in Table 4.

b. Student Interest in Chemistry Labs

The graph in Figure 2 shows the percentage results of the student interest indicators in the labs for each measured aspect.

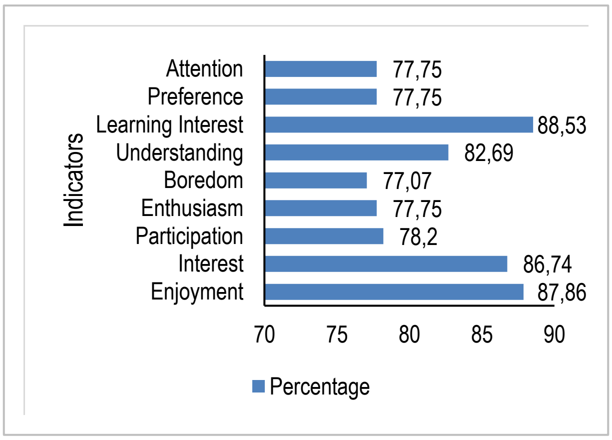

Figure 2. Graph of student interest questionnaire indicators for chemistry practicals

Based on Figure 2, the interest aspect obtained the highest percentage at 88.53%, followed by the enjoyment aspect at 87.86% and interest at 86.74%. Meanwhile, the saturation aspect obtained the lowest percentage at 77.07%. This means that, in general, these results showed that the students' interest in chemistry practicum was in the very good category in almost all of the aspects measured.

c. Practicum Implementation Time

The graph in Figure 3 shows the percentage of practicum implementation time indicators for each aspect measured.

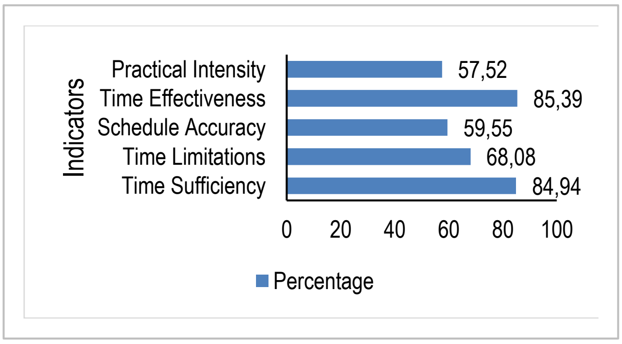

Figure 3. Graph of practical implementation time questionnaire indicators

Based on this graph, the time effectiveness achieved the highest percentage at 85.39%, followed by time adequacy at 84.94%. This result indicated that the practical implementation time was deemed quite effective and adequate. Meanwhile, time constraints achieved 68.08%; schedule accuracy achieved 59.55%; practical intensity achieved 57.52%. This indicated that several obstacles still existed in the implementation of the practical, particularly regarding practical intensity and schedule accuracy.

d. Preparation and Implementation of Practical Work on Material

The results of the analysis of the preparation and implementation indicators for practical materials can be seen in the following graph.

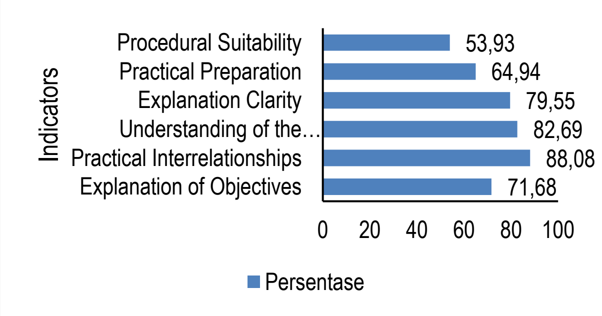

Figure 4. Graph of practical preparation and implementation questionnaire indicators

According to Figure 4, the aspect of relating the practical to the material achieved the highest percentage, at 88.8%, followed by the aspect of understanding the module/LKPD (Worksheet) at 82.69%. Meanwhile, the aspect of explaining the objectives of the practical had the lowest percentage, at 71.68%. Overall, these results indicated that the preparation and implementation of the practical were quite good, especially in terms of its relevance to the learning material, although there were still several aspects that needed improvement.

e. Laboratory Report

The graph in Figure 5 shows the percentage of practical report indicators for each aspect measured.

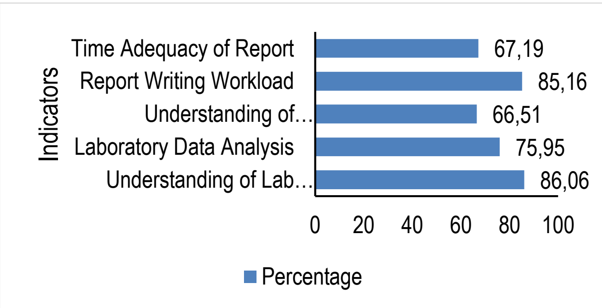

Figure 5. Graph of indicators for the preparation and implementation of practical work questionnaire

Based on this graph, understanding the report format achieved the highest percentage at 86.06%. Meanwhile, understanding the experimental results achieved the lowest percentage at 66.51%. The results indicated that the preparation of practical work reports was quite good, but there were still some obstacles in understanding the experimental results

f. Teacher Ability in Explaining Practical Work

The graph in Figure 6 shows the percentage indicators for teacher ability in explaining practical work for each aspect measured.

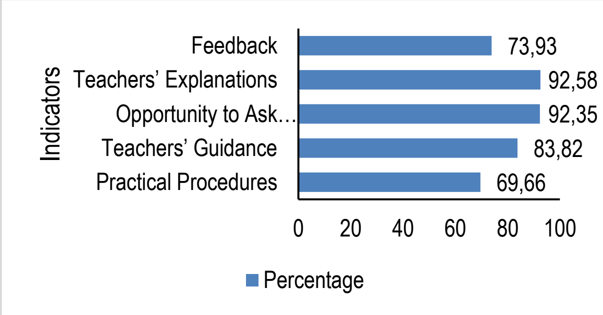

Figure 6. Graph of teachers' ability to explain practical work questionnaire indicators

Based on this graph, the highest percentage was found in the aspect of teachers' explanations, at 92.58%. Meanwhile, the lowest percentage was in the aspect of practical work procedures, at 69.66%. These results indicated that the teacher's role in providing explanations and opportunities for questions during the practical work was very good, but the understanding of practical work procedures still needed to be improved.

g. Topics/Practical Materials

The graph in Figure 7 shows the percentage of topic/practical material indicators for the measured aspects.

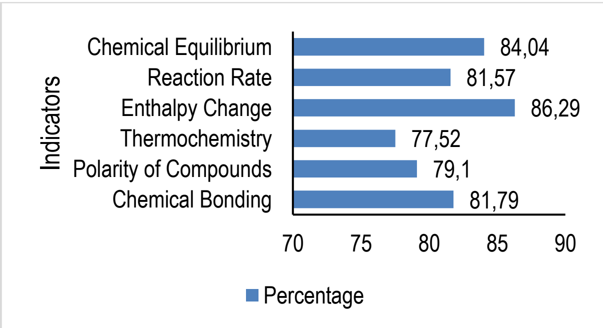

Figure 7. Graph of the TOP/practical material questionnaire indicators

Based on this graph, the highest percentage was for the enthalpy change aspect, at 86.29%. Meanwhile, thermochemistry received the lowest percentage, at 77.52%. This indicated that most of the practicum material was well understood by the students,

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although there were still some materials that needed improvement in both theory and practicum.

h. Characteristics of the Deep Learning-Based Practical Module

The graph in Figure 8 below shows the percentage results of the teachers' ability to explain the practicum based on each aspect measured.

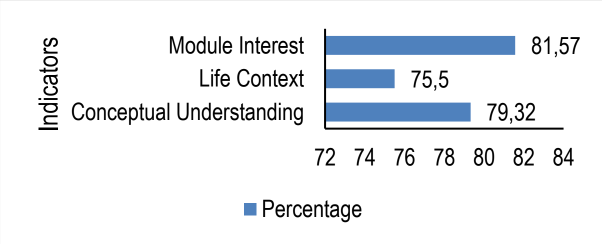

Figure 8. Graph of indicators for the deep learning-based module characteristics questionnaire

Based on this graph, the highest percentage of interest was in the practical module at 81.57%. Meanwhile, the lowest percentage was in the daily life context aspect at 75.5%. This indicated that the deep learning-based module was capable of attracting student interest and engagement in learning. However, the relevance of the material to daily life still needs to be improved to make learning more relevant and meaningful.

3.2. Discussion

The findings of this study provide an explanation of how chemistry practicum implementation influences the application of deep learning in chemistry education. The results indicate that practicum activities support deep learning because they provide opportunities for students to actively construct knowledge through observation, experimentation, discussion, and reflection. This process allows students to move beyond memorizing chemical concepts and develop deeper conceptual understanding, critical thinking, and problem-solving skills. This finding is consistent with the concept of deep learning, which emphasizes mindful, meaningful, and joyful learning through active student involvement in the learning processSugiyono (2019). The teacher's ability to explain practicum activities was identified as the highest indicator (82.47%), suggesting that effective teacher guidance plays an important role in facilitating exploration and reflection during practicum activities. According to Syaf'i & Darnangsih (2025) teachers in deep learning act as facilitators who guide students in constructing knowledge through exploration, application, and reflection. Therefore, when teachers provide clear explanations, opportunities for discussion, and feedback, students are more likely to engage actively and develop deeper understanding.

However, the findings also show that laboratory facilities and infrastructure obtained the lowest percentage (57.41%), indicating that inadequate facilities may limit the optimal implementation of deep learning. Deep learning requires a learning environment that enables students to explore, experience, and reflect on real phenomena. Limited equipment, materials, and safety facilities reduce students' opportunities to conduct experiments independently and meaningfully. This finding supports Haq & Prasetiyo (2025), who stated that deep learning requires learning experiences connected to real-world contexts to encourage students to construct knowledge actively. Therefore, improving laboratory facilities and developing more contextual practicum modules are important factors to strengthen the implementation of deep learning in chemistry learning.

The findings of this study differ from previous studies because most previous research has focused on the effectiveness of chemistry practicums in improving conceptual understanding, laboratory skills, or student engagement, but has not specifically examined whether practicum activities have implemented the principles of deep learning. Therefore, although previous studies reported that chemistry practicums were effective in supporting learning outcomes, it remains necessary to investigate whether these activities have facilitated mindful, meaningful, and joyful learning processes. In this study, the implementation of chemistry practicums was analyzed from the perspective of deep learning, revealing that practicum activities have supported student engagement, conceptual understanding, and reflection; however, several aspects still require improvement, particularly laboratory facilities, practicum intensity, and contextualization of practicum modules. This indicates that the implementation of deep learning in chemistry practicum cannot be determined only by the existence of practicum activities, but also depends on whether the learning process provides opportunities for students to actively explore, connect concepts with real-life contexts, and reflect on their learning experiences. Therefore, schools that have implemented deep learning approaches may still face challenges in ensuring that practicum activities fully represent deep learning characteristics.

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Based on the research results in Table 2, the overall percentage of chemistry practicum implementation indicators supporting deep learning was in the good category. The indicator with the highest percentage was the teacher's ability to explain the practicum at 82.47%, while the lowest indicator was laboratory facilities and infrastructure at 57.41%. These results indicated that the implementation of chemistry practicums was sufficient in supporting deep learning, particularly in helping the students understand the concepts through the teachers' explanations and guidance during the practicum. Practical activities are crucial for providing students with hands-on experience and enhancing their understanding of the subject matter. Through practicum activities, the students gained hands-on learning experiences that encourage critical thinking, improve laboratory skills, better understand the learning material, and practice problem-solving skills. Furthermore, practicums also help students develop their ability to communicate experimental results and ask questions related to the learning process (Imani, 2023)

a. Chemistry Laboratory Facilities and Infrastructure

Based on Table 2 and the graph of laboratory facilities and infrastructure indicators, the percentage was 57.41%, in the moderate category. The highest percentage was found in understanding laboratory SOPs at 84.71%, while the lowest percentages were found in the availability of laboratory equipment at 33.48% and limited materials at 31.01%. These results indicated that the laboratory facilities still did not fully support the optimal implementation of chemistry laboratory work. Although students have a good understanding of laboratory procedures, limited availability of equipment and materials may hinder students from conducting experiments effectively.

The questionnaire results were supported by interviews with chemistry teachers, who stated that the laboratory still lacked equipment, materials, ventilation, fire extinguishers, and laboratory tables that did not meet standards. The teacher also stated that the procurement of laboratory equipment and materials had not been fully realized due to school budget constraints. Furthermore, laboratory coats and safety equipment were still limited, resulting in students not using PPE optimally during laboratory work.

This situation indicated that the implementation of deep learning was not yet fully optimal, as deep learning requires a learning environment that supports student exploration. According to Haq & Prasetiyo (2025), learning should not only focus on theoretical mastery of concepts but also emphasize active student involvement in constructing knowledge through real-world experiences. Meanwhile, Rosyidah et al., (2026) argues that deep learning is based on the principles of mindful, meaningful, and joyful learning, which positions students as active participants in the learning process. Limited laboratory equipment and materials may restrict students' opportunities to conduct independent exploration and investigation. This condition affects the implementation of deep learning because students require direct experiences to construct knowledge, analyze phenomena, and reflect on their learning process. Therefore, inadequate laboratory facilities not only influence the technical implementation of practicum but also reduce opportunities for meaningful and reflective learning experiences.

Furthermore, interviews with chemistry teachers revealed that laboratories still face challenges with ventilation, fire extinguishers, lab tables, and chemical storage. These conditions indicate that learning does not fully support joyful and meaningful learning. According to Azzahra & Jaya (2025), deep learning requires adequate learning facilities to enable students to engage actively, reflectively, and contextually. As can be seen in Table 4, the high level of students' understanding of laboratory SOPs indicates the application of mindful learning, namely learning that is carried out consciously and responsibly during the practicum.

b. Student Interest in Chemistry Labs

Based on Table 2 and the graph showing the students' interest in chemistry practicums, 81.59% were in the good category. The highest percentage was found in the interest aspect at 88.53%, while the lowest percentage was found in the boredom aspect at 77.07%. These results indicated that the students were highly enthusiastic about chemistry practicums. High student interest indicated that practicums could create a pleasant learning atmosphere and increase student engagement. This aligns with the concept of joyful learning in deep learning, which emphasizes enjoyable learning to encourage students to be more active and motivated in their learning. This aligns with research by Ramadhan

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(2025) that found joyful learning can increase student motivation, attention, and participation, thus supporting a deeper understanding of concepts.

The interview results also showed that the students were more interested when chemistry practicums were related to everyday life. This reflected the application of meaningful learning, as the students could connect chemical concepts with real-life experiences. According to Dewi et al. (2025), meaningful learning in the deep learning approach is built through contextual activities that connect learning concepts to real-life situations, resulting in deeper and more meaningful student understanding. Therefore, chemistry practicums can support deep learning because learning becomes more active, contextual and enjoyable.

c. Practical Implementation Time

Based on Table 2 and the graph of the practicum implementation time indicator, the percentage was 71.10%, in the good category. The highest percentage was for time effectiveness at 85.39%, while the lowest percentage was for practicum intensity at 57.52%. These results indicated that practicum time was considered quite effective, but the frequency of practicums was still limited. Although practicum time was considered quite effective, the intensity of practicums was still relatively low. In a deep learning approach, students need sufficient time for exploration, discussion, reflection, and analysis of practicums. According to Feri (2025), deep learning requires a leisurely learning process so that students can develop conceptual understanding, think critically, and reflect on their learning experiences.

The interviews revealed that practicums were usually conducted after the material has been discussed in class, and only certain materials were practiced in a semester. The teachers reported that practicums were implemented according to schedule and were not significantly constrained by time because learning is divided into theory and practicum sessions. However, the limited material for practicums resulted in low practicum intensity. Limited practicum time could reduce students' opportunities to develop critical thinking and problem-solving skills. This indicated that the implementation of deep learning was not yet fully optimal because the students did not receive continuous practicum experience.

Deep learning requires sufficient learning time for students to explore phenomena, discuss findings, evaluate results, and reflect on their learning experiences. Therefore, limited practicum intensity may reduce students' opportunities to develop deeper understanding and higher-order thinking skills. Although the available practicum time was considered effective, increasing the frequency of practicum activities is necessary to provide more continuous learning experiences. Therefore, more effective learning time management is needed so that practicums can be carried out more intensively, thus supporting deeper and more meaningful learning.

d. Preparation and Implementation of Practical Work on Material

Based on Table 2 and the graph of indicators for preparation and implementation of the practicum, the percentage was 73.48%, in the good category. The highest percentage was found for the relevance of the practicum to the material 88.08%, while the lowest percentage was found for the appropriateness of the practicum procedures 53.93%. These results indicated that the practicum helped the students understand the learning material, although there were still challenges in understanding the practicum procedures.

The interview results indicated that the teachers explained the objectives and procedures of the practicum before the activity, thus enabling students to better understand the steps. This reflects the application of mindful learning in deep learning, namely learning conducted with full awareness of the objectives and learning process. According to Rosyidah et al. (2026), mindful learning helps students understand learning objectives and actively engage in the learning process consciously and reflectively.

Furthermore, the relevance of the practicum to the learning material indicated meaningful learning because the students could connect the theory learned with direct practicum experiences. Thus, good practicum preparation could help students understand chemistry concepts more deeply, going beyond simply following practicum procedures. This aligns with research (Sangkota et al., 2024), that suggests that good practicums make the work more focused and enable students to be cognitively and technically prepared for learning. Interactive practicums could also enhance critical thinking, collaborative thinking, and reflection skills, which are key characteristics of deep learning.

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e. Laboratory Report

Based on Table 2 and the lab report indicator graph, the percentage of the students who completed lab reports was 76.17%, in the good category. The highest percentage was for understanding the report format 86.06%, while the lowest percentage was for understanding the experimental results 66.51%. These results indicated that students were quite capable of preparing lab reports, but they still had difficulties in understanding and analyzing the experimental results.

The interview results indicated that the lab reports were prepared based on the student worksheet (LKPD) provided by the teacher. The teacher also stated that some students still had difficulty analyzing lab data, so a presentation of the lab results was conducted to help students better understand the experimental results. Furthermore, the teacher explained that lab reports help the students understand the experimental results because they are required to find sources and connect the experimental results to theory.

In deep learning, the lab reports served not only as a final assignment but also as a reflection tool that supported the development of students' critical thinking skills. According to Mahrunnisya (2025), deep learning emphasizes students' ability to reflect on learning experiences through analysis and evaluation activities. Therefore, the preparation of reports and presentations of practical work played a role in supporting the realization of meaningful learning because through these activities, the students not only report the results of experiments but also understand the meaning and concepts obtained from the experiments that have been carried out

f. Teacher's Ability to Explain Practical Work

Based on Table 2 and the graph showing teachers' ability to explain practical work, the percentage was 82.47%, in the good category, the highest indicator in this study. The highest percentage was found in teacher explanations at 92.58%, while the lowest percentage was found in practical procedures at 69.66%. These results indicated that teachers had good abilities in guiding the students during practical work.

The interviews revealed that the teachers always provided procedural explanations before practical work, guided students in groups, provided opportunities for discussion, and provided feedback on student practical work results. The teachers also stated that practical work can foster the students' critical thinking skills when the practical work results did not align with theory, requiring students to seek alternative sources and discuss the reasons.

In deep learning, the teachers acted as facilitators, helping students construct knowledge independently through exploration and reflection. According to Syaf'i & Darnangsih (2025), deep learning emphasizes active student involvement through the stages of exploration, application, and reflection, guided by the teacher. With discussions, feedback, and guidance during the practicum, students become more active in understanding concepts and developing critical thinking skills, thus supporting the implementation of mindful learning and meaningful learning.

g. Topics/Practical Materials

Based on Table 2 and the topic indicator graph or lab material, the percentage of students was 81.72%, in the good category. The highest percentage was found in enthalpy changes 86.29%, while the lowest percentage was found in thermochemistry 77.52%. These results indicated that the labs helped the students understood chemical concepts, especially abstract concepts.

The interviews revealed that the teachers stated that the labs significantly helped the students understand abstract concepts, such as stoichiometry and chemical equilibrium because they allowed students to directly observe phenomena. The teachers also explained that the labs were aligned with the curriculum and attempted to relate them to everyday life to facilitate the students' comprehension of the concepts being studied.

In deep learning, real-life experiences were crucial for helping the students develop a deeper conceptual understanding. According to Nafi'ah & Faruq (2025), deep learning is effective in developing critical and reflective thinking skills when learning is linked to students' real-life experiences. Therefore, the chemistry labs supported meaningful learning because the students not only memorize concepts but also understand their application through direct experience during the lab.

h. Characteristics of Deep Learning-Based Practical Modules

Based on Table 2 and the graph of the characteristic indicators for deep learning-based practical modules, the percentage was 78.80%, in a good category. The highest percentage was found in the interest aspect of the practical module at 81.57%, while the lowest percentage was found in the context of everyday life at 75.5%. These results indicated that the practical module was quite engaging, but the relevance of the material to everyday life still needed improvement.

The interviews revealed that the teachers stated that relating concepts to everyday life was more often done directly during the lesson rather than written in the practical module. They also explained that the students were involved in presentations and discussions of the practical results to be more active and understand the results in depth. Furthermore, they stated that the practical learning reflected the characteristics of mindful, meaningful, and joyful learning, although the meaningful learning aspect still needed to be strengthened through more contextual learning. According to Rahmawati et al. (2025), the implementation of meaningful learning can be achieved through contextual learning that connects the material to students' real-life experiences. Thus, the development of more contextual and interactive practical modules is very necessary so that the implementation of deep learning can run more optimally.

The results suggest that the availability of a deep learning-based module does not automatically ensure the full implementation of deep learning. The module needs to facilitate contextual activities, student reflection, and connections between chemistry concepts and real-life situations. Therefore, the development of practicum modules should focus not only on presenting experimental procedures but also on encouraging students to analyze, interpret, and apply their understanding in meaningful contexts.

4. CONCLUSION

Based on the research results, the implementation of chemistry practicums in supporting deep learning was generally considered good. The highest indicator was the teacher's ability to explain the practicum, while the lowest indicator was laboratory facilities and infrastructure. The chemistry practicums supported the implementation of mindful, meaningful, and joyful learning because the students were actively involved in observation, experimentation, discussion, and reflection during the practicum. The contribution of this research is providing empirical evidence regarding the extent to which chemistry practicum activities support the implementation of deep learning principles. This study also provides an overview of the factors that influence deep learning implementation, particularly the important role of teachers, laboratory conditions, practicum intensity, and the contextualization of practicum modules. These findings can serve as a reference for educators and schools in improving chemistry practicum designs to create more meaningful and student-centered learning experiences.

In addition, the interview results also indicated that practicums helped the students understand abstract chemistry concepts through direct experience and increased their interest and critical thinking skills. However, the practicum implementation still had several limitations, such as limited laboratory facilities, low practicum intensity, and practicum modules that were not fully contextual. Therefore, further research is recommended to develop more contextual and interactive practicum modules and improve laboratory facilities to support the optimal implementation of deep learning in chemistry instruction

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