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ENHANCING STUDENTS' ENGAGEMENT IN SCIENCE PRACTICUM IN DISTANCE HIGHER EDUCATION FOR QUALITY EDUCATION (SDG 4)

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ABSTRACT

This study identifies and analyzes the key factors influencing students' engagement in science practicum activities within the Open and Distance Higher Education (ODHE) context. 127 students from diverse regions of Indonesia participated in this quantitative study, which assessed perceptions regarding academic challenges, learning interaction, collaborative learning, and the use of technology in online laboratory settings. The results indicate that tutorial modality, employment status, academic achievement (GPA), and residential area significantly influence engagement levels. Students participating in web-based classes and receiving consistent learning feedback reported higher engagement. Conversely, laboratory report writing emerged as a primary challenge, highlighting the urgent need for enhanced scientific writing literacy. The findings are discussed within the Community of Inquiry (CoI) and Self-Determination Theory (SDT) frameworks, emphasizing the importance of teaching presence, social collaboration, and learner autonomy in digital learning environments. Notably, students from rural areas exhibited high motivation despite infrastructural limitations. The study recommends redesigning learning models to include targeted support, structured digital practicum modules, and formative feedback mechanisms. This research contributes to developing inclusive, adaptive, and effective science education practices in ODHE while supporting achieving Sustainable Development Goal (SDG) 4: Quality Education.

Keywords: students' engagement; science practicum; distance higher education; online learning; SDG 4

INTRODUCTION

Distance higher education is a learning concept where students and lecturers are physically separated and connected through the media. The learning can be applied online and offline (Abrami et al., 2011; Strauß & Rummel, 2020). Online learning uses Zoom, Microsoft Teams, Skype, and others, allowing students and lecturers to interact (Parker, 2015; Hollis, 2018; Burgason et al., 2019; Paulsen & McCormick, 2020; Humber, 2021). In contrast, offline learning can be conducted through television broadcasts, radio, webinar classes, or self-study materials in modules (Kamarga, 2002; Engagement, 2013; Groccia, 2018; Buskist & Groccia, 2018). Online learning services at a distance higher education are carried out in an online class, and offline learning services are done through a face-to-face class.

The increasing need for accessible and equitable education makes students' engagement in science practicum critical in achieving Sustai-

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nable Development Goal 4 (SDG 4). The goal is to ensure inclusive and equitable education and promote lifelong learning opportunities. Science practicum plays a crucial role in developing problem-solving, scientific reasoning, and innovation, making its effectiveness in distance learning environments essential for supporting future workforce readiness (Widiasih et al., 2018a; Widiasih, Sukmayadi, et al., 2023).

The practicum is implemented in the laboratories of partner universities and guided by academic lecturers (Firmansyah, Widiasih, et al., 2024; Zakirman et al., 2023). Some topics discussed are carried out independently by students in the laboratory or at home (Sadjati & Pertiwi, 2013; Masitoh et al., 2021; Nugraheni, 2021). The practicum is recorded in a video, and the data, presented as a practicum worksheet, is discussed with the lecturer during the webinar classes (Aisyah et al., 2022; Firmansyah et al., 2024). Videos and practicum worksheets are uploaded to https://lms.ut.ac.id. Lecturers assess the practicum based on the video and practicum worksheet. All practicum worksheets from all assigned experiments are combined into one practicum report and uploaded to https://praktik.ut.ac.id (Johan et al., 2023; Widiasih, Johan, et al., 2023).

Despite these efforts, less than 50% of distance learning students completed practical tasks with full engagement. Significant challenges include inadequate laboratory access, lecturer feedback, and students' self-efficacy. Moreover, studies have shown that students' motivation in practicum decreases by up to 30% when delivered entirely online compared to blended or face-to-face. Addressing these issues is crucial to improving the quality of science learning at a distance higher education.

Given these challenges, it is essential to explore how practicum activities are structured in distance education settings, how students engage in these activities, and what factors influence their level of engagement. To address these issues, this study aims to answer the following questions: (1) How are science practicums conducted at distance higher education? (2) How engaged are distance higher education students in practicum activities? (3) What factors influence students' engagement in practicum activities?

The completion rate of practicum in distance higher education shows that most students are less engaged in practicum activities. Students' engagement is crucial to achieving the expected results and goals of the practicum. Therefore, understanding the factors that influence students' engagement in practicum is important (Aisyah et al., 2022; Widiasih et al., 2021). Psychological and social factors influence students' engagement in practicum. Internal motivation, confidence, and the ability to collaborate with peers are some factors that can influence students' engagement (Ismail et al., 2016a; Darmaji et al., 2019; Ly, 2023; Chea, 2024). In addition to motivation, students' engagement in practicum is also influenced by lecturer support.

Prior research highlights that students' engagement in online science practicums is lower than in conventional settings, primarily due to a lack of direct supervision and limited peer collaboration (Widiasih et al., 2018b; Widiasih et al., 2023). Moreover, studies on distance higher education suggest that their students face higher self-regulated learning challenges than those in face-to-face settings. Given this background, further research is needed to determine which factors most influence engagement in distance science practicums and how these can be optimized.

Research shows that the relationship between lecturers and students can significantly influence learning experiences. Supportive lecturers can help students overcome challenges in practicum and provide the guidance necessary to develop practical skills and conceptual understanding (Vignoli et al., 2018; Kanwal et al., 2020; Chen & Wang, 2020; Alici & Alan, 2022; He et al., 2022; Altarawneh et al., 2023).

Physics practicum also needs to equip 4C or 6C skills: Critical Thinking Skills, Creative Thinking Skills, Collaboration Skills, Communication Skills, Computational Thinking Skills, and Compassion Thinking Skills. (Fatmaryanti et al., 2022; Firmansyah et al., 2022b). These skills are built with the support of practicum activities that apply engagement and collaboration methods digitally and interactively through workspaces to result in a significantly greater increase in conceptual understanding compared to conventional methods (Firmansyah et al., 2022a; Saputra et al., 2023).

However, existing studies have not comprehensively analyzed how engagement factors differ based on employment status, GPA, and geographical location, especially in blended practicums. Most studies have focused on technology integration but lack insights into students' motivation and engagement from a psychological perspective. This study aims to close this research gap by identifying the dominant factors influencing engagement in distance science practicums and providing strategic recommendations.

Another way to make a practicum activity effective in distance higher education is Reciprocal Peer Tutoring (RPT). In introductory physics courses, RPT effectively improves conceptual understanding and problem-solving skills (Bailey et al., 2018; Scharfenberg & Bogner, 2019; Shenoy & Petersen, 2020; Madou et al., 2023). The post-COVID situation has not changed students' engagement in physics laboratory activities. The issue of students' engagement in practicum in distance learning is still a problem (Susanti et al., 2024).

Although previous studies have explored the integration of technology, learning strategies, and infrastructure in distance science education, few have comprehensively examined the combined influence of psychological factors (e.g., learning motivation and self-efficacy), social factors (e.g., peer support and lecturer guidance), and contextual factors (e.g., geographic location, employment status, and academic performance) on students' engagement in science practicums. Most literature emphasizes technological or pedagogical aspects without adequately addressing how engagement varies across diverse students' demographics and learning conditions. This gap is particularly critical in distance higher education, where science practicums are delivered through blended methods—combining independent data collection and hands-on practice in partner laboratories coordinated by regional centers. Limited research has analyzed students' engagement in hybrid practicum models, especially within Indonesian open and distance education. Therefore, studies need to identify the dominant factors influencing students' engagement in distance science practicums and offer strategic recommendations for developing more adaptive, inclusive, and effective practicum designs. Addressing this issue is essential for optimizing learning outcomes and ensuring competency development in the digital era.

This study supports previous research by identifying the primary factors influencing students' engagement in distance learning practicums and evaluating how these factors interact. Unlike previous studies focusing on technological aspects alone, this research considers psychological, social, and logistical dimensions, contributing to a more holistic understanding of students' engagement. The findings provide practical guidelines for improving students' engagement strategies in distance science education, ultimately supporting SDG 4: Quality Education.

Distance learning methods and the integration of technology in education have been widely explored, focusing on students' engagement in theoretical and practical learning activities (Abrami et al., 2011; Hollis, 2018). Prior studies have discussed the implementation of distance learning through self-study materials and technology (Parker, 2015) and the benefits of utilizing structured learning modules to enhance students' autonomy (Kamarga, 2002). Research has also emphasized the role of students' engagement and collaboration in improving conceptual understanding through digital interactive methods (Firmansyah et al., 2022a; Saputra et al., 2023). Additionally, the effectiveness of Reciprocal Peer Tutoring (RPT) in enhancing problem-solving skills in introductory physics courses suggests its potential as a strategy to address low students' engagement in science practicums (Bailey et al., 2018). Despite these advancements, challenges related to students' engagement in distance science practicums persist, particularly regarding active participation, collaboration, and access to practical resources (Susanti et al., 2024). However, limited studies have specifically examined the factors influencing students' engagement in science practicums within distance education settings and how structured learning support, peer collaboration, and technological adaptation impact participation levels. Addressing this gap, this study investigates the key factors of students' engagement in science practicums at distance higher education, providing insights into effective learning strategies to enhance engagement and learning outcomes in open and distance higher education.

METHODS

This study uses a survey method with a quantitative descriptive approach to explore factors that influence students' engagement in science practicums in distance higher education. This methodological approach was chosen because it allows for the systematic collection and statistical analysis of data from a large and geographically dispersed population. Distance higher education needs to operate across multiple provinces. The quantitative approach provides objectivity in measuring the strength and direction of relationships between variables, making it appropriate for answering the research questions that focus on how various psychological, social, and contextual factors influence engagement.

Distance higher education is characterized by a unique coordination system involving laboratories and practicum supervisors from partner institutions distributed across all 39 provinces of Indonesia. The descriptive quantitative approach was chosen because it provides an objective and systematic analysis of the data collected. Through this method, the researcher seeks to identify patterns, trends, and relationships between various variables relevant to students' engagement in practicum and tests the hypotheses.

This research is carried out in stages, starting from an initial review and literature review to identify the main factors influencing students' engagement in distance higher education-based science practicum. After that, research instruments were developed and validated in questionnaires modified from the National Survey of Students' Engagement (2013) and Logli (2016) to suit distance higher education students in Indonesia. Furthermore, sampling was carried out by a random method, where 127 students from 26 provinces in Indonesia were selected representatively to ensure diversity in students' academic and social backgrounds.

Data was collected online by distributing questionnaires sent via email and social media. Students selected as a sample were given four-week periodic reminders to increase the response rate. In this process, researchers ensured that no data was lost or invalid by preliminary screening of incoming results. Incomplete data or anomalies were then excluded from the analysis to maintain the integrity and quality of the research.

The questionnaire in this study consists of four main aspects measuring students' engagement in practicum: academic challenges, learning activities, interaction with lecturers, and learning experiences. Each item in the questionnaire was graded using a 5-point Likert scale, from "Strongly Disagree" to "Strongly Agree." Before use, the instrument was tested for validity and reliability through Exploratory Factor Analysis (EFA) to ensure a suitable structure, and its reliability was tested using Cronbach's Alpha, with an α value of more than 0.7, indicating good internal consistency.

After collecting the data, the analysis was done using the latest Statistical Package for the Social Sciences (SPSS) software. The first stage of the analysis was descriptive statistics, which are used to provide an overview of the demographic characteristics of the respondents and their level of engagement in the practicum. This analysis included frequency distributions, percentages, averages, and standard deviations for each variable measured. The next stage was inferential statistical analysis, where multiple linear regression identifies factors that significantly influence students' engagement.

In the regression analysis, the variable of students' engagement in practicum was used as a dependent variable. The independent variables include the mode of implementation of the practicum (face-to-face, online, blended), grade point average (GPA), employment status (full-time, part-time, non-working), and the area where the student lives (urban, rural). To ensure the accuracy of the results, the significance test was carried out with a confidence level of 95% ($\alpha = 0.05$). This test includes the F test to assess the influence of the regression model as a whole and the t-test to see the influence of each predictor variable on students' engagement.

The study also ensures compliance with research ethical standards. All participants were given information related to the purpose of the research, and consent for participation was obtained voluntarily. The data collected is confidential and contains no personal information that can identify an individual. In addition, the study received approval from the institution's research ethics committee, which ensures that the entire research procedure is carried out ethically and does not harm the respondents.

This systematic and comprehensive research method is expected to provide a deeper understanding of the implementation of science practicum in distance higher education. In addition, this comprehensive analysis describes students' engagement in practicum implementation through several key aspects: academic challenges, learning activities, interaction with lecturers, and learning experiences. The findings also highlight the factors influencing students' engagement in science practicum within distance higher education. Furthermore, the results of this study serve as a foundation for developing more effective strategies to improve the quality of practicum in distance higher education, in alignment with Sustainable Development Goal (SDG) 4: Quality Education.

RESULTS AND DISCUSSION

This study involved 127 students enrolled in programs at distance higher education. 68% of the participants were women between 21 and 56, and the average age was about 34. Figure 1 shows the geographical distribution of respondents in the study related to engagement in science practicum in the distance higher education program.

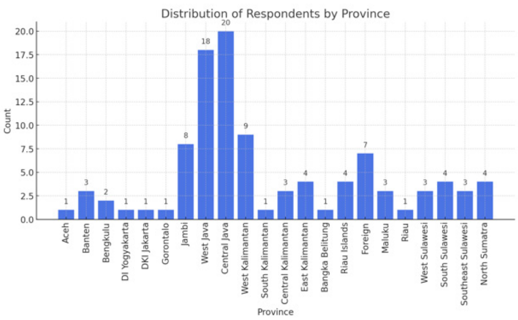

Figure 1. Distribution of Students' Provinces in Practicum

Figure 1 shows that most of the respondents came from Central Java (15.7%) and East Java (15.7%), followed by West Java (14%), West Kalimantan (7.1%), and Banten (6.2%). This distribution reflects the geographical diversity of a fairly broad sample, covering students from different regions throughout Indonesia. Most respondents came from Central Java and East Java, each with 20 respondents, followed by West Java with 18 respondents. Other regions, such as West Kalimantan, East Kalimantan, and North Sumatra, have fewer respondents, with four respondents each. Some provinces, such as Aceh, Gorontalo, and Maluku, have only one respondent, which indicates a disparity in the number of respondents by region.

This geographic distribution analysis is important in distance learning because various factors, including technological readiness, learning strategies, environment, and student motivation, can influence their engagement in science practicums. One of the main factors influencing students' engagement is the technological infrastructure available for online learning. Research shows that the quality of the internet plays an important role in implementing science practicum conducted through platforms such as Microsoft Teams. Limited internet access can hinder students' full participation in online practicum activities, reducing engagement and learning outcomes (Ismail & Ismail, 2021; Pertiwi et al., 2022).

In addition, the readiness of students and lecturers to utilize digital tools effectively is critical. The readiness of lecturers and the availability of appropriate teaching materials also significantly influence the success of implementing a distance practicum (Rosnita, 2016; Dwianto et al., 2017; Haviz et al., 2018; Johan et al., 2018). This wide and diverse geographical distribution also shows that environmental factors, such as different technological conditions in each region, can influence students' learning experiences. In some areas with better internet access, students may be more involved in practicum activities than students in areas with more limited access.

Furthermore, the practicum design itself is essential in encouraging students' engagement. The use of interactive simulations and guided inquiry-based learning has been proven to improve students' science process skills and their engagement in practicum activities (Srisawasdi & Kroothkeaw, 2014; Gunawan et al., 2019; Husnaini & Chen, 2019; Nursetiawati et al., 2020; Panuluh, 2022; Parmin et al., 2021; Bhakti et al., 2023). Well-designed inquiry-based virtual practicum modules can provide a more immersive learning experience and significantly increase students' engagement (Ismail et al., 2016b ; Gunawan et al., 2019; Bhakti et al., 2023).

Environmental factors also play an important role in students' engagement during distance practicums. Conducting experiments from home introduces variability in environmental conditions, such as differences in available materials and weather, which can influence the outcomes of practicum activities (Zubaıdah et al., 2017; Atmojo, 2022; Asilevi et al., 2024; Setyawarno et al., 2024). This variability forces students to adjust their approaches, which can ultimately improve problem-solving skills and engagement in the learning process (Macanas, 2019; Ülger & Çepni, 2020; Astawan et al., 2023).

Students' motivation, both intrinsic and extrinsic, also has a significant impact on engagement rates. High motivation correlates with increased participation and effort in learning activities. Practicum activities considered relevant and interesting can significantly increase students' enthusiasm for science (Aurangzeb, 2021; Syar et al., 2023 Alnaser & Forawi, 2024). In addition, encouraging curiosity and providing opportunities for hands-on experiences, even in virtual formats, can improve engagement and learning outcomes (Halim et al., 2020; Herianto & Wilujeng, 2020; Nurdiana et al., 2023).

The geographical distribution of students in this study reflects the diverse learning contexts across Indonesia. The findings reveal that while most students are from the Java region, a smaller number come from areas with limited internet access, such as Maluku and Gorontalo. This disparity supports Lopes (2023), who emphasizes that unequal digital infrastructure directly influences the quality of online learning. Students from regions with poor connectivity tend to face significant barriers to participating in online practicum activities, highlighting the urgent need to ensure equitable digital access in distance higher education.

The practicum material is based on the laboratory manual for each course. Each practicum course is worth three credits and consists of nine modules containing two to three practicum activities. For example, the practicum topic for the Physics 2 course in one module, Module 2, Geometry Optics, is shown in Table 1.

Table 1. Geometry Optical Practicum

No	Activity Title	Experiment Title	Description
1	Formation of Images in Mirrors	Plane Mirror	Choose one Practicum Activity (PA) Example. PA 2 Formation of Images in Lenses a. Convex Lens b. Concave Lens c. Combined Lens
	Concave Mirror (concave)		
	Convex Mirror (convex)		
2	Formation of Images in Lenses	Convex Lens	
	Concave Lens		
	Combined Lens		
3	Refraction in Glass and Prism	Refraction in Glass	
	Refraction in Prism		

Practicum activities have the following provisions: Students choose several compulsory practicum activities representing each module. The practicum is guided by lecturers selected by the regional office with at least a Master's degree in a field relevant to the practiced course. As proof of completion of the practicum, students document their activities and report the results on the practicum worksheet, which is then uploaded to https://lms.ut.ac.id for feedback from the lecturer.

With a learning management system (LMS), students are facilitated to discuss and collaborate in finding solutions to problems related to the practicum (Akomaning, 2019; Anjum, 2020). This interactive platform allows students to interact with each other and with lecturers to explain concepts, solve problems, and deepen their understanding of the practicum (Sjølie et al., 2021; Haleem et al., 2022; Kerimbayev et al., 2023).

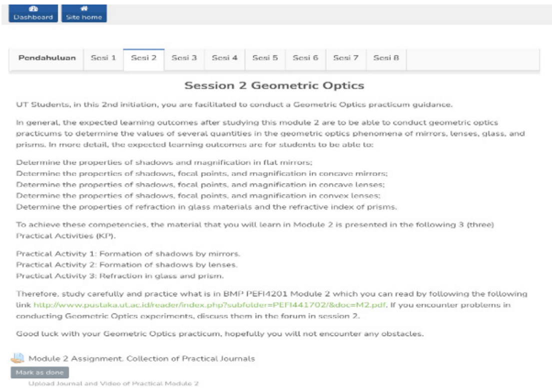

Figure 2. LMS Interface

LMS features include information about practicum materials, objectives, attendance, initiation materials, discussions, and locations to upload practicum worksheets and videos.

At the end of the practicum, students combine all final practicum worksheets into a single comprehensive report and upload them to http://praktik.ut.ac.id for correction by the practicum proofreader appointed by the region. This ensures that the final report is assessed by a qualified individual with relevant expertise in the field.

The instruments used to assess the engagement of distance higher education students in practicum Activities are (1) academic challenges, (2) learning activities, (3) interaction with lecturers, and (4) learning experiences.

Table 2. Students' Academic Challenges in Science Practicums

No	Academic Challenge Level	SA	A	SLA	D	SD
1	I often work harder to meet the standards or expectations of my tutor	36.2	44.1	5.5	8.7	5.5
2	I am challenged to put my best effort into every practicum	47.2	41.7	7.9	2.4	0.8
3	For me, preparing practicum reports is the most difficult part*	7.1	23.6	37	29.1	3.1

4	It is easy for me to learn all the modules in the assigned practicum guide/BMP	9.4	45.7	37.8	5.5	1.6
5	I can complete all practicum tasks on time	25.2	52	18.9	3.1	0.8
6	It takes me longer than I expected to complete one RPP	8.7	26.8	33.1	27.6	3.9
7	Practicum experience helps me express my ideas more clearly	31.5	55.1	12.6	0	0.8
8	Experience in preparing practicum reports helps me write more clearly	35.4	52	11.8	0	0.8
9	Practicum experience helps me think more critically and analytically	37.8	49.6	11.8	0	0.8
10	I am better able to analyze problems (quantitatively) after participating in practicum activities	15	65.4	17.3	0.8	1.6
11	Guidance in practicum implementation in my class encourages the emergence of ideas or methods in the learning process	34.6	53.5	9.4	0.8	1.6
12	I have many difficulties in completing practicum tasks due to the availability of facilities*	7.9	33.1	33.1	21.3	4.7
13	Practicum tasks help me generate ideas, experiences, or specific theories, especially when examining certain cases or situations in-depth	25.2	56.7	15.7	1.6	0.8
14	Practicum tasks help me associate and organize ideas, information, or experiences into interpretations	22	61.4	14.2	1.6	0.8
15	I feel stressed by the practicum tasks given*	5.5	17.3	15.7	42.5	18.9
16	Practicum implementation and reporting tasks help me apply theories or concepts to practical problems, including new situations	29.1	56.7	12.6	1.6	0

*Note: Items marked with an asterisk indicate negative statements.
Explanation: SA = Strongly Agree; A = Agree; SLA = Slightly Agree; D = Disagree; SD = Strongly Disagree

Table 2 presents the survey results on student perceptions of various aspects of practicum activities. The findings showed that most respondents (67.7%) agreed or partially agreed that writing a practicum report was the most challenging aspect of their job. Nevertheless, more than half of the respondents (55.1%) indicated they found learning all the modules in their assigned practical guide easy. In addition, 77.2% of respondents agreed or strongly agreed that they could complete all practicum assignments on time.

In addition, 88.1% of respondents agreed or strongly agreed that practicum guidelines in their classrooms encourage the emergence of new ideas, methods, or processes in the learning process. However, most respondents (41.0%) agreed or strongly agreed that they experienced significant difficulties completing practicum assignments due to limited resource availability.

These findings highlight the need for further investigation related to activities that contribute to the challenges faced by students in completing practicum assignments and writing reports (Barrot et al., 2021). This aligns with Kandel and Kandel (2023), who emphasized that writing skills in science education require clarity and the ability to synthesize data, theory, and reflection. Structured academic support, such as guided writing modules or example-based classes, should be considered to address this gap.

Additionally, it is important to explore strategies to improve access to resources and facilities to support an effective practicum experience (Ulvik et al., 2018).

Table 3. Students' Collaborative Learning in Science Practicums

Active/Collaborative Learning	SA	A	SLA	D	SD
I often work in groups with other students in the practicum guidance class I attend	26	52	12.6	6.3	3.1
I often study together and share knowledge with other students	26.8	52	12.6	4.7	3.9
I often consult/discuss with the tutor/lecturer	39.4	48	3.9	4.7	3.9
I often visit digital learning resources (GPO UT-TV, Virtual Reading Room, Web supplements, etc.) for additional reading materials related to practicum tasks and report preparation	22	55.1	17.3	3.1	2.4
Practicum experience helps me work more effectively with others	29.9	59.8	9.4	0.8	0

Explanation: SA = Strongly Agree; A = Agree; SLA = Slightly Agree; D = Disagree; SD = Strongly Disagree

Based on Table 3, it can be concluded that most respondents (89.8%) agree or strongly agree that the practicum experience helps them work more effectively with others. This shows that practicum activities are important in developing students' collaborative and communication skills (Firmansyah et al., 2024).

In addition, a high percentage of respondents (87.4%) indicated that they often consult and discuss with tutors/lecturers. This highlights the importance of regular communication and feedback to increase student understanding and engagement in the Practicum (Gan et al., 2021).

Furthermore, most respondents (78.7%) reported that they often study together and share knowledge with other students. These findings affirm the value of collaborative learning and peer support in promoting deeper understanding and knowledge acquisition (Firmansyah et al., 2022a, 2024; Zamiri & Esmaeili, 2024).

Overall, the data presented in Table 2 provides strong evidence that the Practicum experience contributes significantly to developing students' collaborative and communication skills (Hadiwangsa et al., 2024), and their ability to communicate effectively with tutors/lecturers and peers.

This confirms the application of Vygotsky's Zone of Proximal Development, where collaborative learning environments support cognitive development. Strategies like Reciprocal Peer Tutoring (Bailey et al., 2018) should be formalized within practicum structures to leverage this peer-based engagement.

Table 4. Students' Interaction with Lecturer in Science Practicums

No	Student and Lecturer Interaction	SA	A	SLA	D	SD
1	I often discuss ideas from readings or learning materials with my tutor/lecturer	25.2	55.9	10.2	3.9	4.7
2	I often discuss with the tutor/lecturer about the assessment components of the practicum implementation	22.8	59.8	6.3	7.1	3.9
3	I always receive prompt feedback from the tutor/lecturer on my practicum exercises/tasks	31.5	53.5	4.7	3.9	6.3
4	I often receive guidance in conducting practicum implementation from the tutor/lecturer	40.9	44.9	5.5	4.7	3.9
5	I often receive guidance in preparing practicum reports	40.2	46.5	3.9	3.9	5.5

Explanation: SA = Strongly Agree; A = Agree; SLA = Slightly Agree; D = Disagree; SD = Strongly Disagree

Based on Table 4, most respondents (86.7%) agreed or strongly agreed that they often receive guidance in preparing practicum reports. This shows that lecturers play an important role in supporting students in developing writing skills and ensuring the quality of their reports (Kandel & Kandel, 2023).

Similarly, a high percentage of respondents (85.8%) indicated that they often receive guidance from tutors/lecturers in carrying out practicum activities. This shows that the lecturer provides continuous support and explanation to students throughout the Practicum process.

In addition, most respondents (85.0%) reported that they always get quick feedback from tutors/lecturers regarding their Practicum assignments. This highlights the importance of timely and constructive feedback to enhance student learning and improve the quality of their work.

In addition, many respondents (82.7%) indicated that they often discuss the components of the practicum assessment with tutors/lecturers. This shows that students are actively involved in understanding the criteria and expectations related to their practicum, which can contribute to improving performance and learning outcomes (Firmansyah et al., 2021).

Finally, a high % of respondents (81.1%) reported discussing ideas from readings or learning materials with their tutors/lecturers. This shows that students actively seek explanations and a deeper understanding of the concepts and principles related to their practicum.

Overall, the data in Table 4 provides strong evidence that student-lecturer interaction is important in supporting learning and students' engagement in practicum activities at distance higher education. The findings show that lecturers provide valuable guidance, feedback, and support to develop students' practical skills, knowledge, and understanding.

Table 5. Students' Learning Experiences in Science Practicums

No	Learning Experience	SA	A	SLA	D	SD
1	I often communicate regularly with other students about non-tutorial matters (possibly related to work, family, race, religion, beliefs, politics, etc.)	18.1	43.3	18.9	14.2	5.5
2	I often use online learning tools (LMS, Zoom, computers, etc.)	31.5	54.3	13.4	0.8	0
3	Practicum experience has helped me gain knowledge or skills related to work.	40.9	48	11	0	0
4	I often participate in online practicum discussions (including via email, and WhatsApp groups)	32.3	51.2	14.2	1.6	0.8
5	I often use computer technology to analyze data (involving statistics, spreadsheets, etc.)	24.4	52.8	19.7	3.1	0
6	I always create practicum video assignments and upload them to online platforms (e.g., YouTube, TikTok, etc.)	18.1	37.8	32.3	9.4	2.4
7	Practicum experience helps me learn effectively and independently	36.2	51.2	11	0.8	0.8
8	I often attend training on the use of applications related to practicum implementation (LMS pages, practice pages)	15.7	42.5	30.7	8.7	2.4

Explanation: SA = Strongly Agree; A = Agree; SLA = Slightly Agree; D = Disagree; SD = Strongly Disagree

Based on Table 5, most respondents (89.0%) agree or strongly agree that the practicum experience has helped them acquire knowledge or skills related to their future careers (Kahila et al., 2024). This shows that practicum activities are important in preparing students for work by providing hands-on experience and developing relevant skills (Adeosun et al., 2022).

Similarly, a high percentage of respondents (87.4%) indicated that the Practicum experience had helped them learn effectively and independently. This shows that Practicum activities encourage independent learning and encourage students to take control of their learning process (Lian et al., 2024).

In addition, most respondents (85.8%) reported using online learning resources, such as LMS, Zoom, and computers. This highlights the importance of technology in supporting learning and students' engagement in practicum activities.

Furthermore, many respondents (83.5%) indicated that they often participate in online discussions related to the practicum. This shows that students actively engage in collaborative learning and sharing knowledge through online platforms.

Finally, a high percentage of respondents (77.2%) reported using computer technology to analyze data, including statistical analysis and spreadsheets. This shows that students are developing important data analysis skills required in various fields of study and professional practice. Overall, the data presented in Table 5 provide strong evidence that the Practicum experience contributes significantly to students' career preparation, self-learning skills, and ability to use technology and data analysis tools. These findings show that Practicum activities effectively equip students with the knowledge, skills, and abilities necessary to succeed in their future endeavors.

Based on the additional data provided, it can be concluded that most respondents (61.4%) often communicate regularly with other students about topics unrelated to the tutorial, which may be related to work, family, race, religion, and political beliefs. This shows that students build relationships and foster community outside the academic realm.

In addition, many respondents (58.3%) indicated that they often attend training sessions on using applications related to the practicum, such as LMS and practicum pages. This shows that students actively try to improve their skills and knowledge in technology to support their learning in practicum courses (Salim et al., 2023).

In addition, most respondents (55.9%) reported that they always create video assignments for the practicum and upload them to online platforms such as YouTube and TikTok. This shows that students adopt innovative approaches to learning and utilize technology to share their work, collaborate with peers, and potentially reach a wider audience.

Overall, the additional data provides interesting insights into student social interaction, technology engagement, and creative expression in the context of Practicum activities. These findings suggest that students actively seek opportunities to connect with others, learn new skills, and explore creative ways to engage with learning materials and assignments (Ong & Quek, 2023).

Table 6. Comparison of Students' Engagement in Practicum Courses

Category	Sub- Category	(N=127)		Students' Engagement		p-value
		N	%	Mean	SD	
Gender	Female	86	68	131.53	18.68	0.170
	Male	41	32	135.63	13.97	
Age	< 30 years old	44	35	135.34	18.03	0.252
	≥ 30 years old	83	65	131.54	16.94	
Last Education	Graduates of High School or Equivalent	60	47	131.93	18.61	0.575
	Non-Graduates of High School or Equivalent	67	53	133.69	16.24	
type of device	Handphone & Tablet	62	49	130.97	19.27	0.235
	Laptop/PC	65	51	134.66	15.23	
Internet acces	Difficult and Very Difficult	16	13	126.19	19.04	0.146
	Easy and Very Easy	111	87	133.82	16.97	
Tutorial Type	Face-to-face Practicum in Laboratory/Online Tutorial/Web Tutorial	66	52	129.11	17.07	0.011*
	Face-to-face Practicum in Laboratory/Online Tutorial/Web Tutorial	61	48	136.92	16.86	
Number of Practicum	< 2 Practicum	70	55	134.64	15.93	0.208
	≥2 Practicum	57	45	130.67	18.87	
GPA	< 3.34	97	76	130.69	18.28	0.002**
	≥ 3.34	30	24	139.87	11.64	
Employment Status	Working Part Time & Freelance	50	39	128.62	19.88	0.037*
	Working Full Time	77	61	135.61	14.99	
Domicile Area	Dominantly Rural & Border	95	75	134.58	18.19	0.028*
	Dominant Urban and Overseas	32	25	127.75	13.56	

Note:* Correlation is significant at the 0,01 level (2-tailed); * Correlation is significant at the 0,05 level (2-tailed)

Based on Table 6, it can be concluded that there are significant differences in students' engagement in practicum courses in various categories, regional office locations, tutorial types, GPAs, employment status, and residential areas. These findings show that students enrolled in regional offices located on the island of Java, actively attending online classes and web classes, achieving a GPA of 3.34 or higher, working full-time, and living in areas that are mostly rural or bordering urban areas tend to show higher levels of engagement compared to their peers. The challenges that many students encounter in rural areas are greater than those encountered by students who live in urban areas, and this can significantly increase students' engagement (Lopes, 2023).

Table 6 presents data on student engagement in science practicum based on several categories, including gender, age, and education. The table identifies several important findings that influence students' engagement in science practicum in the Distance higher education program, including the type of device used, internet access, type of tutorial, number of practicums, GPA, employment status, and area of residence.

The analysis of this table highlights that multiple factors, including the type of tutorial, GPA, employment status, and area of residence, significantly influence students' engagement in science practicums at distance higher education. A more detailed examination of each aspect reveals that the Level of Academic Challenge plays a crucial role, as students with higher GPAs tend to demonstrate greater engagement. However, 67.7% of students struggle with report writing, indicating that additional academic support is needed to enhance their performance. At the same time, 77.2% of students complete their practicum assignments on time, suggesting that many students develop strategies to meet academic expectations despite these challenges. Student Activity in Practicum Courses is shaped by tutorial modes, where students participating in web-based or blended classes exhibit higher engagement than those in fully online settings. This indicates that the opportunity for synchronous interaction and structured engagement within blended formats contributes positively to students' engagement.

Additionally, 78.7% of students frequently engage in peer discussions, reinforcing the role of collaborative learning in enhancing practicum experiences. However, 41.0% of students report difficulties in completing their practicum tasks due to limited resources, emphasizing the need for improved accessibility to learning materials and digital tools. Student-lecturer interaction emerges as another key determinant, as 86.7% of students receive guidance in writing practicum reports, and 85.0% report receiving timely feedback on their assignments, significantly enhancing engagement.

Furthermore, 81.1% frequently discuss learning materials with lecturers, underlining the importance of continuous academic support. Lastly, Enriching the Educational Experience through accessible resources and interactive practicum designs significantly enhances participation, particularly among students in rural and semi-urban areas. Interestingly, students from these regions demonstrate higher engagement, possibly due to their strong motivation to overcome geographical barriers to learning. These findings underscore the necessity of a structured and well-supported practicum environment to optimize students' engagement and learning outcomes. Ensuring adequate technological infrastructure, fostering interactive practicum designs, and addressing environmental and motivational factors are essential for enhancing students' engagement and the overall effectiveness of science education in distance learning (Srisawasdi & Kroothkeaw, 2014; Ülger & Çepni, 2020; Atmojo, 2022; Bhakti et al., 2023; Setyawarno et al., 2024).

Based on the statistical analysis of 127 students using SPSS, several key factors influencing students' engagement in learning were identified. These findings can be further interpreted using the Self-Determination Theory (Deci & Ryan, 1985), where autonomy, competence, and relatedness are central to learning motivation. Students with higher GPAs and full-time employment status likely possess greater self-regulation and intrinsic drive, enhancing their engagement. Students who participated in web-based classes demonstrated a higher average engagement (M=136.92, SD=16.86) compared to those attending face-to-face laboratory or online classes (M=129.11, SD=17.07), with a statistically significant difference (p=0.011). This result highlights the importance of structured, technology-integrated learning environments in fostering students' engagement.

Additionally, employment status also had a significant impact, where full-time students exhibited higher engagement (M=135.61, SD=14.99) than those working part-time or freelancing (M=128.62, SD=19.88), with a significant difference (p=0.037). This suggests that full-time professionals may have stronger motivation and time management skills, leading to greater engagement in learning activities.

These findings underscore the necessity of a structured and well-supported practicum environment to optimize students' engagement and learning outcomes. Ensuring equitable access to digital infrastructure, fostering interactive practicum models, and addressing psychological and contextual variables are essential for delivering high-quality distance science education aligned with SDG 4.

CONCLUSION

This study examined the implementation and effectiveness of science practicum activities within distance higher education settings, focusing on students' engagement and influencing factors. The findings indicate that science practicums in distance learning are delivered through a blended model, combining asynchronous modules, synchronous classes, and technology-enhanced learning platforms. Students are guided by qualified lecturers and utilize LMS-based tools to complete and submit their practicum. Factors influencing students' engagement include experimentation, reporting, and collaborative discussions.

Students' engagement in practicum activities was generally high, especially in collaborative learning, tutor interaction, and independent knowledge acquisition. However, challenges persist, particularly in report writing and access to adequate digital infrastructure and learning resources. These obstacles influence engagement levels and highlight the need for enhanced academic and technological support.

Several key factors significantly influence students' engagement, including learning strategies, academic performance, employment status, and residential area. Students participating in online classes, achieving higher academic outcomes, and residing in rural or semi-urban regions exhibited greater engagement in practicum activities. These findings emphasize the importance of learning design, digital accessibility, and learner motivation in shaping effective practicum experiences in distance education.

Overall, this study underscores the need for inclusive, flexible, and well-supported practicum models to ensure equitable and meaningful engagement in science learning, aligning with the global vision of SDG 4: Quality Education.

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