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FAKTOR YANG MEMPENGARUHI KEGIATAN PRAKTIKUM BIOLOGI: STUDI PADA PRAKTIKUM STRUKTUR PERKEMBANGAN TUMBUHAN

FACTORS INFLUENCING BIOLOGY PRACTICAL ACTIVITIES: STUDY ON PLANT DEVELOPMENTAL STRUCTURE PRACTICUM

Dita Purwinda Anggrella[1*], Nurul Hidayah[1], Nurul Latifah[1]
[1]Biology Education Study Program, Faculty of Education, Universitas Islam Negeri Raden Mas Said Surakarta, Indonesia
*E-mail: dita.anggrella@staff.uinsaid.ac.id

Abstract. Biology practicum is an important part of learning that aims to strengthen conceptual understanding through direct experience. This study aims to identify factors that influence biology practicum activities, especially on the material of plant development structure. This study uses a quantitative method with a survey approach, involving 15 students of the Biology Education study program who have participated in the Plant Development Structure practicum. Data were collected through a closed questionnaire with a Likert scale (1-5) and structured interviews with students and lecturers to obtain more in-depth information. The analysis showed that collaboration skills had the highest average (4.53) and were the dominant factor in supporting the smooth running of the practicum. Student motivation also played a significant role (4.13), indicating high enthusiasm for participating in the practicum. Other factors, such as laboratory facilities, use of practicum tools, and time management, had the same average value (3.80), indicating that these factors were quite supportive but still needed improvement. Meanwhile, understanding practicum procedures had the lowest average (3.53) with the highest standard deviation (0.834), indicating significant variation in student understanding. The interview results revealed that limited laboratory facilities, lack of skills in using laboratory equipment, and difficulties in time management were the main obstacles to laboratory activities. Overall, this study highlights the importance of collaboration skills and motivation in supporting the effectiveness of laboratory work. In addition, improvements in understanding procedures and providing more adequate facilities and tools are needed to improve the quality of learning in biology laboratory activities.

Keywords: Biology Practicum, Practicum Factors, Plant developmental Structure

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INTRODUCTION

Practical methods have a strategic role in supporting 21st-century learning (Hofstein & Lunetta, 2004) for prospective biology teachers because they provide a deep understanding of biological concepts and train pedagogical skills relevant to the needs of the times (Subramaniam, 2014). In practical activities, prospective biology teacher students develop critical thinking skills (Sudargo & Asiah, 2010), analytical, and problem-solving through direct exploration of natural phenomena (Agustina & Saputra, 2016), such as plant structure and development. In addition, the laboratory practicum method encourages prospective teachers to understand how to design, implement, and evaluate interactive and student-centered laboratory-based learning activities (Agustina & Saputra, 2016; Gurvitch & Metzler, 2009; Mugaloglu & Sarıbas, 2010), following the principles of 21st-century learning (Susilo et al., 2020). Thus, the practical method not only supports mastery of biological material (Ozgelen et al., 2013) but also prepares students to become competent, innovative educators who can inspire the generation of 21st-century learners (Brown et al., 2013).

One of the materials prospective biology teachers must master is the structure of plant development. This material is very important because it is the basis for understanding various physiological and ecological processes in plants for prospective biology teachers. Practical activities in the laboratory can help understand concepts practically and theoretically, thus supporting prospective teachers in developing their pedagogical abilities (Hofstein & Lunetta, 2004; Lunetta et al., 2013; Millar, 2004) and design interactive laboratory-based learning activities (Sachyani et al., 2024). Through the practical method, prospective teachers can integrate concepts with natural phenomena around them to make learning more contextual and relevant for students (Suryawati & Osman, 2018). Integrating concepts with context also supports developing critical, analytical, and innovative thinking skills that align with the demands of 21st-century learning (Anggrella, 2024).

However, during practical activities in the laboratory, various problems can arise which can affect the course of the experiment and the results obtained, such as a lack of understanding of practical procedures and limited tools and materials (Aliyah & Puspitasari, 2022; Anggrella et al., 2021; Wahyudiati, 2016), lack of skills in laboratory techniques. As a result, students have difficulty understanding the basic theoretical concepts of experiments because the results do not match expectations or are difficult to analyze correctly (Wahyudiati, 2016). Research by Saputra et al. (2023) shows that problems in the laboratory can trigger scientific reasoning and learning outcomes (Simbolon & Sahyar, 2015).

Biology practicums are a key component in 21st-century learning oriented towards mastering biological concepts and developing the pedagogical skills of prospective teachers (Maknun et al., 2012). Previous research shows that practicums play an important role in training critical thinking skills (Royani et al., 2018), creative thinking skills (Khanifah & Saefan, 2016), problem-solving, and analysis, which are in line with the needs of modern education (Gunawan et al., 2020). However, practical activities often experience obstacles, such as limited laboratory facilities and learning resources (Anggrella et al., 2021), lack of technological support, inadequate implementation time, and laboratory staff readiness in preparing for practicals (Agustina et al., 2021). In addition, prospective teacher students often face challenges in understanding practical procedures in depth, especially if the guide is not presented systematically or if the lecturer's guidance is less than optimal (Anggrella et al., 2021).

This study is important because few studies specifically explore the factors that influence the success of biology practicum activities on the material of plant development structure, especially in the context of prospective biology teachers. By identifying and analyzing these factors, the results of this study are expected to provide strategic recommendations to improve the quality of practicum implementation, thus supporting the achievement of superior and innovative prospective teacher competencies following the demands of the 21st century.

METHOD

Research Design

This research uses a mixed-method approach with a descriptive research type. This approach aims to identify factors that influence biology practicum activities, especially on the material of plant development structure, through data collection from research subjects.

Subjects of study

The research subjects were 15 Biology Education study program students participating in the plant development structure practicum. For ethical reasons, students may not participate in research if they do not wish to.

Research Instruments

The research instrument is a closed questionnaire with a Likert scale (1-5) to collect data on factors influencing practicum activities, such as laboratory facilities, understanding of practicum procedures, motivation, use of practicum tools, time management, collaboration skills, and practicum preparation. This instrument is equipped with several open questions through structured interviews conducted with the lecturer and several students to obtain more in-depth data on obstacles and factors contributing to practicums' sustainability. Before use, the instrument has been validated by experts and tested for readability.

Data Analysis Techniques

Data were analyzed using quantitative descriptive techniques and content analysis. The questionnaire results were analyzed using descriptive statistics to identify the dominant factors influencing the practicum activities. Data from interviews and observations were analyzed using content analysis with step data reduction, data presentation, and conclusion-drawing techniques to provide a more comprehensive picture of the factors influencing the practicum (Cohen et al., 2018).

RESULTS

This study surveys biology education students who have taken a plant development structure practicum. The results of the survey and interviews show factors that influence practicum activities, namely laboratory facilities, understanding of practicum procedures, motivation, use of practicum tools, time management, collaboration skills, and practicum preparation (Table 1).

Table 1. Results of Descriptive Statistical Analysis

	Laboratory Facilities	Understanding Practical Procedures	Motivation	Use of Practical Tools	Time Management	Collaboration Skills	Practical Preparation
Mean	3.80	3.53	4.13	3.80	3.80	4.53	3.67
N	15	15	15	15	15	15	15
Std. Deviation	0.561	0.834	0.516	0.414	5.361	0.516	0.617
Media	4.00	3.00	4.00	4.00	4.00	5.00	4.00
Variance	0.314	0.695	0.267	0.171	0.314	0.267	0.381

Based on the analysis results in Table 1, several factors influence the success of practical activities. Collaboration skills have the highest average (4.53) and a median of 5.00, indicating that the ability to work together is a dominant factor in supporting the smooth running of the practicum. Motivation also plays an important role, with an average of 4.13, indicating that participants have a high drive to participate in this activity. Laboratory facilities, use of practicum tools, and time management have the same average (3.80), indicating that these factors support the practicum, although they can still be improved. Meanwhile, understanding practicum procedures has the lowest average (3.53) with the highest standard deviation (0.834), indicating that participants' understanding of the procedures is still diverse and can be challenging in practicum activities. Preparation for practicum has an average value of 3.67, indicating that participants' readiness is quite good but can still be improved to support the effectiveness of practicum implementation. Motivation and collaboration skills are the most supportive aspects while understanding practicum procedures needs more attention to improve the quality of learning in practicum activities. The results of these descriptive statistics are supported by the results of interviews with students as follows:

Laboratory Facilities

Figure 1 shows the opinions of prospective teacher students about the available laboratory facilities.

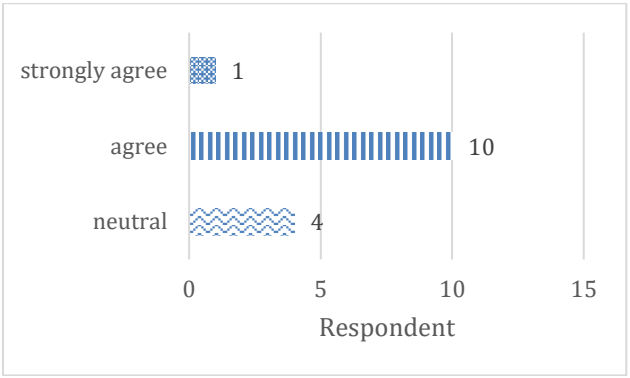

Figure 1. Laboratory Facilities

Based on Figure 1. Most respondents (10 out of 15) felt that the laboratory facilities were inadequate to support the practicum. This result indicates that laboratory facilities still have deficiencies. The results of interviews with lecturers and students support this. In addition, students stated the reasons for the difficulties in terms of laboratory facilities as follows:

> "The limited number of microscopes meant we had to take turns in large groups. As a result, the time for observation was too short, and we did not have enough time to understand the details of plant tissue." (Respondent 2)

This statement is reinforced by the lecturer in charge of the course, who stated that laboratory facilities play an important role in practical activities.

> "The current laboratory facilities are sufficient for basic practical needs, but for more complex practicals, such as making permanent preparations or observing plant tissues in detail, we still lack tools such as microtomes and special tissue dyes. In addition, the number of microscopes is often insufficient for all students, so they have to share in large groups, which limits observation time." (Respondent 1)

Practical procedures

The survey results show that the practical procedures influence students in the practical activities, as shown in Figure 2.

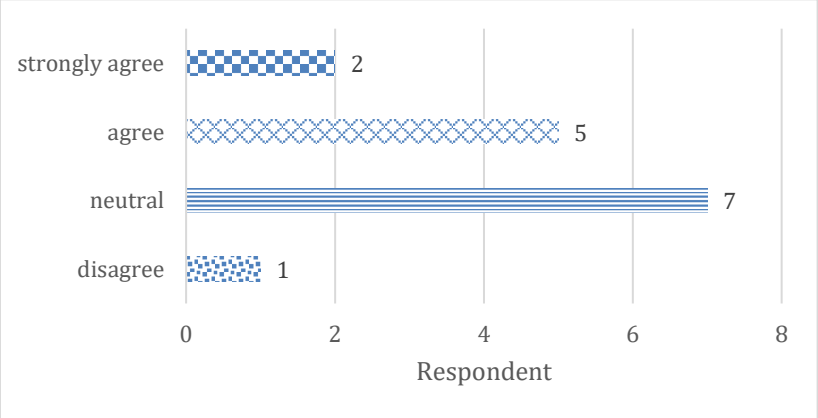

Figure 2. Understanding the practical procedures

Figure 2 shows five students who found it difficult to understand the practicum procedure, two very difficult, and seven neutral. The results of this survey are proven by the results of the interview with the head of the practicum group, stating that:

> "Many friends feel that the procedures are too complicated to understand quickly, especially if they have never tried them. Some procedures, like making tissue slices for microscopy, require additional practice. If there is a simulation session before the practicum, it might be more helpful for friends to understand the procedures." (Respondent 4)

In addition, the lecturer stated

> "Lack of understanding of the procedure is often the main obstacle. Some students do not read or study the lab guide first, so they are confused during the implementation. This condition makes the lab time less effective because most of the time is spent re-explaining the procedure." (Respondent 1)

Student motivation

The survey results show that motivation is one of the internal factors that influence biology practicum activities; 11 students stated that they agreed, and three students stated that it greatly influences, as shown in Figure 3.

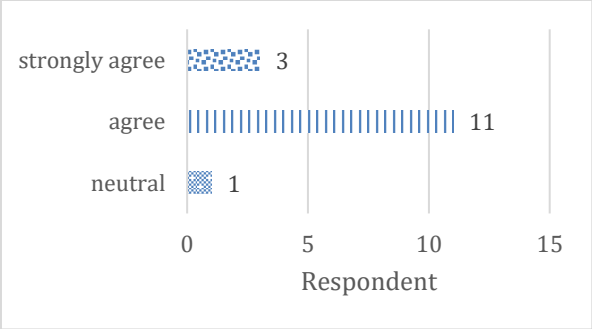

Figure 3. Student motivation

In addition to the survey results in Figure 3, which are supported by interview results, it also shows that students and lecturers in charge of the course agree that motivation influences biology practical activities.

> "I feel more motivated when I get a clear explanation from the lecturer or assistant about what to do and the steps. However, sometimes, my enthusiasm decreases if the tools or materials available are inadequate. In addition, if the results of my practicum are not as expected, I often feel less confident to try again." (Respondent 3)

In addition, it is supported by the statement of the lecturer in charge of the course.

> "In general, students' motivations are quite diverse. Some are enthusiastic, especially students with a good theoretical basis. However, some seem less motivated because they feel this practicum is too difficult, especially in making tissue preparations and detailed observations using a microscope. One of the challenges for us is how to make students better understand the relevance of this practicum to real life so that they feel more enthusiastic about this activity." (Respondent 1)

Skills in Using Practical Tools

The survey results showed that 12 students felt less skilled in using practical tools, which affected the practical process, as shown in Figure 4.

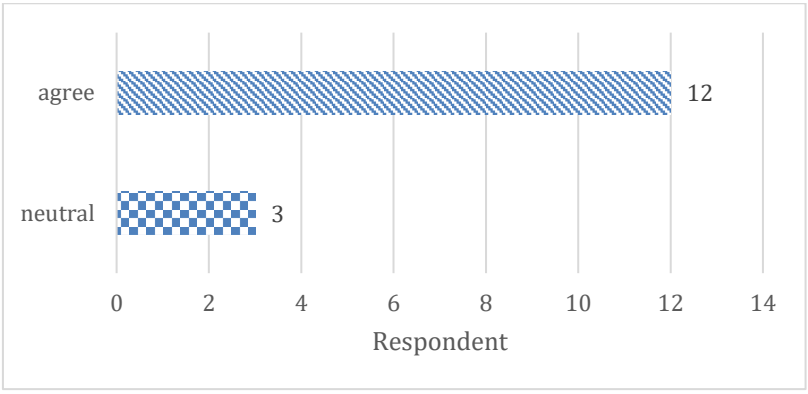

Figure 4. Use of practical tools

The survey results in Figure 4 show that students still find it difficult to apply practical tools. These results are supported by interviews with students and lecturers teaching the course.

> "The use of unfamiliar laboratory tools is an obstacle. Sometimes, it is difficult to focus clearly, especially if the observed object is very small. In addition, tools such as microtomes are also difficult to use because they require special techniques that I have never learned before." (Respondent 5)

This statement is supported by the opinion of the lecturer in charge of the course as follows:

> "New students are sometimes less skilled in using microscopes, microtomes, or measuring pipettes. One reason is that they rarely get the chance to practice beforehand. Using these tools requires repeated practice to get used to it." (Respondent 1)

Time management

Time management is also one factor influencing students' practical activities. The survey results show that 10 students feel they cannot manage their time, which affects the practical process. 1 student stated that they strongly agree, and three students stated that they are neutral, as shown in Figure 5.

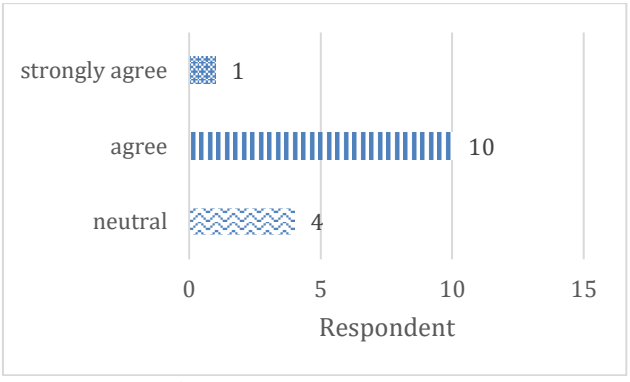

Figure 5. Time management

Based on the questionnaire results in Figure 5, which state difficulties in managing time, supported by the following interview results:

"There are some procedures that do not run smoothly, such as waiting for your turn to use certain tools. This makes me lose much time." (Respondent 5)

"Efficiency problems often arise due to lack of coordination, such as when the distribution of tools or materials is slow." (Respondent 1)

Collaboration skills

Collaboration skills also influence the smooth running of practical activities; 6 students feel less skilled in collaboration in teams or practical groups, and nine students feel neutral, as shown in Figure 6.

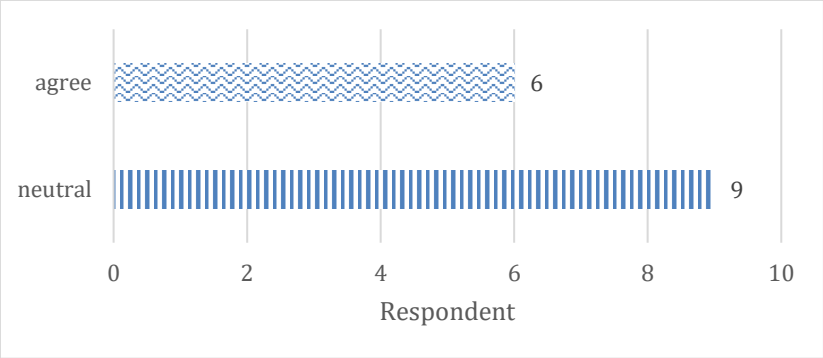

Figure 6. Collaboration skills

The survey results in Figure 6 are supported by the results of interviews with students and lecturers teaching the course as follows:

"I find it difficult to work in a team when there is a division of tasks, especially when I have to be responsible for tools that I rarely use. Sometimes, I also feel confused about how to record the results of observations correctly. This causes the results I get to be less than optimal." (Respondent 5)

"Students often appear to be less skilled in operating laboratory equipment or following procedures that have been explained. This is due to the lack of technical preparation before implementing the practicum. In addition, the lack of individual practice outside of practicum time makes students less familiar with laboratory equipment." (Respondent 1)

Preparation for practical work

The survey results in Figure 7 show that eight students felt that they were not well prepared for the practicum, six students felt neutral that practicum preparation affected practicum activities, and one strongly agreed that practicum preparation affected biology practicum activities.

The survey results in Figure 7 are supported by interviews with students as follows:

"I found it difficult to follow the practicum because I did not fully understand the material given before the activity took place. Sometimes, I read the practicum guide only briefly without really studying the steps, so I was confused when it was implemented." (Respondent 9)

"Time to study the material was often limited due to other assignments, so I came to the lab unprepared. As a result, I did not know what to do and often relied on friends to get me started on the work." (Respondent 4)

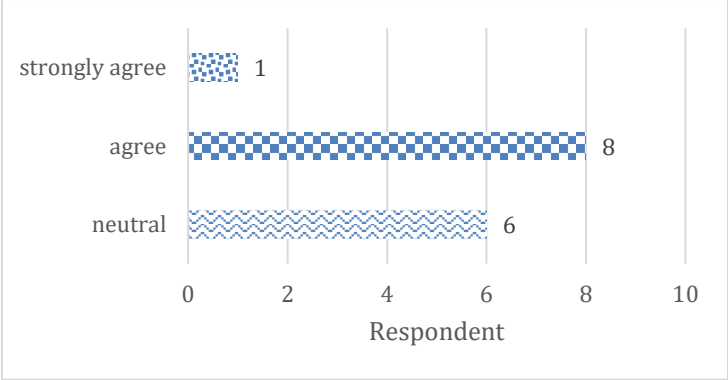

Figure 7. Preparation for the Practicum

In addition, the results of interviews with the biology practicum lecturers stated the following:

> "Lack of student preparation is usually seen in how they handle laboratory equipment and procedures. Minimal preparation makes students unable to follow the flow of the practicum properly, so the results obtained are less than optimal." (Respondent 1)

DISCUSSION

Based on the survey results, the factors that influence the practicum activities of plant development structure biology show that collaboration skills (4.53) and motivation (4.13) are the main factors that support the smooth running of the practicum while understanding the procedure has the lowest average (3.53), indicating variations in understanding among students. Other factors influencing practicum activities are laboratory facilities, use of practicum tools, time management (3.80), and practicum preparation (3.67).

Collaboration skills

The study results indicate that collaboration skills are a dominant factor in the success of practical activities. This result aligns with previous studies that state that laboratory teamwork can improve work efficiency and a deeper understanding of concepts (W. Johnson & T. Johnson, 2019). Students with good collaboration skills tend to find it easier to share tasks, exchange information, and help each other complete practicum procedures, thereby increasing learning effectiveness. Six students admitted they were less skilled in working together in teams or practicum groups, while nine others expressed a neutral attitude. Difficulties in collaboration were seen in the division of tasks, especially when students had to be responsible for rarely used tools or recording observation results correctly. In addition, the lack of skills in operating laboratory equipment and following the procedures explained were also obstacles. This condition was due to the lack of technical preparation before the practicum and individual practice outside the practicum session. According to research by Malik and Ubaidillah (2021), there were differences in the collaboration skills of female and male students in experimental activities. Shi et al. (2015) argued that female students speak more in a minority group, while male students are more active in speaking when working alone. In addition, Shi et al. (2015) also stated that female students tend to take on supporting roles in collaboration during experiments, while male students are more dominant in the main role. Therefore, efforts are needed to improve students' collaboration and technical skills, such as through additional training or independent practice sessions, so that practical activities can run more effectively and the results are optimal.

Student Motivation

Motivation is also an important factor, with a high average score. Strong motivation encourages students to be more active in understanding the practicum procedures, using laboratory equipment more optimally, and managing time well. This finding is supported by Deci & Ryan's (2000) research on auto-determination theory, which explains that intrinsic motivation plays a key role in increasing participation and involvement in the learning process. Therefore, efforts to maintain and improve student motivation, such as through an interesting and relevant learning approach, are very important. The interview results showed that various internal and external factors influenced student motivation to participate in the plant development structure practicum. Internal factors were influenced by understanding and self-confidence. Resource person one stated that students with a strong understanding of theory showed higher enthusiasm in the practicum. This discussion shows that initial academic ability is an important factor supporting motivation. Wibrowski et al. (2016) support this statement that there is a relationship between initial ability and motivation . Understanding the basic concepts makes it easier for students to follow procedures and achieve the expected results.

On the other hand, Resource Person 3 revealed that the practicum results that are not as expected often reduce motivation and self-confidence. Meanwhile, external factors are influenced by support and facilities. Resource Person 3 emphasized the importance of clear explanations from lecturers or practicum assistants. Structured explanations help students feel more confident and focused on practicum tasks. Resource Person 3 also showed that student motivation can decrease if the tools or materials available are inadequate. This condition causes frustration because students cannot carry out practicum tasks optimally, affecting their enthusiasm for learning. This result aligns with Maknun's (2015) opinion that laboratory facilities and infrastructure affect the success of practicum activities. Student motivation in the plant development structure practicum is influenced by theoretical understanding, availability of facilities, support from lecturers/assistants, and the relevance of activities to real life. This result is in line with the research of Vonnisye & Tandirerung (2018) that the factors that influence learning motivation in practicum are lecturer factors, peers, praise/punishment, practicum activities, lecture materials, student understanding, lecture room conditions, and laboratory facilities.

Laboratory Facilities

On the other hand, laboratory facilities, use of laboratory equipment, and time management received a fairly good average score (3.80). The availability and quality of laboratory facilities can affect students' learning experience. According to Hofstein & Lunetta (2024), adequate laboratories can improve the overall laboratory experience and support a better understanding of concepts. Limited laboratory facilities are a significant obstacle in supporting practical activities, especially in meeting complex practical needs. In addition, the obligation for students to bring practical materials can create an additional burden that affects their learning motivation. Therefore, it is necessary to improve the quality and quantity of laboratory facilities and better logistical support to ease the burden on students so practicals can run effectively and support optimal learning outcomes. Based on research by Aliyah & Puspitasari (2022), biology laboratory facilities can affect student learning outcomes regarding conceptual understanding and practical skills. Adequate facilities not only increase the efficiency of the practicum process but also provide opportunities for students to develop analytical and problem-solving skills through direct experience. On the other hand, limited facilities can hinder in-depth exploration of the material, so the learning outcomes achieved are less than optimal. Therefore, investment in the procurement of laboratory equipment and materials, such as microscopes, microtomes, and tissue dyes, is a priority to support improving the quality of biology learning, especially in the course of plant development structure.

Practical Tools Usage Skills

The study results showed that the use of laboratory equipment is an important factor in supporting the effectiveness of laboratory work, and most participants have similar understanding and experience in this aspect. Although students can use it, training or assistance is still needed to ensure optimal use of the equipment. Lack of skills in laboratory equipment impacts objects not focused on the microscope, or imperfect preparations can reduce the accuracy of data and observations. Laboratory time that should be used for observation is wasted because students have to try to use the equipment correctly repeatedly. Continuous difficulties can reduce students' self-confidence and motivation to try again (Surgandini, 2018). In addition, the results of interviews with respondents showed challenges in implementing biology practicums, especially related to technical skills, teamwork, and mastery of laboratory equipment. Lack of technical skills and mastery of equipment resulted in less than optimal practicum results, as expressed by Respondent 5. In addition, ineffective teamwork and limited technical skills of students can affect the quality of data obtained and the accuracy of the analysis of the results. This problem shows the importance of improving students' technical skills by providing technical training sessions before the practicum begins, including simulations of the use of equipment and explanations of data recording steps, providing access for students to practice using laboratory equipment outside of official practicum hours, encouraging discussion and coordination within the team to ensure fair and efficient division of tasks, and providing clear role guidance to each member. This result aligns with previous research that training can provide experience using biology practicum equipment (Mertha et al., 2024).

Time management

The analysis results show that the time management factor has an average (mean) of 3.80 from 15 respondents, which indicates that this factor plays a significant role in the smooth running of the practicum activities. The high standard deviation value, which is 5.361, indicates that there is quite a large variation in the respondents' perceptions regarding the effectiveness of time management in practicums. Time management plays an important role in practicum activities. However, a better strategy is still needed to optimize time so that all stages of the practicum can run more efficiently and evenly for all participants. Based on the survey, ten students admitted to having difficulty managing time, which impacted the smooth running of the practicum.

Meanwhile, one student strongly agreed that time management affected the practicum process, and three other students were neutral. Some of the obstacles identified included delays in waiting for their turn to use the tools and lack of coordination in distributing tools and materials, which resulted in inefficiency in implementing the practicum. This study's results align with Maknun's research (2015), which states that time management is one factor that influences practicum activities. This research suggests that improvements in time management, such as more effective scheduling and better coordination, are needed to improve the efficiency and quality of students' practicum experiences.

Practical Preparation

Preparation for the practicum is also an influential factor, with an average value of 3.67. Although it shows a fairly good level of readiness, there is still a possibility that some students do not prepare enough before the practicum, for example, when reading the guide or understanding the purpose of the practicum. Research by Abrahams & Millar (2008) confirms that good preparation before the practicum is crucial to increase learning effectiveness, reduce errors in executing procedures, and increase students' confidence in conducting experiments. Based on the interview results, it was identified that one of the main problems in biology practicum activities is the lack of understanding and preparation of students for the practicum

material. This problem is influenced by several factors, as explained by the respondents, namely lack of understanding of the material, limited time for preparation, how to handle equipment and carry out practicum procedures, and students' mastery of laboratory skills. This result is in line with Maknun's research (2015), which found that inhibiting factors for practicum are time and limited equipment. Lack of preparation and understanding of the material before the practicum is a significant challenge that hinders the effectiveness of laboratory learning (Dwi et al., 2024). Efforts to overcome these problems include providing special time for learning the material before the practicum, using interactive teaching methods such as virtual simulations, emphasizing the importance of reading the practicum guide, and understanding the steps that must be taken. Meanwhile, based on research by Dwi et al. (2024) shows that it is necessary to have more mature practicum planning and collaboration between all parties involved to overcome the problem of constraints on practicum procedures. In contrast, according to Rahayu & Eliyarti (2019), this is due to a lack of motivation towards carrying out practical work.

Understanding Practical Procedures

Meanwhile, the understanding of the practicum procedure had the lowest average (3.53) with the highest standard deviation (0.834), which indicated that participants' understanding of the procedure still varied. This result could be caused by a lack of preparation before the practicum or differences in practicum experience among students. Research by Hofstein & Lunetta (2004) showed that a lack of understanding of the procedure can cause errors in implementing practicums and hinder the achievement of learning objectives. Therefore, there needs to be a more effective strategy for providing students with a better understanding, such as through more comprehensive practicum guides, initial demonstrations before practicums, or interactive learning media. Based on the results of interviews and surveys, it show that understanding the procedures for practicums on plant development structures is considered interesting by students. However, understanding them has several challenges, especially on topics involving tissue observation using a microscope. This result shows a need for a more in-depth initial explanation to help students clearly understand the objectives and procedures of observation. In addition, more detailed practicum guides are considered important so students can focus more on what to observe and how to do it. By improving the presentation of materials and guides, the quality of learning through practicums can be improved so that students understand the concepts being studied becomes optimal. This is supported by research by Adlini et al. (2023), which shows that materials equipped with detailed technical instructions and work procedures can make it easier for students to carry out practicums and improve 21st-century skills (Nurfathurrahmah et al., 2024).

Students also felt that some procedures, such as tissue sections for microscopy, required additional practice due to their difficulty level. The class leader highlighted that simulations before the practicum could be an effective step to provide initial experience for students to prepare them for the actual procedure better. The lecturer also revealed that students' understanding of the procedure was often the main obstacle. The unpreparedness of students who did not read or study the guide first confused the practicum. This result impacted time effectiveness because the lecturer had to repeat the explanation during the practicum session. The practicum activities would be less than optimal if students did not understand the work procedures in the laboratory (Putrisari & Subiantoro, 2022). This condition would impact the practicum results and students' essential lab skills (Maknun et al., 2012). Lack of procedural understanding can also hinder the achievement of learning objectives and reduce practical skills (Maknun et al., 2012), which should be obtained during the practicum (Maknun, 2015).

Overall, the results of this study confirm that collaboration skills and motivation are the main factors that support the success of practicums. In contrast, understanding procedures and preparation for practicums need more attention to improve the effectiveness of laboratory

activities. Therefore, a learning strategy is needed that focuses on improving laboratory facilities and emphasizes strengthening students' understanding of procedures and readiness to face practicums. The results of this study indicate that improving the quality of laboratory facilities, providing simulations before practicums, and training in the use of tools and time management skills can improve the effectiveness of biology practicum activities. In addition, a more interactive approach to learning and better initial provision can help students be better prepared to participate in practicums.

CONCLUSION

Based on the research results, several main factors influence the practicum activities' success. Collaboration skills are the most dominant factor, with the highest average, indicating that the ability to work together greatly supports the smooth running of the practicum. Motivation also plays an important role in encouraging active participation. Factors such as laboratory facilities, use of practicum tools, and time management have significant roles, although they can still be improved. However, the understanding of practicum procedures shows the lowest value with quite high variation, indicating differences in the level of understanding among participants, which can be a challenge in implementing the practicum. In addition, practicum preparation also needs to be improved in order to support the effectiveness of the activity as a whole. Therefore, to improve the quality of learning in practicum activities, a better strategy is needed to clarify practicum procedures and increase participant readiness before carrying out the practicum. The results of this study can be a reference for institutions, lecturers, and students in identifying and fixing existing obstacles so that practicums can run more optimally and support the expected learning achievements.

REFERENCES

Abrahams, I., & Millar, R. (2008). Does Practical Work Really Work? A study of the effectiveness of practical work as a teaching and learning method in school science. *International Journal of Science Education*, 30(14), 1945–1969. https://doi.org/10.1080/09500690701749305

Adlini, M. N., Arya, M., Nasution, M. W., Nurshabirah, Nandhini, S., & Agustina, T. (2023). Analisis Kebutuhan Mahasiswa Tadris Biologi Universitas Islam Negeri Sumatera Utara Medan Terhadap Modul Praktikum. *Jurnal Riset Pendidikan Dan Pengajaran*, 2(2), 150–155. https://doi.org/10.55047/jrpp.v2i2.458

Agustina, P., & Saputra, A. (2016). Analisis Keterampilan Proses Sains (Kps) Dasar Mahasiswa Calon Guru Biologi Pada Matakuliah Anatomi Tumbuhan (Studi Kasus Mahasiswa Prodi P. Biologi Fkip Ums Tahun Ajaran 2015/2016). *Prosiding SNPS (Seminar Nasional Pendidikan Sains)*, 3(0), 71–78. https://publikasiilmiah.ums.ac.id/handle/11617/9397?show=full

Agustina, P., Saputra, A., Khotimah, E. V. A. K., Agustina, T. W., Amida, N., Supriyanti, F. M. T., Anjarwati, S., Wardany, K., Khoirudin, M., Novitasari, C., Ary, P., Wati, P., Pujiastutik, H., Astika, E., Anggraeni, S., Supriatno, B., Bago, A. S., Dahlan, U. A., Jendral, J., … Anggraeni, S. (2021). Analisis Kendala Praktikum Biologi di Sekolah Menengah Atas (Obstacles Analysis of Biology Laboratory Practice of High School). *Jurnal Education and Development*, 6(2). https://doi.org/10.22437/bio.v7i2.12777

Aliyah, G. R., & Puspitasari, E. D. (2022). Biology Laboratory: Facilities, Infrastructure and Utilization in Biology Learning. *Journal on Biology and Instruction*, 2(2), 77–88. https://doi.org/10.26555/joubins.v2i2.6956

Anggrella, D. P., Nurjanah, L. & Sudrajat, A.K. (2024). Development of Critical Thinking and Collaboration Skills in Science Learning at Elementary School: A Case Study. *Al*

Ibtida: Jurnal Pendidikan Guru MI, 11, 172–186. http://dx.doi.org/10.24235/al.ibtida.snj.v11i2.14469

Anggrella, D. P., Rahmasiwi, A., & Purbowati, D. (2021). Eksplorasi kegiatan praktikum ipa pgmi selama pandemi covid-19. *SAP (Susunan Artikel Pendidikan)*, 6(1), 76–83. https://doi.org/10.30998/sap.v6i1.9612

Brown, P., Friedrichsen, P., & Abell, S. (2013). The Development of Prospective Secondary Biology Teachers PCK. *Journal of Science Teacher Education*, 24(1), 133–155. https://doi.org/10.1007/s10972-012-9312-1

Cohen, L., Manion, L., & Morrison, K. (2018). Research Methods in Education (8th ed.). Routledge. https://doi.org/10.4324/9781315456539

Deci, E. L., & Ryan, R. M. (2000). The "What" and "Why" of Goal Pursuits: Human Needs and the Self-Determination of Behavior. *Psychological Inquiry*, 11(4), 227–268. https://doi.org/10.1207/S15327965PLI1104_01

Dwi, F., L., S., Muftih, I., Nurhadi, M., & Afdal, M. (2024). Peningkatan Keterampilan Siswa dalam Pemahaman Materi Kimia Melalui Pelatihan Praktikum di SMAN 3 Luwu Timur. *MAHABAKTI: Jurnal Pengabdian Masyarakat dan Mahasiswa Bakti*, 1(1), 8–16. https://doi.org/10.35580/mahabakti.v1i1.1550

Gunawan, G., Harjono, A., Nisyah, M., Kusdiastuti, M., & Herayanti, L. (2020). Improving students' problem-solving skills using inquiry learning model combined with advance organizer. *International Journal of Instruction*, 13(4), 427–442. https://doi.org/10.29333/iji.2020.13427a

Gurvitch, R., & Metzler, M. W. (2009). The effects of laboratory-based and field-based practicum experience on pre-service teachers' self-efficacy. *Teaching and Teacher Education*, 25(3), 437–443. https://doi.org/https://doi.org/10.1016/j.tate.2008.08.006

Hofstein, A., & Lunetta, V. N. (2004). The laboratory in science education: Foundations for the twenty-first century. *Science Education*, 88(1), 28–54. https://doi.org/10.1002/sce.10106

Khanifah, K., & Saefan, J. (2016). Pengaruh Model Project Based Learning melalui Metode Praktikum terhadap Kemampuan Berpikir Kreatif pada Materi Getaran Harmonis Siswa Kelas XI MIA SMA Negeri 1 Comal. *Jurnal Penelitian Pembelajaran Fisika*, 7(1), 49–55. https://doi.org/10.26877/jp2f.v7i1.1141

Lunetta, V. N., Hofstein, A., & Clough, M. P. (2013). Learning and Teaching in the School Science Laboratory: An Analysis of Research, Theory, and Practice. *Handbook of Research on Science Education*, January 2007, 393–441. https://doi.org/10.4324/9780203824696-18

Maknun, D. (2015). Evaluasi Keterampilan Laboratorium Mahasiswa Menggunakan Asesmen Kegiatan Laboratorium Berbasis Kompetensi Pada Pelaksanaan Praktek Pengalaman Lapangan (PPL). *Jurnal Tarbiyah*, 22(1), 21–47. http://dx.doi.org/10.30829/tar.v22i1.4

Maknun, D., Surtikanti, R. R. H. K., Munandar, A., & Subahar, T. S. (2012). Keterampilan Esensial dan Kompetensi Motorik Laboratorium Mahasiswa Calon Guru Biologi dalam Kegiatan Praktikum Ekologi. *Jurnal Pendidikan IPA Indonesia*, 1(2), 141–148. https://doi.org/10.15294/jpii.v1i2.2131

Malik, A., & Ubaidillah, M. (2021). Multiple Skill Laboratory Activities: How To Improve Students' Scientific Communication and Collaboration Skills. *Jurnal Pendidikan IPA Indonesia*, 10(4), 585–595. https://doi.org/10.15294/jpii.v10i4.31442

Mertha, I. G., Merta, I. W., Bahri, S., Ilhamdi, M. L., & Bachtiar, I. (2024). Mikroteknik Pembuatan Preparat Kromosom Politen Drosophila sp. Pada Guru-Guru Biologi di Lombok Tengah. *Jurnal Pengabdian Magister Pendidikan IPA*, 7(4), 1817–1821. https://doi.org/10.29303/jpmpi.v7i4.10098

Millar, R. (2004) The Role of Practical Work in the Teaching and Learning of Science, High

School Science Laboratories: Role and Vision National Academy of Sciences, Washington DC. https://www.scirp.org/reference/referencespapers?referenceid=3327211

Mugaloglu, E., & Sarıbas, D. (2010). Pre-service science teachers' competence to design an inquiry based lab lesson. *Procedia - Social and Behavioral Sciences*, 2(2), 4255–4259. https://doi.org/https://doi.org/10.1016/j.sbspro.2010.03.674

Nurfathurrahmah, N., Ariyansyah, A., & Suryani, E. (2024). Pengembangan E-Panduan Praktikum Teknik Pengelolaan Laboratorium Berbasis PjBL untuk Meningkatkan Pembelajaran Abad 21. *JagoMIPA: Jurnal Pendidikan Matematika dan IPA*, 4(1), 60–69. https://doi.org/10.53299/jagomipa.v4i1.412

Ozgelen, S., Yilmaz-Tuzun, O., & Hanuscin, D. L. (2013). Exploring the Development of Preservice Science Teachers' Views on the Nature of Science in Inquiry-Based Laboratory Instruction. *Research in Science Education*, 43(4), 1551–1570. https://doi.org/10.1007/s11165-012-9321-2

Putrisari, D., & Subiantoro, A. W. (2022). PENGEMBANGAN VLAB UJI ZAT MAKANAN DENGAN MODEL DISCOVERY LEARNING UNTUK MENGEMBANGKAN KETERAMPILAN PROSES SAINS SISWA KELAS XI SMA. *Jurnal Edukasi Biologi*, 8(1), 69–79. http://dx.doi.org/10.21831/edubio.v8i2.18147

Rahayu, C., & Eliyarti, E. (2019). Deskripsi Efektivitas Kegiatan Praktikum Dalam Perkuliahan Kimia Dasar Mahasiswa Teknik. , 7(2), 51–60. https://doi.org/10.23971/eds.v7i2.1476

Royani, I., Mirawati, B., & Jannah, H. (2018). Pengaruh Model Pembelajaran Langsung Berbasis Praktikum Terhadap Keterampilan Proses Sains dan Kemampuan Berpikir Kritis Siswa. *Prisma Sains: Jurnal Pengkajian Ilmu Dan Pembelajaran Matematika dan IPA IKIP Mataram*, 6(2). https://doi.org/10.33394/j-ps.v6i2.966

Sachyani, D., Waxman, P. T., Sadeh, I., Herman, S., Levi Ferber, M., Yaacobi, M., Choresh, O., Link, E., Masa, S.-R., Ginsburg, S., & Zion, M. (2024). Teachers' views of Future-Oriented Pedagogy as part of inquiry-based molecular biology teaching in high school biology laboratories. *Journal of Biological Education*, 58(5), 1130–1151. https://doi.org/10.1080/00219266.2023.2174157

Saputra, F. H., Alatas, F., & Suryadi, A. (2023). Jenis Penalaran Ilmiah Apa Yang Digunakan Mahasiswa Dalam Menyelesaikan Permasalahan Suhu Dan Kalor?: Studi Pada Praktikum Fisika Umum. *Jurnal Kumparan Fisika*, 6(1), 27–36. https://doi.org/10.33369/jkf.6.1.27-36

Shi, W. Z., He, X., Wang, Y., & Huan, W. (2015). Effects of lab group sex composition on physics learning. Eurasia Journal of Mathematics, Science and Technology Education, 11(1), 87–92. https://doi.org/10.12973/eurasia.2015.1308a

Simbolon, D. H., & Sahyar, S. (2015). Pengaruh Model Pembelajaran Inkuiri Terbimbing Berbasis Eksperimen Riil dan Laboratorium Virtual terhadap Hasil Belajar Fisika Siswa. *Jurnal Pendidikan dan Kebudayaan*, 21(3), 299–316. https://doi.org/10.24832/jpnk.v21i3.192

Subramaniam, K. (2014). Student teachers' conceptions of teaching biology. *Journal of Biological Education*, 48(2), 91–97. https://doi.org/10.1080/00219266.2013.837405

Sudargo, F., & Asiah, S. (2010). Kemampuan pedagogik calon guru dalam meningkatkan kemampuan berpikir kritis dan keterampilan proses siswa melalui pembelajaran berbasis praktikum. *Jurnal Pengajaran Matematika dan Ilmu Pengetahuan Alam (JPMIPA)*, 15(1), 4–12. https://doi.org/10.18269/jpmipa.v15i1.35983

Surgandini, A. (2018). Peningkatan Kemampuan Pemahaman Materi Berdasarkan Kesulitan Belajar Mahasiswa Papua pada Perkuliahan Aljabar Linear dan Penumbuhan Karakter Percaya Diri. *Kreano, Jurnal Matematika Kreatif-Inovatif*, 9(2), 120–138. https://doi.org/10.15294/kreano.v9i2.14326

Suryawati, E., & Osman, K. (2018). Contextual learning: Innovative approach towards the development of students' scientific attitude and natural science performance. *Eurasia Journal of Mathematics, Science and Technology Education*, 14(1), 61–76. https://doi.org/10.12973/ejmste/79329

Susilo, H., Kristiani, N., & Sudrajat, A. K. (2020). Development of 21st century skills at the senior high school: Teachers' perspective. *AIP Conference Proceedings*, 2215(1), 30018. https://doi.org/10.1063/5.0000559

Vonnisye, V., & Tandirerung, W. Y. (2018). Identifikasi Faktor-Faktor yang Mempengaruhi Motivasi Belajar Mahasiswa Agroteknologi pada Mata Kuliah Botani. *CELEBES BIODIVERSITAS : Jurnal Sains dan Pendidikan Biologi*, 2(1), 52. https://doi.org/10.51336/cb.v2i1.167

W. Johnson, D., & T. Johnson, R. (2019). *Cooperative Learning: The Foundation for Active Learning*. In Active Learning - Beyond the Future. https://doi.org/10.5772/intechopen.81086

Wahyudiati, D. (2016). Analisis Efektivitas Kegiatan Praktikum Sebagai Upaya Peningkatan Hasil Belajar Mahasiswa. *Jurnal Tatsqif*, 14(2), 143–168. https://doi.org/10.20414/jtq.v14i2.27

Wibrowski, C. R., Matthews, W. K., & Kitsantas, A. (2016). The Role of a Skills Learning Support Program on First-Generation College Students' Self-Regulation, Motivation, and Academic Achievement: A Longitudinal Study. *Journal of College Student Retention: Research, Theory & Practice*, 19(3), 317–332. https://doi.org/10.1177/1521025116629152