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Investigating the challenges of first-year education students in physics practicum

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Abstract
Basic Physics I practicum is a critical practicum for first-year education students. This study aimed to investigate the factors causing difficulties in the Basic Physics I practicum among 164 first-year education students from geography, mathematics, biology, and physics education programs at Mulawarman University. A questionnaire was distributed to the students after completing the practicum, and the responses were analyzed using the Likert scale, Spearman correlation test, Mann-Whitney U, and Kruskal-Wallis test. The results showed that the complexity of the practicum reports posed significant challenges for students. Additionally, correlations were found between motivation, interest, and the difficulties students experienced. Differences in difficulty were also observed based on the study program and gender. The findings suggest that policymakers should consider these factors to support first-year students in Basic Physics I practicum, ultimately enhancing their learning and understanding.

Keywords: physics practicum challenges, first-year education students, motivation and interest, statistical analysis in education, gender and study program differences

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I. Introduction

Educational activities are closely related to learning and learning activities. Learning is an effort process carried out by someone who wants to cause new changes in his overall behavior based on his experience in interacting with the environment. In contrast, learning is an activity that seeks to gain knowledge, skills, and positive values by utilizing various learning resources [1]. One of the places where learning and learning activities occur is in the laboratory, be it in a school laboratory, a university, or a faculty laboratory.

The laboratory of the Faculty of Teacher Training and Education, Mulawarman University, is a place where students and lecturers can conduct experiments, increase the acquisition and improvement of knowledge, and develop process skills and intellectual abilities such as observation, classification, measurement, exploring the relationship between one concept and another, forming hypotheses, making predictions, communicating, experimenting, building models, skills using tools, and so on [2]. Basic Physics Practicum is one of the core activities in Physics learning at the University level. Practicum activities are an

inseparable part of science learning because the practicum will train students' skills, starting from the skills of observing a problem to the skills in communicating research results in the form of work reports and with the practicum, students will be more skilled in using practicum equipment in the laboratory [3]. In the first semester at Mulawarman University, new students from study programs such as physics education, mathematics education, biology education, and geography education are required to take a basic physics I practicum course. The Basic Physics I Practicum trains students in experiments on measurement uncertainty, mechanics, energy and work, fluids, and heat, reinforcing concepts from the Basic Physics I course and bridging theory with practice.

The first year of college is a transitional phase where students adapt to changes in both the educational system and a new environment, moving from a high school setting to that of higher education [4]. Many students continue to exhibit learning behaviors typical of high school during this period. However, a large number of students struggle to develop the independence needed for effective learning in college [4]. Their ability to manage and control their study habits is often insufficient, potentially hindering their academic success if not addressed promptly. Another study found that some groups of first-year students had a low level of adjustment in college in the academic, social, and personal dimensions and were less satisfied with living life in college [5]. Furthermore, the study also found differences in the adjustment of first-year students in personal-emotional aspects between males and females, where men had a higher average adjustment score [5]. However, at Mulawarman University, especially in the physics education study program, it was found that the average final score of students in Basic Physics I practicum was relatively low and below the range of 70 and lower than the average final score of students in Basic Physics II practicum (Table 1). This shows that a challenge causes first-semester students not to get the maximum score, so when they take the Basic Physics II practicum, there is an adaptation that leads to an increase in scores. While previous studies highlight first-year students' academic adaptation challenges, research on difficulties specific to the Basic Physics I Practicum remains limited. Transitioning from high school to university labs presents unique obstacles, including independent learning, connecting theory with practice, and using laboratory equipment. The lower scores in Basic Physics I suggest adaptation difficulties that need further investigation to improve student learning outcomes. Basic Physics Practicum I covers fundamental physics topics, including measurement uncertainty mechanics, energy and work, fluids, and heat. The Basic Physics II practicum discusses static and dynamic electricity, vibrations and waves, and the properties of light and optical devices. Basic Physics III discusses modern physics, relativity, the effects of light wave dualism, the photoelectric effect, the Compton effect, and core physics.

Table 1. Final Score Data of Physics Education Students Class of 2022 from the information system of the physics education study program

Courses	Average Score
Basic Physics Lab I	73.57
Basic Physics Lab II	74.57
Basic Physics Lab III	72.99

Previous research suggests that the obstacles students face include writing that does not follow the rules of academic writing, poor synthesis skills, inappropriate use of formats, the ability to compile arguments and connect theories, and the use of poorly understood texts [6]. These difficulties can be divided into two main categories: internal factors and external factors. Internal factors refer to the student, while external factors refer to other aspects of influence. Internal factors include lack of motivation, interest, attention, and health problems during the internship [7]. Weaknesses in terms of “mind-on” and “hands-on” are also included in internal factors. External factors include lack of equipment and materials, lack of practical guidance, absence of lecturers, inadequate lecturer explanations, absence of laboratory assistants, large amounts of practical materials, many practical questions, and complete teaching materials unrelated to the practical plan. There are too many questions, reports, and poorly structured internship guides [7]. Another study revealed the problems faced by the PMIPA FKIP laboratory at Mataram University, where there was an increase in the number of students who used the laboratory both for practicum and research. Still, the facilities and infrastructure in the last 3 years have not increased [2]. Even much laboratory equipment is in the condition of minor damage and heavy damage. Other studies suggest students have difficulty carrying out practicums due to not being accustomed to doing practicum, especially students whose school days were affected by the COVID-19 pandemic [8].

Unfortunately, no research discusses the challenges and obstacles first-year education students face when taking Basic Physics Practicum I. So, this research comes to fill the existing research gap. So, this research is here to fill the existing research gap. This study aims to investigate the factors that cause difficulties for first-year students of 2024 study programs, Physics Education, Biology Education, Mathematics Education, and Geography Education when doing Basic Physics I practicum. We hypothesize that there are influences such as motivation and understanding of materials, tools, and materials, report problems, busy schedules, intensity and completeness of laboratory use when students are still in junior high school or high school, the origin of the study program, and gender. This research is essential to provide information to educators and policymakers to provide appropriate treatment to maximize first-year education students' learning process.

II. Methods

This research was conducted quantitatively to test the hypothesis that has been made. The sample selection was carried out by purposive sampling, a method chosen to ensure that participants with relevant characteristics—first-year education students who had completed the basic physics practicum—were included in the study. A total of 164 students participated, with details of 57 geography education students, 47 math education students, 40 biology education students, and 20 physics education students. This sampling approach was used to target specific academic disciplines, allowing for a diverse range of perspectives on the practicum experience. The gender distribution included 126 female students and 38 male students, ensuring a balanced representation of gender in the study. The instrument was made in the form of a questionnaire distributed to students after completing the basic physics practicum I for 4 months. No specific treatment was applied during the practicum. Data were collected after students completed the standard Basic Physics I practicum, which covered experiments on measurement uncertainty, mechanics, energy and work, fluids, and heat under normal conditions. The instrument is an adaptation of previous research instruments by Falentino *et al*. [9]. The questionnaire was chosen to capture students' experiences and perceptions of the practicum efficiently. The questionnaire was designed with preliminary questions regarding demographic information, including gender and study program. The second section of the questionnaire assessed the frequency of laboratory use during junior and senior high school. Responses were scored on a scale of 1 to 4: Score 1 represented "rarely or never," Score 2 represented "2 to 3 times a month," Score 3 represented "once a week," and Score 4 represented "2 to 3 times a week." Additionally, the questionnaire included questions about the perceived completeness of the junior and senior high school laboratories, which were evaluated using a Likert scale ranging from 1 to 5. On this scale, Score 1 indicated "very incomplete," and 5 indicated "very complete." [9].

In the next section, we used an adapted instrument regarding the internal and external factors of difficulty in carrying out the practicum [2]. The instrument was chosen because it effectively captures students' subjective experiences and the specific challenges they face during the practicum. In the internal factors, we added questions about the student's understanding of the material, and then in the external factors, we did not use questions about the absence of lecturers, the absence of assistants, inappropriate practice questions, and no coordination of lecturers, assistants, and laboratory assistants. The questionnaire was further modified to include questions regarding obstacles faced by students in the practicum, such as difficulties with a complicated practicum report format and challenges arising from inexperience or limited exposure to practicum activities. The remaining question components were retained. Responses were analyzed using a Likert scale ranging from 1 to 5, with difficulty categories as defined in previous research. The difficulty categories were: 0-25% ("no difficulty"), 26-50% ("less difficulty"), 51-75% ("enough difficulty"), and 76-100% ("difficulty in practicum"). The Likert scale percentage was calculated using Equation 1 [10], where n_1, n_2, …, n_5 is the number of people choosing the score level.

$$\text{Score} = \left(\frac{(n_1 \times 1) + (n_2 \times 2) + ... + (n_5 \times 5)}{(n_1 + n_2 + ... + n_5) \times 5} \right) \times 100 \quad (1)$$

To analyze the relationship between motivation and interest in the total difficulty of students, the Spearman test (Correlation based on rank (Different Scale)) was used. This technique was chosen because it is appropriate for measuring the strength and direction of the monotonic relationship between two ordinal variables. A correlation test was conducted between Interest and Difficulty, and Motivation and Difficulty. Followed by the Spearman correlation test for intensity of laboratory use to difficulty and laboratory

completeness to difficulty, as these variables are also ordinal and non-parametric. To analyze the relationship between the study program and difficulty, the Kruskal-Wallis test was used, as it is suitable for comparing differences between more than two independent groups with ordinal data. To analyze the relationship between gender and difficulty, the Mann-Whitney U test (non-parametric for two categories) was conducted, as it is effective for comparing two independent groups with ordinal data. These techniques were selected to accommodate the nature of the data and provide reliable insights into the factors influencing students' difficulties in the practicum. The instruments used in this study and the corresponding analysis methods are summarized in Table 2, which outlines the variables measured, their respective scales, and the statistical techniques employed for data analysis.

Table 2. Overview of Instruments Used and Data Analysis Methods in the Study

Instrument	Description	Scale	Analysis Method
Demographics	Gender, study program	Categorical	Descriptive Statistics
Lab Use Frequency	Frequency of lab use in high school	1-4 scale	Spearman Correlation (with Difficulty)
Lab Completeness	Perceived completeness of labs	Likert 1-5	Spearman Correlation (with Difficulty)
Internal Factors	Motivation, interest, understanding	Likert 1-5	Descriptive Statistics, Spearman Correlation
External Factors	Lab equipment, reports, atmosphere	Likert 1-5	Descriptive Statistics, Spearman Correlation
Total Difficulty	Overall difficulty level	0-100%	Descriptive Statistics
Motivation/Interest	Motivation and interest levels	Likert 1-5	Spearman Correlation (with Difficulty)
Study Program	Difficulty of the study program	Categorical	Kruskal-Wallis Test
Gender	Difficulty by gender	Categorical	Mann-Whitney U Test

III. Results and discussion

The percentage of difficulty for each analysis point was obtained based on the data collected through the questionnaire. The analysis was divided into internal and external factors, as done in previous research [2]. Internal factors can be seen in Table 3, and external factors can be seen in Table 4.

Table 3. Internal Factors of Student Difficulty

Question	Percentage (%)	Interpretation
Lack of Motivation	47	Less difficulty
Lack of Interest	45	Less difficulty
Lack of Attention	45	Less difficulty
Lack of Understanding of Material	52	Enough difficulty

Table 4. External Factors of Student Difficulty

Questions	Percentage (%)	Interpretation
Lack of Equipment and Materials	36	Less difficulty
Lack of Practical Guidelines	45	Less difficulty
Unclear Assistant Explanation	41	Less difficulty
Too Many Reports	57	Enough difficulty
Dense Practical Material	53	Enough difficulty
Dense Practical Schedule	50	Less difficulty
Test Results Not Returned	42	Less difficulty
Excessive Practical Material	47	Less difficulty
Complicated Report Format	56	Enough difficulty
Uncomfortable Lab Atmosphere	33	Less difficulty
Lack of Experience	56	Enough difficulty

The distribution of answers from students in order of the difficulty factor with the highest average can be seen in Figure 1. It can be seen that the highest factor causing difficulties is too many reports, followed by lack of experience and too complicated format. Through correlation test analysis, we found a correlation between lack of motivation and the difficulties students feel. The more they lack or have problems with motivation, the higher the total difficulty they feel. The same goes for their interest, where the lower or more problematic their interest is, the higher the total difficulty they feel.

The Spearman correlation between motivation and difficulty is 0.625, while the Spearman correlation between interest and difficulty is 0.60 (Figure 2).

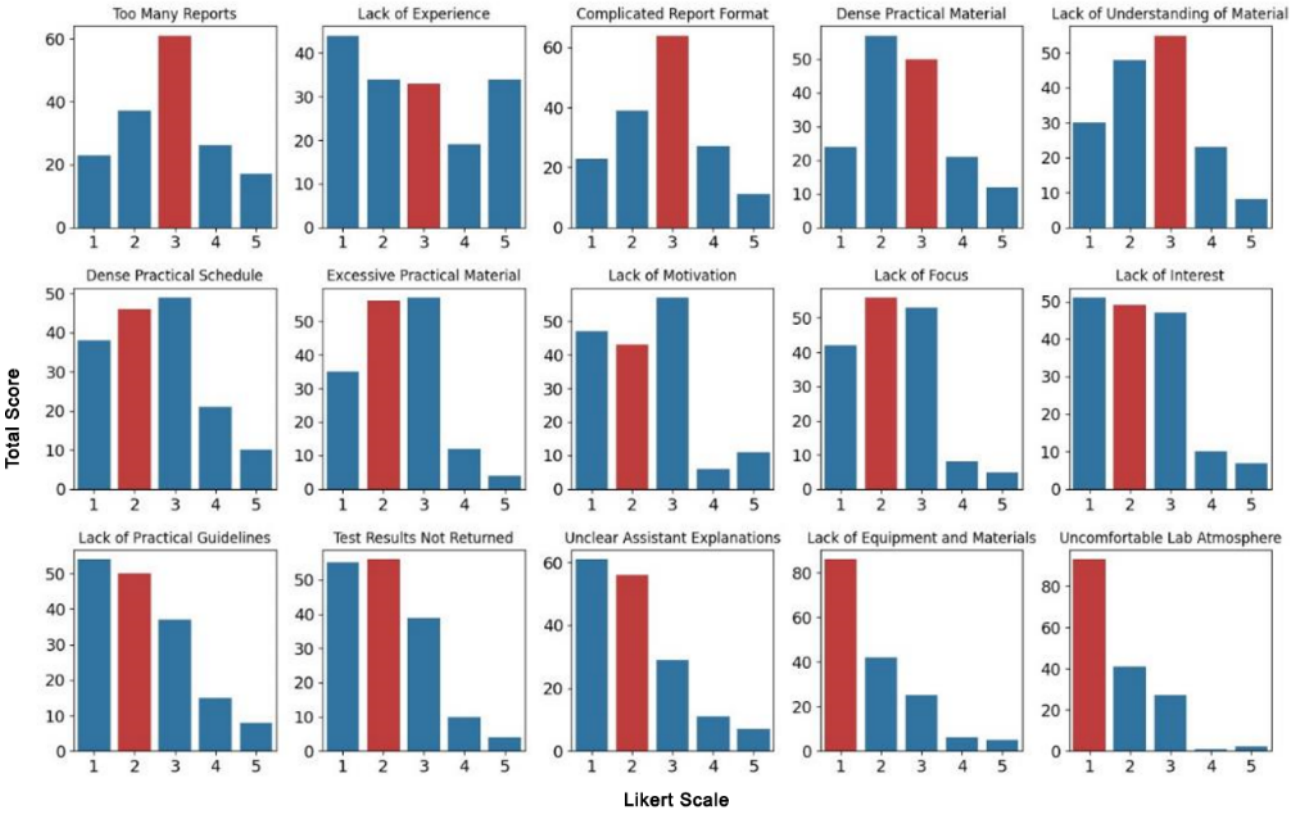

Figure 1. Distribution of Difficulty Factors by highest average.

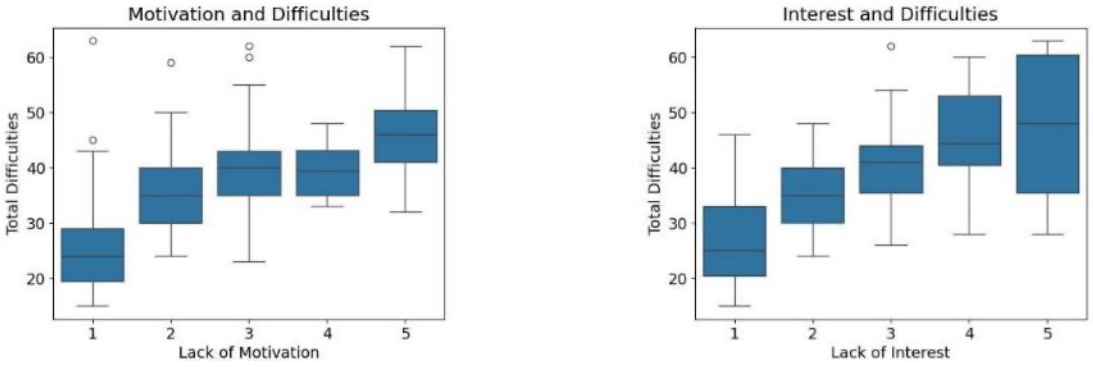

Figure 2. Correlation of Lack of motivation to total difficulty and Correlation of lack of interest to total difficulty

Analyzing internal factors using a Likert scale shows that students do not feel they have enough difficulty due to a lack of motivation, interest, or attention. However, what is unique is that when analyzed using the Spearman correlation test, a relationship is obtained where the more disrupted the student's motivation, the more difficult it is for students to face practicum. This can be caused by the fact that some first-year education students have high enthusiasm and motivation, especially during their first year in college, and hope to achieve high scores [11]. Students with great motivation will strive hard, do not want to give up, and read hard to improve learning outcomes and solve their problems [12]. Motivation also plays an essential role as a reason why students choose one behavior among other behaviors, such as some students choosing to go to the mall with their friends after the lecture ends, but it is also found that some students prefer to go home so that they have more time to complete their assignments [13]. When they have problems in terms of motivation, it will lead to disorders such as procrastination. Previous research shows a strong and negative relationship between learning motivation and procrastination. When students have low learning motivation, procrastination behavior will be high [14], [15], likewise with interest, where interest in learning has a significant effect on student achievement [16], [17]. Students with good learning achievement usually have interest and are accompanied

by regular habits because students feel happy when studying [17]. They will experience more difficulties. In addition to motivation and interest factors, Figure 3 and Table 3 also show that a lack of understanding of the practicum material is enough to make students feel difficult. These results align with previous research that shows students' difficulties in doing practicum and analyzing data are caused by a lack of understanding of the practicum material tested [18]. This student's lack of understanding also ultimately affects the resilience of their motivation and interest because when the material is difficult to understand, it can reduce student learning motivation [19].

On external factors, it shows that students find it quite difficult because there are too many reports (Table 4 and Figure 1). Students felt overwhelmed because they had to make reports for each practicum session. This is not to mention the added burden of working on reports from other courses, such as biology and chemistry, which causes too many reports to be made each week. The overly complicated report format also causes students to have difficulties with complicated technical report requirements such as neatness, report format, in-depth statistical analysis, many references, and specific layout (56%). The report format required many revisions because students often misunderstood the technicalities. As a result, the report processing time becomes longer than it should be. In addition, practicum material that is too dense also makes it difficult for students (53%), such as the delivery of material in one practicum session that is too much or intense.

This causes students to have difficulty understanding the material because they have to complete several experiments in a short time. For example, two complex experiments are carried out in one session lasting 2 or 3 hours. Of course, this will cause students to feel difficulties due to shallow understanding and a decrease in the report quality due to the very short processing time. In the end, this many tasks or reports can cause students to experience stress and burnout [20]. This snowball effect causes students to understand less and increases their stress because of the high demand, but they cannot understand the lecture material [21], [22]. This is different from previous research, which revealed that students experienced difficulties due to the lack of practicum tools [2]. However, in this study, the opposite was true, with the smallest percentage of discomfort among others (Table 4 and Graph 1), which shows that education students at Mulawarman University are quite comfortable with laboratory conditions and the atmosphere during practicum. This shows that each laboratory has different challenges, depending on the problems and needs of each laboratory.

The intensity of laboratory use during senior high school and junior high school is presented in Table 5, showing that most students rarely or never used laboratory facilities, with lower utilization rates in junior high school compared to senior high school. Then, we analyzed the relationship between the intensity of laboratory use and the difficulties felt by students (Figure 3). The results show no significant correlation between the intensity of laboratory use and the difficulties students feel. But uniquely, the distribution of factors that cause difficulties, very high students who feel less experience using the laboratory affect their difficulties.

This can be caused by students whose intensity of laboratory use is less, feeling less familiar with laboratory equipment, so they feel it is a part that is quite difficult for them. As for students who are accustomed to doing practicum during junior high school or high school, they still feel the same difficulty because they are not so burdened with practicum reports. Justification for this can be seen by the high number of students who find it difficult because of the large number of reports, the format that is too complicated, and the practicum material that is too dense (Figure 1). Table 5 shows the intensity of use of senior high school and junior high school laboratories.

Table 5. Intensity of use of senior high school and junior high school laboratories

Group	Percentage (%)	
	Senior High School	Junior High School
Rarely or never	53.7	76.8
2 to 3 times a month	31.1	17.1
Once a week	10.4	5.5
2 to 3 times a week	4.9	0.6

Table 5 shows a very low intensity in the use of laboratories when students are still in high school or junior high school. This difference is even more apparent when these results are compared with previous research, which measured the intensity of laboratory use in Samarinda. There is a significant difference between school children in Samarinda, who frequently use laboratories, and first-year education students who have studied [9]. This is thought to be because Mulawarman University's first-year education students mostly come from regional and rural schools, which may have minimal facilities and intensity of laboratory use

compared to those in big cities. This is also supported by previous research, which revealed that there is still a visible gap between schools in Java and outside Java, which have minimal access to libraries and laboratory quality [23].

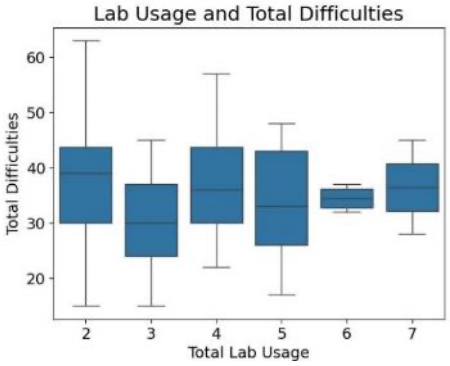

Figure 3. Lab usage and total difficulties

In terms of laboratory completeness, it is also very low, such as 51% of junior high school laboratories are very incomplete, and 26% of high school laboratories are very incomplete (Table 6). However, the unique thing is that when the correlation between laboratory completeness and student difficulty is tested, it also shows no significant correlation (Figure 4). Just like the previous reason, whether both students who have a complete laboratory setting or not do not feel the influence on the practicum of basic physics I in lectures because the challenges and difficulties they face are many in terms of reports, report formats, and dense material from the practicum. But of course, it also needs to be a special concern for the government about the lack of opportunities for students to learn in the laboratory while in junior high school and high school. Previous research through interviews with teachers revealed that practicum is rare, and one of the factors that causes is inadequate equipment at school [24].

Table 6. Senior high school and junior high school laboratory equipment

Group	Percentage (%)	
	Senior High School	Junior High School
Very incomplete	26	51
Incomplete	16	20
Fairly complete	31	18
Complete	20	9
Very complete	7	2

Then, we analyzed the effect of the study program on the difficulties experienced by students using the Kruskal-Wallis Test (Figure 5). The test showed that students from the Geography study program experienced a significantly higher difficulty undergoing basic physics I practicum than students from other programs. This result could be due to the fact that when they were in high school, students of geography study programs mostly came from the Social Science field [25], so when they were in grades XI and XII of high school, they no longer did science practicum. The characteristics of geography subjects are more social approaches and interaction with the environment [26], rarely involving laboratory equipment directly for science practicum. Therefore, it is understandable why students from geography education. Previous research also revealed differences in the use of technology and time allocation, such as students from the Natural Sciences clump taking a lot of time in practicum and the innovation of technological advances in its implementation. In contrast, social science students are less visible in the use of technology and a looser time allocation because there are few practicums in the laboratory [27]. Nevertheless, a physics practicum is still essential, considering that geography disciplines still require understanding physics concepts. Therefore, this study program conducts basic physics practicum I for first-year students.

Then, we also analyze how gender affects the difficulty of basic physics practicum I individually. The statistical technique used Mann-Whitney U, non-parametric for both categories. The results show that gender has no significant effect on the difficulties experienced by students (Figure 6). However, when this analysis was carried out on the effect of gender on difficulties due to lack of tools and materials, it showed a significant

difference. Males experience more difficulties due to insufficient tools and materials (Figure 7). This shows that male students are more sensitive to the problem of practicum tools and materials than female students. This is because male students find it easier to learn by engaging in hands-on activities, while female students prefer persuasive and communicative learning methods [10]. In addition, previous research also conveyed differences between male and female students in responding to problems, where male students show greater curiosity and interest than females [28]. This is caused by problems such as a lack of tools or materials or damaged practicum equipment; male students are more easily disturbed than female students.

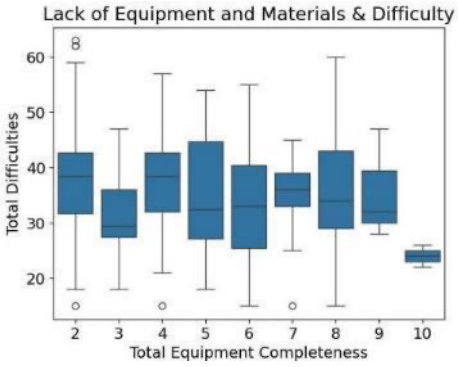

Figure 4. Lack of equipment, materials and difficulty

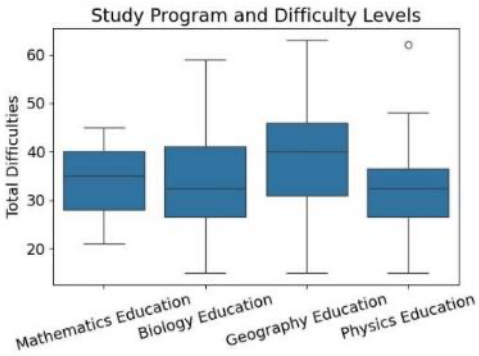

Figure 5. Study Program and difficulty levels

The study was limited by its sample, which consisted solely of students from Mulawarman University, thereby potentially restricting the generalizability of the findings to institutions with different laboratory facilities, curricula, and student demographics. Moreover, the study did not thoroughly explore the factors underlying the observed decline in performance in subsequent practicum courses, indicating the need for further research to investigate these issues in greater depth.

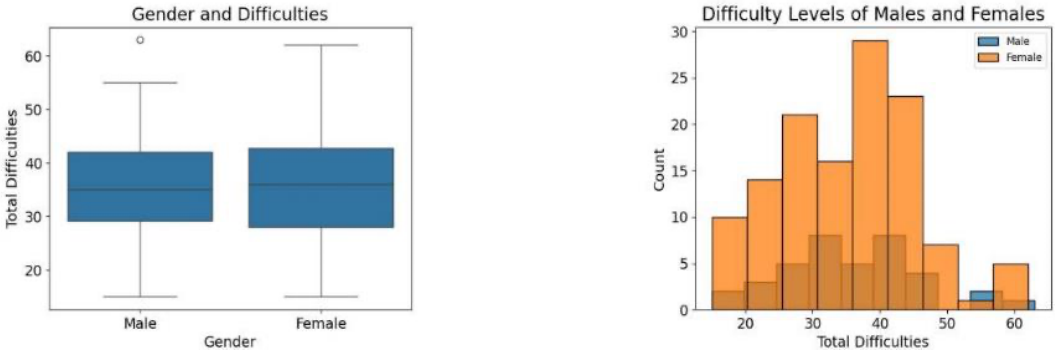

Figure 6. The influence of gender on students' difficulty in carrying out Basic Physics I practicum

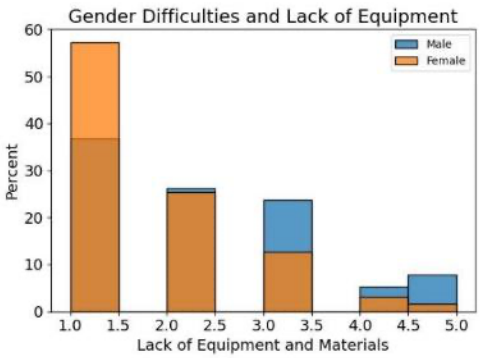

Figure 7. Gender difficulties and lack of equipment

IV. Conclusions

This study identifies factors contributing to difficulties in the Basic Physics I practicum for students in physics, biology, mathematics, and geography education. Internal factors, such as motivation and interest, were correlated with overall practicum difficulty, indicating that reduced motivation leads to more challenges. Poor understanding of the material also contributed to difficulties, particularly in report analysis. External factors, such as excessive reports, complicated formats, and dense material, further added to student stress and pressure. Laboratory intensity and completeness had a weak correlation with difficulties, though lack of practicum experience was a factor. Geography students faced greater difficulties, possibly due to limited prior exposure to scientific practicum. Gender did not significantly affect overall difficulty but influenced challenges related to the lack of practicum tools. This research emphasizes the need for improved practicum systems and laboratory access to better support student learning.

However, this study also had limitations in the research sample, which consisted only of students from Mulawarman University, potentially limiting the generalization of the findings to other institutions with different laboratory facilities, curricula, and student demographics. Future research should explore the decline in performance in subsequent practicum courses.

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