

## Analysis Of Microbial Culture Learning: Understanding The Relationship Between Technical Competence And Students' Perspectives At Dharmawangsa University, Medan

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### Abstract

*This study examines the relationship between test scores and students' perceptions of learning microbial cultures. The objectives of the research were to determine how students' technical skills correspond with their subjective perceptions of difficulty in various aspects of learning, and to identify the most difficult aspects of learning microbial cultures. Data were collected through tests and questionnaires administered to microbiology practicum students. Analysis revealed a significant correlation between test scores and student perceptions in most aspects of learning, but with variation between aspects. Aspects of basic microbial culture concepts showed a positive correlation, suggesting that students with a strong understanding of the concepts perceived less difficulty. In contrast, bacterial inoculation techniques showed a negative correlation, indicating a mismatch between technical ability and perceived difficulty. The analysis provides a comprehensive view of the factors influencing the learning of microbial culture. The results show that students perceive bacterial inoculation techniques as the most challenging aspect, despite moderately skilled students demonstrating adequate technical ability. Potential sources of technical complexity in the inoculation process, such as steps requiring precision and access to hands-on equipment, contribute to students' perceived difficulty. Although the relationship between test scores and student perceptions of microbial culture learning has been explored in this study, additional research is needed to delve deeper into the complex factors that contribute to this relationship*

**Keywords:** *Correlation of Values and Perceptions, Microbial Culture, Microbiology Learning, Student Perceptions*



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## INTRODUCTION

Microbiology, as a branch of biological science that studies microorganisms such as bacteria, viruses, and fungi, has significant relevance in the context of fisheries education. An in-depth understanding of microbiology is an important aspect of equipping fisheries students, given the role of microorganisms in the success of aquaculture and food safety. Fisheries microbiology is closely related to the health and sustainability of aquatic environments, water quality management, and the welfare of fish as the primary fishery resource (Sarker 2023). Fisheries students who understand the concept of microbiology can more effectively manage various challenges that arise, such as fish diseases, sustainability of the aquatic environment, and optimization of fish feed quality. In addition, knowledge of microbiology also drives innovation in feed technology, fish disease treatment, and fisheries resource management (Puri et al., 2023). Understanding the concept of microbiology is a critical foundation for fisheries students to develop sustainable solutions in dealing with the complex dynamics of the fisheries sector.

Hands-on activities are necessary to develop students' understanding of microbiology and its application to fisheries. Through practicum, students are not only introduced to the theory of microbiology, but also have the opportunity to apply this knowledge directly in a laboratory environment (Nurtamara et al., 2023). The importance of practicum activities lies in developing students' practical skills in handling microorganisms that play a role in aquaculture. Microbiology practicum and laboratory research activities are the main means for students to hone their skills in microbial culture. However, in this process, some students often face certain obstacles or difficulties that may affect their ability to understand and apply microbial culture techniques.

This study aimed to identify factors that may impact the level of difficulty experienced by students in the context of microbial culture and analyze the challenges they may encounter. By examining these factors, we can gain insight into the obstacles that students may face and identify opportunities to improve microbiology education. The study's results are expected to have a positive impact on the development of microbiology curricula in higher education. This will ensure that students not only acquire a strong conceptual understanding but also the ability to apply practical skills in real-world situations.

## METHOD

The study employed a descriptive method that utilized a survey approach, interviews, and tests as the primary data collection tools. The sample was selected through purposive sampling, taking into account the representativeness of the student population. The research sample comprised of 53 students (41 males and 12 females) from the Faculty of Fisheries at Dharmawangsa University who had completed the Practical Course in the Fundamentals of Fisheries Microbiology. The study utilized a questionnaire that presented closed statements in the form of a Likert scale. The questionnaire comprised of six variables, namely: basic concepts of microbial culture, preparation of culture media, sterilization techniques, inoculation techniques,

isolation and identification, and interpretation of culture results. The test also encompassed these six variables. The evaluation of proficiency in the concept of microbial culture was assessed via a written examination, whereas the evaluation of the remaining variables was conducted through a practical examination. The data from the questionnaire will be computed using the following formula:

$$NP = \frac{R}{S} \times 100\% \quad (1)$$

Description:

NP: Percentage value

R : Score obtained

S : Maximum score

The evaluation criteria are determined based on the percentage value of each main item in the questionnaire. Criteria are assigned using a scale ranging from 0% to 20% for very low, 21% to 40% for low, 41% to 60% for medium, 61% to 80% for high, and 81% to 100% for very high. The written assessment is scored on a scale of 1 to 100. Practical tests are conducted to evaluate respondents' accuracy in performing each stage of microbial culture. The study employed the Pearson correlation test to examine the correlation between test scores and student perceptions.

## **RESULT AND DISCUSSION**

### **Assessment of Student Evaluation in Microbial Culture**

This study seeks to analyze comprehensively the challenges that students face in microbial culture to gain a better understanding of their understanding and application of essential concepts in the microbiology laboratory. The evaluation of the microbial culture practicum covers various aspects, including the basic concepts of microbial culture. The methodology used in this study is adapted from [Ogodo et al. \(2022\)](#). The assessment of students' understanding of microorganism growth on culture media is contingent upon their comprehension of the underlying concepts and their ability to adapt the composition of materials appropriately. Practical skills in preparing media that support microbial growth are important indicators for this evaluation.

The assessment of students' ability to apply correct and effective sterilization procedures, maintain hygiene, and prevent contamination in microbial cultures is evaluated, including their sterilization and inoculation techniques. Additionally, their accuracy and precision in inoculating microorganisms into culture media are also evaluated. The evaluation focuses on the isolation and identification of microorganisms, measuring students' ability to understand and carry out these steps in the context of the practicum. Emphasizing the ability to isolate and identify microbial colonies is intended to support the development of critical skills in microbiology.

The interpretation of microbial culture results requires students to identify microbial species, draw conclusions based on observations and analysis, and develop microbiology skills for future use. The evaluation provides a comprehensive understanding of students' ability to apply microbial culture concepts in a laboratory setting. The results are presented in the table below.

**Table 1.** Student Evaluation Scores on Microbial Culture Learning

Rubric for Test Assessment	Average	Criteria
Basic Concepts of Microbial Culture	80	High
Preparing culture media	73	Medium
Proper sterilization	97	High
Bacterial inoculation technique	63	Low
Microbial isolation and identification	72	Medium
Interpreting culture results	67	Low

The table presents the variations in student performance regarding different aspects of microbial culture. It is evident that students have a strong understanding of the basic concepts of microbial culture, with an average score of 80. This high average score demonstrates the students' success in comprehending the principles of microorganism growth on culture media. Students who have a good understanding of the fundamental concepts of microbial culture are able to grasp the basic principles involved in culturing microorganisms. Access to good learning resources, such as mandatory reference books, online materials, and related references, is important for learning microbial culture. Additionally, effective teaching methods, such as the problem-based instruction learning model, can be helpful. The approach is supported by the results of observations and interviews. According to [Idmal and Wahyuni \(2019\)](#), providing students with engaging learning resources, such as online materials and current references, can help them understand basic learning concepts. Additionally, possessing reference and module books can also assist students in comprehending the microbial culture concept, as demonstrated by test results. According to [Purnawanto \(2023\)](#), the use of diverse learning resources can aid students with varying learning preferences in understanding the presented concepts. Additionally, [Novianti et al., \(2020\)](#) have shown that the integration of Problem-Based Instruction (PBI) can enhance students' critical thinking skills in problem-solving, thereby facilitating a better comprehension of the concepts.

The section on preparing culture media (mean score 73) suggests that some students may face difficulties in this process. The test in this section covers the preparation of basic and enriched test media. Mistakes are often made by students when calculating the composition of materials or when performing laboratory techniques. These errors can be attributed to weak numeracy and science literacy skills ([Manolito et al., 2016](#)). This test for making culture media requires students to calculate the precise amount of several ingredients needed for each composition. It is important for students to be able to accurately calculate the amount of each material, perform dilutions, and use tools properly.

In contrast to the test results obtained during the preparation of culture media, the average student score during the sterilization stage was high, at 97. This suggests that students are proficient in applying sterilization techniques, reflecting their ability to maintain cleanliness and prevent contamination in microbial cultures. It is worth noting that the microbiology laboratory is equipped with an autoclave and digital oven that students can easily use. [Khairul et al. \(2023\)](#) suggest that the use of appropriate and current tools can have a significant impact on the success of student learning. In

addition, it is important for students to be able to properly sterilize glass, plastic, and metal media and tools.

The Bacterial Inoculation Technique study resulted in an average score of 63, which is considered low and may indicate a lack of skill or difficulty in performing the procedure. The test involved the use of spreading and four-quadrant scratch techniques for inoculation. The students faced some challenges during the inoculation process, particularly when using L rods and loops. This caused some damage to the media. Additionally, they encountered difficulty in estimating the scratched and unscratched quadrants, which resulted in an improper distribution of the cultured microbes. Furthermore, opening the Petri dish lid with one hand proved to be problematic as it required proximity to the Bunsen flame and limited hand movement inside the laminar. The task of microbial inoculation requires individuals to possess adequate training and emotional composure to perform well. It is worth noting that the sample used in this study consisted mostly of male participants (41 individuals). As [Vekli \(2021\)](#) points out, female students tend to have a higher perception of investigative learning skills in science compared to male students. It is possible that this factor may have influenced the low score in this section.

The microbial isolation and identification test results show an average score of 72, indicating that some students may face challenges with this task. Factors contributing to these difficulties include the complexity of the identification process, which involves intricate techniques and methods, especially for microorganisms with similar characteristics. It is possible that students may encounter difficulties in identifying microorganisms, which may be attributed to a lack of practical experience and limited understanding of the appropriate identification steps. Furthermore, the process of identifying microorganism colonies can be impeded by the complexity of their characteristics. It may be challenging for students who do not possess a comprehensive understanding of the characteristics of certain microorganisms to identify them.

Based on the culture results, which have a mean of 67, it appears that some students may face challenges in comprehending and interpreting microbial culture results. This may be due to various factors, including the intricate analysis required to interpret culture results, such as microorganism growth, color, and patterns. Furthermore, identifying and comprehending the differences in growth substances produced by microorganisms may pose a challenge for some students. Analyzing and interpreting cultural results can be challenging, especially for students who have not yet fully developed their analytical skills. Additionally, effectively conveying findings in a scientific manner is crucial. Difficulties in formulating and presenting findings clearly and systematically can impede the proper communication of analysis results ([Syahputro, 2020](#)). Finally, it is important to note that interpreting cultural results can be challenging for some students when attempting to connect practical results to abstract concepts. Therefore, it may be helpful to relate findings to previously learned theoretical concepts.

### **Student Perceptions of Learning Microbial Culture**

This study aimed to gather data on the level of difficulty experienced by students when learning microbial culture. A survey questionnaire was used to assess



six key variables, which were also the main factors in the test assessment. The percentage values obtained from the survey responses indicate the level of difficulty experienced by the students. It is worth noting that lower percentage values may indicate a lower level of difficulty. Please refer to the survey results presented in the table below.

**Table 2.** Perceptions of Microbial Culture Learning

Rubric for Test Assessment	Average (%)	Criteria
Basic Concepts of Microbial Culture	69	Medium
Preparing culture media	65	Medium
Proper sterilization	80	High
Bacterial inoculation technique	25	Low
Microbial isolation and identification	42	Low
Interpreting culture results	40	Low

The study investigated the perceptions of students regarding the difficulty levels of various aspects of microbiology, with a particular emphasis on microbial inoculation techniques. According to the results, 25% of the participants found microbial inoculation techniques to be the most challenging aspect. According to interviews conducted with the students, it was found that they experience a sense of insecurity when writing about the media. They express anxiety about making errors and lack confidence in their abilities. It is interesting to note that microbial inoculation techniques had the lowest value (63) when compared to other aspects. The students' self-confidence emerged as a key factor in determining their ability to execute microbial culture techniques successfully. The study suggests that students with high levels of self-confidence may be more likely to approach laboratory experiments with courage, view mistakes as opportunities for learning, and be more willing to try new techniques. Furthermore, the study found that self-confidence had a positive impact on the students' attitudes toward microbiology learning, providing a solid psychological foundation and motivational encouragement. The study suggests that students' perception of the high difficulty level associated with microbial inoculation techniques may be significantly influenced by their lack of self-confidence. The findings highlight the importance of improving students' self-confidence to enhance their performance in microbiology practicums (Putri et al., 2022). It is possible that some students may perceive this aspect as difficult due to a lack of confidence in their abilities.

It is a commonly accepted fact that proficiency in microbial culture techniques requires extensive practice or frequent repetition. However, due to limited laboratory resources at Dharmawangsa University, with only one dry laboratory that also serves as a microbiology laboratory, students face significant challenges in gaining adequate experience. Nevertheless, repetition can help students become familiar with the use of tools and proficient execution of cultural procedures. Repetition-based learning has been shown to enhance student competence, as demonstrated in Ardiyanto et al., (2023) study.

Mellisa and Natasya's (2023) research indicates that students perceive sterilization as the least difficult aspect, with 80% of students finding it easy to

understand. Its research indicates that students perceive sterilization as the least difficult aspect, with 80% of students finding it easy to understand. This suggests that sterilization is a comprehensible topic for students. The difficulty level of sterilizing tools, materials, and culture media in microbiology practicum can be influenced by various factors, including psychological, technical, and practical experience. It is important to consider students' level of knowledge and understanding of the importance of sterilization, as this can affect their assessment of the level of difficulty. Some students who possess a comprehensive understanding of microbiology concepts and are aware of the risks of contamination may consider sterilization to be a critical step. It is essential to remain impartial and refrain from making subjective assessments.

Technical factors are an important consideration in shaping student perceptions. The proficiency in operating sterilization equipment, determining the appropriate time, and ensuring its effectiveness can significantly impact students' confidence in facing this process. Overcoming potential technical difficulties, such as setting temperature or pressure in a sterilizer, may also influence perceptions of difficulty. According to [Mukagihana et al., \(2020\)](#), the availability of adequate tools greatly influences the level of difficulty experienced by students. At Dharmawangsa University's microbiology laboratory, students have found the digital autoclave to be easier and more practical to operate than the manual autoclave.

Additionally, previous practical experience has been shown to play a significant role. According to [Jurišević and Černe \(2021\)](#), students' perception of sterilization difficulty and confidence may be affected by their familiarity with biology lab work or previous experience operating sterilizers. It is worth noting that those with minimal experience may find sterilization to be more challenging. In this study, students were able to learn and practice various sterilization techniques in prerequisite courses such as general biology and fisheries biology. Furthermore, sterilization techniques were also covered in other biology courses, which allowed for a comprehensive understanding of proper sterilization procedures. This approach ensured that students gained ample experience in this important area.

However, it is encouraging to see that the majority of students perceive their ability to master basic concepts of microbial culture and prepare culture media as high, with 69% and 65% respectively. It is important to keep in mind that these aspects are in the medium category, suggesting that they are not insurmountable obstacles. Furthermore, it is worth noting that a significant percentage of students report finding it challenging to isolate and identify microbes (42%) and interpret culture results (40%). It is important to keep in mind that these aspects are in the medium category, suggesting that they are not insurmountable obstacles. It is important to keep in mind that these aspects are in the medium category, suggesting that they are not insurmountable obstacles. This text can also be used as evaluation material for instructors to address areas that students find challenging.

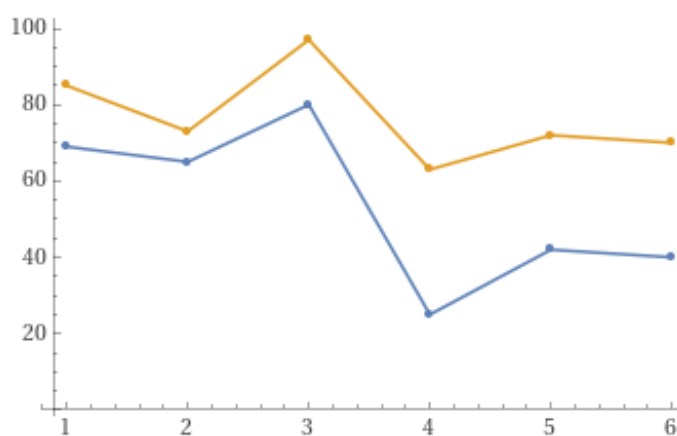
### **Correlation of Test Scores and Student Perceptions**

The study of microbial culture is an integral part of the study of microbiology, where students are introduced to essential techniques for the growth and identification of microorganisms. In this context, it is important to assess students' understanding

and ability to apply basic microbial culture concepts. Data obtained from tests can provide an objective picture of the extent to which students have mastered technical skills (Nurhayati and Effendi 2021). On the other hand, students' perceptions of the level of difficulty of learning microbial culture also play an important role in understanding their learning experience.

This analysis explores the correlation between test results and student perceptions on six aspects of microbial culture learning: basic concepts of microbial culture, preparing culture media, correct sterilization, bacterial inoculation techniques, microbial isolation and identification, and interpreting culture results. The test data includes numerical values that reflect the student's ability to apply microbial culture techniques. Student perception data was measured in percentages reflecting their assessment of the level of difficulty in each aspect of learning.

The study aimed to investigate the correlation between students' perceptions and their actual performance in microbial culture. Correlation analysis was conducted between the two data sets. The use of both objective test data and students' subjective perceptions can provide a more comprehensive understanding of the factors that influence learning in microbial culture. This understanding can guide the development of more effective learning strategies. Jabnabillah and Margina (2022) used the Pearson correlation test to determine the relationship between test scores and student perceptions of learning microbial culture. The results showed a positive correlation coefficient of 0.902, as depicted in Figure 1.



**Figure 1.** Correlation between test scores and student perceptions of microbial culture learning

The correlation analysis showed a consistent positive correlation between students' grades and their perceptions of various aspects of microbial culture. These aspects include basic conceptual understanding, preparation of culture media, correct sterilization, isolation and identification of microbes, and interpretation of culture results. This suggests that students who perform well on these aspects of the test have a positive perception of their difficulty level. Students with a strong understanding of basic concepts of microbial culture tend to perceive it as less complicated. Therefore, developing a strong foundation in the subject is important for effective learning.



Several factors can influence this correlation. First, students' comprehension of basic microbial culture concepts can significantly enhance their perception of the level of difficulty (Tsabita et al., 2020). Students with a solid microbiology knowledge base tend to feel more confident and better equipped to handle basic concepts. Similarly, Kusuma (2023) found a positive correlation between comprehension, biology literacy, and the ability to learn biology. With a solid grasp of the concept, students are likely to have positive learning outcomes and perceptions of the concept.

Effective teaching approaches can significantly influence student perceptions (Kriesna 2023). Teachers should aim to explain the basic concepts of microbial culture clearly and facilitate student understanding to create a supportive learning environment. If the presentation of the material is confusing or lacks clarity, students may struggle even if they have a good understanding. Furthermore, students' perceptions can be influenced by their practical experience in applying basic concepts of microbial culture. Those who are familiar with microbiology lab work or have previous experience performing microbial cultures may be more likely to view it as a surmountable challenge.

The correlation analysis between students' grades and their perceptions of preparing cultural media revealed a positive correlation. This suggests a parallel between technical skills and the perceived level of difficulty. Students who score high on the test for preparing cultural media tend to have a positive perception of the difficulty level of this aspect. Factors such as understanding instructions, accurately measuring ingredients, and technical expertise may influence this correlation.

In the correct sterilization analysis, a strong positive correlation was observed between students' grades and their perceptions. This suggests that students with good technical skills in sterilization tend to view it as a less challenging task. This correlation may be influenced by factors such as knowledge of sterilization methods, adherence to procedures, and practical skills.

The correlation between grades and perceptions on microbial isolation and identification is moderately positive. This suggests that students with good technical skills in this area tend to have positive perceptions of the level of difficulty. The relationship between knowledge of isolation procedures, accuracy in identification, and practical skills can contribute to this correlation. Additionally, the availability of adequate teaching materials supports this positive correlation (Sholihah and Sofiyana, 2019).

When interpreting cultural results, it is important to note that there is a moderate positive correlation between students' grades and their perceptions. This suggests that the ability to analyze cultural results is related to positive perceptions regarding the level of difficulty. Factors such as understanding the concept of interpreting results, accuracy in observations, and data interpretation can influence this correlation.

In contrast to the previous aspect, the correlation analysis of the bacterial inoculation technique reveals a significant negative correlation between students' grades and their perceptions. This suggests that students who score high on the bacterial inoculation technique test tend to have less favorable perceptions of the difficulty of this aspect. The accessibility of practical equipment, which serves as a crucial educational tool, significantly promotes autonomous learning. This, in turn,

impacts academic achievement and student perceptions (Firdausy et al., 2019). In addition, the nature of the interrelationship may be determined by factors such as the frequency of laboratory sessions (Aliyah and Puspitasari 2022), the complexity of technical procedures, proficiency in laboratory techniques, hands-on experience, or a lack of confidence in performing related tasks.

## CONCLUSION

Through correlation analysis between students' grades and perceptions of microbial culture learning, several critical findings have been discovered. Overall, a significant connection between technical ability (as measured by tests) and student perceptions of difficulty in most aspects of learning was observed. However, it is important to note that the strength and direction of correlation vary between aspects, providing deep insight into the learning dynamics of microbial cultures. For example, in the fundamental principles of microbial culture, there is a positive correlation, indicating that a better comprehension of the concept is associated with a lower perceived level of difficulty. This implies that students with a solid knowledge base tend to perceive basic concepts as surmountable. Conversely, the technical aspects of bacterial inoculation showed an interesting negative correlation. Students who scored highly on the bacterial inoculation technique test perceived this aspect as more challenging. Technical and practical factors may contribute to this perception. To improve microbial culture learning, a holistic approach that incorporates conceptual understanding, technical skills, and practical experience is essential. These findings can help teachers design more targeted learning strategies, identify areas that need more attention, and create supportive learning spaces. Efforts to improve microbial culture learning can be more effective and responsive to student needs. Although this study explores the relationship between test scores and student perceptions of microbial culture learning, further research is needed to delve deeper into the complex factors that contribute to this relationship.

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**Author contributions** : All authors contributed to the study's conception and design. Material preparation, data collection and analysis were performed by all authors. The first draft of the manuscript was submitted by [**Dwi Tika Afriani**]. All authors contributed on previous version and revisions process of the manuscript. All authors read and approved the final manuscript.