



The Influence of Student Perceptions on Learning Outcomes in the Food Microbiology Course

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ABSTRACT

Purpose of the study: This study aims to determine the description of students' perceptions of the Food Microbiology course, analyze students' learning outcomes in the course, and identify the influence of students' perceptions on learning outcomes to provide a basis for developing more effective learning strategies in higher education environments.

Methodology: This study employed a quantitative approach with a survey method. The research instruments consisted of a Likert-scale questionnaire and documentation of learning outcome scores. The sampling technique used simple random sampling. Data analysis was performed using descriptive statistics, the Kolmogorov-Smirnov normality test, ANOVA linearity test, Product Moment correlation, and simple linear regression using IBM SPSS Statistics software.

Main Findings: Student perceptions of the Food Microbiology course were moderate, while student learning outcomes were generally good. The research data were normally distributed and met the linearity assumption. Correlation analysis showed a strong relationship between student perceptions and learning outcomes. Simple linear regression results indicated that student perceptions significantly influenced learning outcomes in the Food Microbiology course.

Novelty/Originality of this study: The novelty of this research lies in its empirical analysis of the influence of student perceptions on learning outcomes, specifically in Food Microbiology courses, a topic rarely studied. This research provides a novel contribution to understanding the importance of student perceptions as a determinant of academic success and serves as a basis for developing more contextual and effective learning strategies.

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1. INTRODUCTION

Learning in higher education is a complex process influenced by various internal and external factors. One internal factor that significantly contributes to learning success is student perception of the courses they take [1], [2]. Perception reflects how students view, assess, and respond to a learning process based on their experiences [3], [4]. Positive perceptions of a course tend to encourage active student engagement in the learning

process [5], [6]. Conversely, negative perceptions can influence learning motivation and ultimately impact learning outcomes.

Learning outcomes are a crucial indicator in assessing the success of the educational process in higher education. Student learning outcomes are influenced not only by cognitive abilities but also by affective factors such as interest, motivation, and perceptions of learning [7], [8]. In the context of higher education, learning outcomes serve as a measure of the effectiveness of lecturers' delivery of material and the level of student understanding of the material being studied [9], [10]. Therefore, understanding the factors that influence learning outcomes is crucial. Studying the relationship between student perceptions and learning outcomes can provide a more comprehensive picture of the dynamics of learning in higher education [11], [12].

The Food Microbiology course is a crucial course that demands conceptual understanding and analytical skills from students [13], [14]. This course examines various microorganisms that play a role in food processing, spoilage, and safety [15], [16]. The complexity of the material, encompassing both theory and application, often presents a challenge for students. Many students find the course challenging because it requires a cross-concept understanding of biology, chemistry, and food technology. This can shape perceptions that ultimately influence how students engage with the learning process [17], [18].

Students' perceptions of the Food Microbiology course can be shaped by the various learning experiences they encounter during their studies [19], [20]. The teaching methods used by lecturers, the availability of learning media, the classroom atmosphere, and the level of difficulty of the material are some factors that can shape these perceptions [21], [22]. When students perceive the course as relevant, interesting, and applicable, they tend to demonstrate greater enthusiasm for learning [23], [24]. Conversely, if the course is perceived as complex and uninteresting, students may experience decreased motivation to learn. This situation has the potential to impact academic learning outcomes.

Various previous studies have examined the relationship between student perceptions and learning outcomes in various fields of study [25], [26]. Most studies indicate that positive perceptions correlate with increased student motivation and academic achievement [27], [28]. However, studies specifically examining the influence of student perceptions on learning outcomes in Food Microbiology courses are relatively limited. Existing research generally focuses on learning strategies or evaluation of academic achievement without examining the perception aspect in depth. This situation indicates a research gap that requires further investigation.

The gap analysis shows that there are still few studies that integrate the measurement of student perceptions with the analysis of learning outcomes in the context of applied science courses such as Food Microbiology. The novelty of this research lies in its specific focus on analyzing student perceptions of the Food Microbiology course as a variable influencing learning outcomes. This research is important because it can provide empirical information for lecturers and institutions in designing more effective learning strategies. The urgency of this research is further strengthened given the critical need to improve the quality of learning in the food sector to produce competent graduates. Therefore, this research is expected to make a significant contribution to the development of student-centered learning.

Based on the above description, it is important to conduct research to examine in depth the relationship between student perceptions and learning outcomes in the Food Microbiology course. This research is aimed at obtaining a comprehensive overview of student perceptions of the Food Microbiology course. Furthermore, this research also aims to determine student learning outcomes in the course. Furthermore, this study aims to analyze whether there is an influence of student perceptions on learning outcomes in the Food Microbiology course. The main objective of this research is to obtain empirical evidence that can serve as a basis for developing learning strategies to improve the quality of student learning outcomes.

2. RESEARCH METHOD

2.1. Type and Location of Research

This study used a quantitative approach with a survey method aimed at identifying students' perceptions of the Food Microbiology course. The survey method was chosen because it is effective in obtaining an overview of current phenomena based on data collected from respondents [29], [30]. This approach focuses on measuring existing conditions or symptoms without conducting an in-depth investigation into the factors causing these symptoms. Therefore, this study does not emphasize the analysis of complex cause-and-effect relationships between variables. The study was conducted at the Faculty of Tarbiyah and Teacher Training, Alauddin State Islamic University, Makassar, with students of the Biology Education Study Program as the subjects. Respondents in this study were students who had taken the Food Microbiology course, thus having relevant learning experiences to assess perceptions of learning in the course.

2.2. Research Approach

The approach used in this study is a pedagogical approach based on educational theories as a basis for analyzing the learning process [31], [32]. This approach is used to examine students' perceptions regarding their

learning experiences in the Food Microbiology course. Furthermore, this research is supported by a sociological approach that emphasizes social interactions during the data collection process. This sociological approach allows researchers to obtain data through direct relationships with research subjects. In this study, these interactions were conducted with students of the Biology Education Study Program as research respondents.

2.3. Research Population and Sample

Population definition is a crucial step in research because it defines the boundaries of the subjects to be studied. A population is the entire object or subject of research that possesses specific characteristics consistent with the research objectives. A population can also be defined as all individuals or groups that serve as sources of data and information needed by researchers. By clearly defining the population, research results can be more focused and have a measurable scope. In this study, the population used was all students in the Biology Education Study Program, Faculty of Tarbiyah and Teacher Training, who had taken the Food Microbiology course, totaling 83 students.

The sample is a portion of the population selected to represent the characteristics of the entire population. Sampling is used to ensure the research process is more effective and efficient without compromising the validity of the data obtained [33], [34]. The sample in this study consisted of 27 students in the Biology Education Study Program. The sampling technique used was simple random sampling. This technique involves selecting sample members randomly without considering any specific stratification within the population, as all members of the population are assumed to have relatively homogeneous characteristics.

2.4. Research Design

The research design in this study can be seen in Figure 1 below:

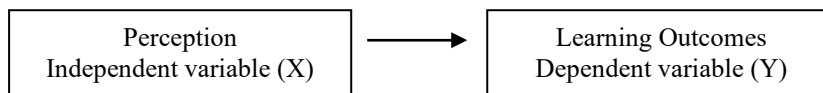


Figure 1. Research Design

2.5. Research Instruments

A research instrument is a tool used to obtain data related to the variables being studied. This instrument serves as a measurement tool to uncover phenomena related to the research object, both social and academic. In developing a research instrument, guidelines in the form of an instrument grid are required so that each variable indicator can be measured systematically. This grid is compiled based on indicators relevant to the research objectives. With an instrument grid, the data collection process can be conducted in a more focused and structured manner.

In this study, the instrument used was designed to measure students' perceptions of the Food Microbiology course. The instrument took the form of a questionnaire designed based on predetermined perception indicators. The questionnaire was used to obtain data regarding students' views, assessments, and responses to the learning process in the course [35], [36]. Meanwhile, data on student learning outcomes was obtained through available academic grade documentation. Therefore, learning outcome variables were not included in the questionnaire questions but were analyzed based on grade documentation obtained from relevant parties. The grid for the perception questionnaire used in this study can be seen in Table 1 below:

Table 1. Perception Questionnaire Grid

| Variable | Indikator | Item Number |
|------------|--|-----------------------|
| Perception | Connecting objects through the five senses (Sensation) | 2,4,9,18,19 |
| | Attention to objects (Attention) | 1,6,7,10,11,13,17 |
| | Interpreting objects (Interpretation) | 3,5,8,12,14,15, 16,20 |

After the questionnaire outline was compiled, the next step was to develop a questionnaire guideline containing several statements related to students' perceptions of the Food Microbiology course. This questionnaire used a Likert scale to measure respondents' level of agreement with each statement. The alternative answers provided were Strongly Agree, Agree, Undecided, Disagree, and Strongly Disagree. The Likert scale was chosen because it allows for systematic measurement of respondents' attitudes, opinions, and perceptions. This allows the data obtained to be analyzed quantitatively according to the research requirements.

For positive statements, scoring was carried out sequentially from highest to lowest. Respondents who chose Strongly Agree were given a score of 5, Agree a score of 4, Undecided a score of 3, Disagree a score of 2, and Strongly Disagree a score of 1. Conversely, for negative statements, the scoring system was reversed. Respondents who chose Strongly Agree were given a score of 1, Agree a score of 2, Undecided a score of 3, Disagree a score of 4, and Strongly Disagree a score of 5. This scoring system aims to maintain consistency in

data interpretation so that higher scores still indicate a more positive perception of the Food Microbiology course.

2.6. Data Collection Techniques

Data collection techniques in this study utilized several methods tailored to the research needs to ensure accurate and relevant data. The simultaneous use of several techniques aimed to obtain more comprehensive data regarding students' perceptions of the Food Microbiology course and their learning outcomes. These techniques complement each other, supporting the completeness of the information needed for the study. Thus, the data obtained can provide a more objective picture of the variables studied. The data collection techniques used included observation, questionnaires, and documentation. Observations were conducted while students were attending the Food Microbiology course. The type of observation used was participant observation, in which the researcher was directly involved in the learning situation alongside the research subjects [37]. This technique allowed the researcher to directly observe student activities during the course. Through observation, the researcher was able to obtain supporting information regarding the learning conditions and student responses to the material taught. The results of the observations were used as supplementary data to understand students' perceptions of the course.

In addition to observation, data collection was also conducted through the distribution of questionnaires to the research respondents. The questionnaires were used to obtain data on students' perceptions of the Food Microbiology course. Each respondent was asked to provide written answers to a number of statements based on their learning conditions and experiences. This instrument was constructed using a Likert scale, allowing for quantitative data measurement. The data obtained from the questionnaire were then analyzed to obtain a comprehensive picture of student perceptions. Documentation techniques were used to obtain data on student learning outcomes in the Food Microbiology course. This data was obtained through academic archives or grade documents available in the study program. Documentation was chosen because it provides objective and accountable data. These learning outcomes were used as indicators of student academic achievement in this study. Furthermore, the documentation data was analyzed along with student perception data to determine whether perceptions influenced learning outcomes.

2.7. Data Analysis Techniques

The data analysis technique in this study was conducted through two stages: descriptive statistical analysis and inferential statistical analysis. Both stages were used to obtain a comprehensive overview of the data and to test the formulated research hypotheses. Descriptive statistical analysis aims to describe the characteristics of data obtained from respondents without generalizing to the broader population. Meanwhile, inferential statistical analysis was used to examine the relationship and influence between student perception variables and learning outcomes in the Food Microbiology course. By using these two analytical techniques, the research results are expected to provide objective and measurable information. Descriptive statistical analysis was used to describe the research data as it is based on the results of field data collection [38]. This analysis aimed to obtain a general overview of student perceptions and learning outcomes in the Food Microbiology course. The steps taken in descriptive analysis include determining the data range, determining the number of interval classes, calculating the interval class length, calculating the mean value, standard deviation, and percentage. These calculations were performed to systematically present the data distribution to facilitate interpretation. The results of the descriptive analysis were then used as a basis for understanding trends in the research data.

Next, inferential statistical analysis was used to test the research hypotheses and determine the relationship between the independent and dependent variables. The initial stage of inferential analysis was conducted through prerequisite tests, including normality, homogeneity, and linearity tests. The normality test was conducted to determine whether the research data were normally distributed. The homogeneity test was used to ensure that the data came from homogeneous variances. The linearity test aimed to determine whether the relationship between student perception variables and learning outcomes was linear. After the prerequisite tests were met, the analysis continued with a correlation test using the Product Moment correlation. This analysis aimed to determine the level of relationship between student perceptions of the Food Microbiology course and their learning outcomes. The obtained correlation coefficient values were then interpreted based on the level of relationship categories, ranging from very low to very strong. Correlation analysis provides an overview of the direction and strength of the relationship between variables. Thus, it can be determined whether student perceptions are statistically related to learning outcomes.

To determine the magnitude of the influence of perception variables on learning outcomes, this study used simple linear regression analysis. This analysis is used to construct a regression equation that describes the functional relationship between the independent and dependent variables. The regression equation can be used to determine the extent of changes in learning outcomes influenced by changes in student perceptions. Furthermore, a regression F-ratio test was also conducted to determine the feasibility of the regression model used. This analysis is crucial to ensure that the developed model can be used to explain the relationships between variables.

The next step is to test the significance of the regression coefficients, which aims to determine whether the influence of student perception variables on learning outcomes is statistically significant. This test is conducted by comparing the calculated statistical value with the critical value at a certain significance level. If the test results show a significant value, the research hypothesis is accepted. Conversely, if it is not significant, the research hypothesis is rejected. The results of this test serve as the primary basis for drawing research conclusions. Through a series of data analysis techniques, this study is expected to provide a clear picture of student perceptions in the Food Microbiology course, the learning outcomes achieved, and the interplay between the two. The use of descriptive and inferential statistical analysis allows for systematic and scientific processing of the data. The results of the analysis will then be used to answer the research problem formulation. Thus, the conclusions obtained can be academically justified. Furthermore, the research results can also serve as a reference in developing more effective learning strategies in the future.

3. RESULTS AND DISCUSSION

3.1. Descriptive Statistical Analysis of Student Perceptions

Table 2. Frequency Distribution and Percentage of Perception

| Interval Class | Frequency (f) | Percentage (%) |
|----------------|---------------|----------------|
| 62 – 65 | 3 | 11.11 |
| 66 – 69 | 4 | 14.81 |
| 70 – 73 | 6 | 22.22 |
| 74 – 77 | 6 | 22.22 |
| 78 – 81 | 4 | 14.81 |
| 82 – 85 | 4 | 14.81 |
| Amount | 27 | 100 |

The results of the descriptive statistical analysis of student perception obtained an average value of 73.87 in the interval 74-77 in the medium category. The percentage of student learning outcomes in the medium category was 22.22% with a total of 6 people. The percentage of student learning outcomes in the low perception category (below the average interval) and high (above the average interval) were 48.14% and 29.62% with a total of 13 and 8 people, respectively.

3.2. Descriptive Analysis of Student Learning Outcomes

Table 3. Frequency Distribution and Percentage of Student Learning Outcomes

| Interval Class | Frequency (f) | Percentage (%) |
|----------------|---------------|----------------|
| 78 – 80 | 12 | 44.44 |
| 81 – 83 | 1 | 3.70 |
| 84 – 86 | 2 | 7.40 |
| 87 – 89 | 2 | 7.40 |
| 90 – 92 | 3 | 11.11 |
| 93 - 95 | 7 | 25.92 |
| Amount | 27 | 100 |

The results of the descriptive statistical analysis of student learning outcomes obtained an average value of 85.44 in the interval 84-86 with a total of 2 students. The percentage of student learning outcomes in this interval is 7.40%. The percentage of student learning outcomes in the low and high categories are 48.14% and 44.43%, respectively, with a total of 13 and 12 students.

3.3. The Influence of Perception on Student Learning Outcomes

Data normality testing is performed to determine whether research data is normally distributed. This test is essential as a prerequisite for using parametric statistical analysis. In this study, the normality test was used to examine the data distribution of student perception and learning outcomes variables. Data processing was performed using IBM SPSS Statistics software using the Kolmogorov-Smirnov test. The results of the normality test serve as the basis for determining the suitability of the data for subsequent analysis.

The Kolmogorov-Smirnov test is a widely used method for testing data normality because the procedure is relatively simple and objective. This method does not rely on visual interpretation as is the case with normality testing through graphs, thus minimizing differences in interpretation between researchers. The basic concept of this test is to compare the distribution of research data with a standard normal distribution. The standard normal distribution is data that has been transformed into Z-scores and is assumed to be normally

distributed. Through this comparison, it can be determined whether the research data has a distribution pattern approximating a normal distribution.

The basis for decision-making in the Kolmogorov-Smirnov test is determined based on the significance value (Sig.). If the significance value is less than 0.05, the data is considered to be non-normally distributed because there is a significant difference from the standard normal distribution. Conversely, if the significance value is greater than 0.05, the data is considered to be normally distributed because there is no significant difference from the standard normal distribution. This criterion is used to assess the appropriateness of the data before further analysis. The following presents the results of the normality test for the variables studied.

Table 4. One-Sample Kolmogorov-Smirnov Normality Test

| Statistics | Indicator | X | Y |
|---------------------------------|----------------|--------|--------|
| N | | 27 | 27 |
| Normal Parameters ^{ab} | Mean | 74.15 | 85.41 |
| | Std. Deviation | 6.597 | 6.979 |
| Most Extreme Differences | Absolute | 0.083 | 0.225 |
| | Positive | 0.083 | 0.225 |
| | Negative | -0.073 | -0.175 |
| Kolmogorov-Smirnov Z | | 0.431 | 1.170 |
| Asymp. Sig. (2-tailed) | | 0.992 | 0.129 |

Based on the normality test using the Kolmogorov-Smirnov test above, the KSZ value for variable X (learning motivation) was 0.431, and KSZ for variable Y (learning outcomes) was 1.170. The Asymp.Sig. (2-tailed) for variable X was 0.992 and variable Y was 0.129. The results were greater than 0.05 (>0.05), thus concluding that the data were normally distributed and could proceed with regression analysis.

The linearity test was conducted to determine whether there was a significant linear relationship between the two research variables. This test is one of the requirements that must be met before conducting linear regression analysis. In this study, the linearity test was used to ensure that the relationship between student perception variables (X) and learning outcomes (Y) met the linearity assumption. The results of this test serve as the basis for determining the feasibility of using simple linear regression analysis. Thus, the analysis can produce more accurate and reliable results.

Decision-making in the linearity test is based on the significance value (Sig.) obtained from the statistical test results. If the significance value is greater than 0.05, then the relationship between variables X and Y is declared linear. Conversely, if the significance value is less than 0.05, then the relationship between the two variables is declared non-linear. This criterion is used as a reference in assessing the pattern of relationships between variables. The results of the linearity test are then considered in implementing the regression analysis in this study.

Table 5. ANOVA Linearity Test

| Variable | Source of Variation | Sum of Squares | df | Mean Square | F | Sig. |
|--------------------------------------|---------------------------|----------------|----|-------------|-------|-------|
| Learning Outcomes*Student Perception | Between Groups (Combined) | 768.019 | 18 | 42.668 | 0.685 | 0.761 |
| | Linearity | 1.682 | 1 | 1.682 | 0.027 | 0.874 |
| | Deviation from Linearity | 766.336 | 17 | 45.079 | 0.723 | 0.728 |
| | Within Groups | 498.500 | 8 | 62.313 | - | - |
| | Total | 1266.519 | 26 | - | - | - |

Based on the ANOVA test results to test for linearity of the data, the calculated F value was 0.723 with a significance value (Sig.) of 0.728. Next, the calculated F value was compared with the F table value of 3.20 to provide a basis for decision-making. The comparison showed that the calculated F value was smaller than the F table value (0.723 < 3.20). Furthermore, the obtained significance value was also greater than the 0.05 level of significance (0.728 > 0.05). Based on the linearity testing criteria, it can be concluded that there is a linear relationship between student perception variables and learning outcomes.

Correlation analysis is used to determine the level of relationship or interconnection between research variables through a statistical approach. This analysis aims to measure the strength and direction of the relationship between the independent and dependent variables. Through correlation analysis, it can be determined whether the relationship between variables is positive, negative, or no relationship at all. The results of this analysis provide an initial overview of the relationship between student perceptions and learning outcomes. Thus, correlation analysis is a crucial step in identifying patterns of relationships between variables.

Meanwhile, regression analysis is used to predict the magnitude of changes in the dependent variable (Y) based on changes in the independent variable (X). This technique allows researchers to determine the extent of influence of the independent variable on the dependent variable. In this study, regression analysis was used to predict student learning outcomes based on their level of perception of the Food Microbiology course. Through this analysis, the direction of influence and the magnitude of the perception variable's contribution to learning outcomes can be determined. Therefore, regression analysis plays a crucial role in quantitatively answering research hypotheses.

Tabel 6. Model Summary

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|-------|------------------|----------|-------------------|----------------------------|
| 1 | .90 ^a | .55 | .35 | 7.05628 |

The R figure of 0.90 shows that the correlation between perception variables and learning outcomes is strong.

Tabel 7. Model ANOVA^b

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|-------|------------|----------------|----|-------------|-------|--------------------|
| 1 | Regression | 5.888 | 1 | 5.888 | 0.118 | 0.034 ^a |
| | Residual | 1244.779 | 25 | 49.791 | - | - |
| | Total | 1250.667 | 26 | - | - | - |

The probability value in the Sig. (significant) column is 0.034, which is smaller than the SPSS standard of 0.05 or 5 percent, the regression model can be used to predict the dependent variable.

Tabel 8. Coefficients^a

| Model | Variable | Unstandardized Coefficients (B) | Std. Error | Standardized Coefficients (Beta) | t | Sig. |
|-------|--------------------|---------------------------------|------------|----------------------------------|-------|-------|
| 1 | (Constant) | 7.960 | 16.096 | - | 5.651 | 0.000 |
| | Persepsi Mahasiswa | 0.075 | 0.217 | 0.069 | 0.344 | 0.734 |
| 2 | (Constant) | 1.040 | 1.335 | - | 4.015 | 0.000 |

The results of this study indicate that students' perceptions of the Food Microbiology course are in the moderate category. This indicates that most students have a fairly positive view of the learning process, material, and learning experiences they gain during the course. Perceptions in the moderate category can be influenced by various factors, such as the learning methods used, the difficulty level of the material, and the students' ability to understand food microbiology concepts, which tend to be abstract and applied. In the context of science learning, students' perceptions are often formed through repeated learning experiences, especially when they encounter material that requires in-depth conceptual understanding. Therefore, students' perceptions that are not yet fully in the high category indicate that there is still room for improvement in the learning strategies used.

The Food Microbiology course requires mastery of basic concepts of microorganisms, fermentation processes, food safety, and the analysis of microbial contamination in food. The complexity of this material can be challenging for students, especially if the presentation is not fully linked to real-world contexts or adequate laboratory practice. According to constructivist learning theory, students' understanding will develop optimally if they are able to connect theoretical concepts with direct experience. When this relationship isn't strong, students tend to perceive the course as difficult to understand. This may explain why student perceptions remain moderate and not entirely positive.

On the other hand, student learning outcomes demonstrate that academically, students have achieved the established learning standards. This indicates that even though students' perceptions are not yet at a very high level, they can still demonstrate good academic performance. This suggests that learning outcomes are influenced not only by perceptions but also by other factors such as intrinsic motivation, learning discipline, initial academic abilities, independent learning strategies, and a supportive learning environment. In higher education, students generally possess academic adaptability that enables them to achieve optimal learning outcomes despite facing certain perceptions of course difficulty. Thus, perception is a supporting factor, but not the sole determinant of learning success.

The results of the prerequisite analysis tests, which showed a normal data distribution and a linear relationship, provided a strong statistical foundation for further analysis of the relationships between variables. These findings indicate that the relationship between student perceptions and learning outcomes can be analyzed parametrically using a simple linear regression approach. Methodologically, the fulfillment of the assumptions of normality and linearity strengthens the validity of the analysis. Furthermore, this condition indicates that the

research data meets the standards for producing more objective interpretations. Therefore, the results of the correlation and regression analyses can be used as a basis for explaining the relationship between the two research variables.

The strong correlation between student perceptions and learning outcomes indicates that perceptions are closely related to student academic achievement. This aligns with educational psychology theory, which states that positive perceptions of a course can increase student engagement in the learning process. Students who view a course as relevant and interesting tend to be more active in attending lectures, engaging in discussions, and studying the material independently. This more intensive learning activity ultimately has the potential to improve learning outcomes. These findings reinforce the view that the affective dimension of learning plays a significant role in student cognitive achievement.

However, the regression coefficient results indicate that the influence of perceptions on learning outcomes is not entirely dominant. This suggests the possibility that student learning outcomes in the Food Microbiology course are also influenced by other variables not measured in this study. Factors such as students' basic biology competencies, intensity of out-of-class learning, laboratory facilities, quality of interactions with lecturers, and readiness for learning evaluations may be additional variables influencing academic achievement [39], [40]. These findings emphasize that learning outcomes are a multidimensional phenomenon that cannot be explained by a single factor. Therefore, a more comprehensive approach is needed to improve student learning outcomes.

Practically, the results of this study provide important implications for the development of Food Microbiology learning in higher education. Lecturers need to design learning strategies that foster positive student perceptions through more interactive, contextual, and applied approaches. Strengthening practical-based learning, food safety case studies, and the use of digital learning media can be alternatives to increase student interest and perceptions of this course. Furthermore, educational institutions need to provide adequate learning facilities to enhance students' learning experiences. By creating a more positive perception, it is hoped that the quality of the learning process and student learning outcomes in the Food Microbiology course can continue to improve.

The findings of this study provide important implications for the development of learning strategies in higher education, particularly in Food Microbiology courses. The significant relationship between student perceptions and learning outcomes indicates that affective aspects of learning play an important role in supporting academic achievement. Positive student perceptions can encourage greater engagement, motivation, and participation during the learning process, which ultimately contributes to improved learning outcomes. Therefore, lecturers are encouraged to design more interactive, contextual, and student-centered learning approaches to strengthen positive perceptions toward the course. The integration of laboratory-based activities, problem-based learning, digital learning media, and real-world food safety case studies may enhance students' learning experiences and conceptual understanding. Furthermore, this study contributes to the educational field by providing empirical evidence that student perceptions should be considered as an important factor in evaluating and improving the quality of instruction in applied science courses at the university level.

This study has several limitations that should be considered when interpreting the findings. First, the study involved a relatively small sample size consisting of students from a single study program at one university, which may limit the generalizability of the results to broader educational contexts. Second, the study only examined student perceptions as an independent variable influencing learning outcomes, while other potential factors such as learning motivation, prior academic ability, learning styles, teaching quality, and laboratory facilities were not included in the analysis. Third, the use of self-reported questionnaires may introduce response bias because students' answers may be influenced by subjective judgments or social desirability. In addition, the cross-sectional design of the study only describes relationships between variables at one point in time and does not fully explain causal relationships. Therefore, future studies are recommended to involve larger and more diverse samples, include additional influencing variables, and apply longitudinal or mixed-method approaches to obtain a more comprehensive understanding of factors affecting student learning outcomes in Food Microbiology courses.

4. CONCLUSION

Based on the results of the study conducted on 27 students as a sample, it can be concluded that the main objectives of this study have been achieved, namely to determine the description of students' perceptions of the Food Microbiology course, determine student learning outcomes, and analyze the influence of perceptions on learning outcomes. The results of the analysis show that students' perceptions of the Food Microbiology course are generally in the moderate category, which indicates that students have a fairly good view of the learning process although there are still variations in perceptions among respondents. Meanwhile, student learning outcomes are generally in the good category, which indicates that most students have been able to achieve the expected learning competencies. Furthermore, the results of the inferential analysis prove that student

perceptions have an influence on learning outcomes in the Food Microbiology course. This finding indicates that the more positive students' perceptions of the course being studied, the greater the opportunity to achieve optimal learning outcomes, so that student perceptions are one of the important factors that need to be considered in efforts to improve the quality of learning. Future research is recommended to involve larger and more diverse samples from different universities to improve the generalizability of the findings regarding the relationship between student perceptions and learning outcomes in Food Microbiology courses. In addition, future studies should examine other influencing variables such as learning motivation, self-regulated learning, teaching methods, and laboratory-based learning experiences using mixed-method or longitudinal approaches to obtain a more comprehensive understanding of factors affecting student academic achievement.

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AUTHOR CONTRIBUTIONS

Conceptualization, I. and P.M.; Methodology, I.; Software, I.; Validation, I. and P.M.; Formal Analysis, I.; Investigation, I.; Resources, I.; Data Curation, I.; Writing – Original Draft Preparation, I.; Writing – Review & Editing, I. and P.M.; Visualization, I.; Supervision, P.M.; Project Administration, I.; Funding Acquisition, P.M.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

USE OF ARTIFICIAL INTELLIGENCE (AI)-ASSISTED TECHNOLOGY

Not applicable.

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