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Perceptions of Prospective Physics Teachers on the Application of Statistics in Education

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ABSTRACT

The Application of Statistics in Education (ASE) course is one of the courses attended by pre-service physics teachers to enable them deal with research data using statistical analysis. This study aims to analyse students' perceptions of the ASE material prior to attending the lectures. The research method employed is descriptive quantitative. The research sample consists of 37 students in the Physics Education study program who are taking the ASE course. Data were collected through the Student Perception towards Statistics Questionnaire (SPSQ) instrument, which comprises 40 statements with four Likert scale rating criteria: Strongly Agree, Agree, Disagree, and Strongly Disagree. The data were analysed using Rasch modeling, specifically Wright Map Analysis, to map participant perceptions, while the percentage agreement of participants was analysed based on four aspects of the SPSQ questionnaire. The results of the average percentage analysis of participants' agreement for each aspect are: (1) attitude towards Statistics at 97.3%, categorized as very good, (2) the importance of Statistics in daily life and profession at 97.3%, categorized as very good, (3) the ability to process statistical data using data analytics tools at 37.84%, categorized as poor, and (4) the ability to apply Statistics in education at 8.8%, categorized as very poor. Furthermore, the Wright Map Analysis indicates that all participants had a favorable attitude and were eager to learn more about how statistics are implemented in education. They agreed that it is critical to master and be able to apply advanced statistics techniques in educational and research contexts.

Keywords:

perception
pre-service physics teachers
statistics application

INTRODUCTION

Perception is another term for an individual's view or opinion on something (Sutrisman, 2019). If students have a positive perception of their learning, they are more likely to achieve success. Vetter & Newen (2014) stated that perception is a constructive process involving prior knowledge and experience (Vetter & Newen, 2014). According to Altman in 2016, perception is the process by which humans capture stimuli and interpret them in meaningful ways (Altman, 2016). As a result, perception is crucial since it can impact students' learning performance in any subject.

At the university level, undergraduate students study Statistics, including those in the Physics Education program. Statistics is the science of managing and analysing data. The term "Statistics" refers to data or the results of data analysis, whereas "statistical science" is the study of data. Generally, statistics is used to describe or draw conclusions from data, often with probability theory (Purwaningrum & Sari, 2019). Statistics is widely used in research across various fields, such as economics, business, education, and others (Hijazi & Zoubeidi, 2017; Kovacs et al., 2023).

The statistics course is very important as it helps students understand and use information and numbers effectively, which is necessary for making data-driven decisions (Wijaya et al., 2016). Students take statistics courses with various views on statistics. Although statistics is a branch of mathematics, it involves other activities that require judgment (Dani & Al Quraan, 2023). In learning statistics, basic mathematical skills such as arithmetic operations are insufficient. Students also need to understand how to present data in graphs, use x and y axes, calculate data with formulas, and the concept of probability. The statistics course aims to enable

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students to understand statistical concepts and procedures, as well as implement them in analysing research problems (Muhtadin, 2023).

In the context of physics education, a good understanding of statistics is very important, especially in analysing experimental and research data. Understanding statistical methods for data analysis and the ability to interpret quantitative information are essential for conducting quantitative research. However, students often find it challenging to operate statistics and understand the results. Research conducted by Dani & Al Quraan (2023) shows that students often find statistics and quantitative topics more difficult compared to other fields, and their negative attitudes often become the main obstacle. Many students tend to avoid using quantitative methods and prefer qualitative research approaches. Research shows that student motivation, lecturer influence, statistical understanding, and data analysis skills significantly affect their ability in quantitative research (Dani & Al Quraan, 2023). In the context of physics education, prospective teachers often face challenges in understanding and applying statistical concepts effectively. High motivation and support from lecturers can enhance statistical skills for students or prospective teachers. However, a deep understanding and good data analysis skills are key factors that determine how they apply statistical knowledge in their educational practice. Therefore, it is critical to evaluate how prospective physics teachers understand and apply statistics in education.

Previous studies have not extensively revealed the perceptions of prospective physics teachers towards the application of statistics, and existing research results are often influenced by their views on mathematics in general. In Indonesia, few studies report students' perceptions of statistical material, especially its application in education. According to Male & Lumbantoruan (2020), most students have a positive perception of statistics. However, they find it difficult to communicate statistical results and view statistics as a challenging subject (Male, 2020). The purpose of this study is to analyse the perceptions of prospective physics teachers towards the application of statistics in education using Wright Map Analysis (Rasch modeling).

The purpose of this study is to explore and understand the perception of prospective physics teachers towards the application of statistics in education. The research focuses on how these prospective teachers assess the importance of statistics in the teaching and learning process, as well as how they integrate statistical concepts into the physics curriculum. By exploring this view, it is hoped that this study can identify the challenges and opportunities faced by prospective physics teachers in applying statistics, as well as provide recommendations that can improve their competence in using statistics to improve the quality of physics education. The benefits of this research include an increased understanding of the perception of prospective physics teachers towards statistics, which can be used to develop more effective and relevant training programs and curricula. In addition, the results of this study can help education policymakers in designing better strategies for the integration of statistics in physics education. Ultimately, this research is expected to contribute to improving the quality of physics teaching and learning through better and effective use of statistics.

METHOD

This study employs a descriptive quantitative method to analyse the perceptions of prospective physics teachers on the use of statistics in education. The descriptive quantitative method is an approach within quantitative research that focuses on depicting and describing the characteristics of a phenomenon or variable based on numerical data (Ahyar et al., 2020; Kuantitatif, 2016). This method is used to systematically collect, organize, and analyse data to obtain a clear picture of the phenomenon under study. The research sample consists of 37 second-year (Academic year of 2022/2023) and third-year (Academic year of 2021/2022) undegraduate students from the Physics Education study program, comprising 11 male and 26 female students. The students involved in this study are those who will take the Applications of Statistics in Education (ASE) course during the Short Semester of the 2023/2024 academic year.

The instrument used in this study is the Student Perception towards Statistics Questionnaire (SPSQ), designed to measure various aspects of students' perceptions of statistics in education. This questionnaire consists of 40 statements, including 4 negative and 36 positive statements, grouped into 4 aspects: (1) attitude towards statistics, covering interest and difficulties in learning statistics; (2) the importance of statistics in daily life and profession, encompassing views on the relevance of statistics in everyday life and career in education; (3) the ability to process statistical data using data analytics tools, including the use of statistical software such as Excel and SPSS; (4) the ability to apply statistics in education, encompassing understanding and applying statistical concepts in an educational context through various statistical tests, including descriptive and inferential statistical tests, hypothesis testing using parametric and non-parametric tests, regression analysis, ANOVA, and others.

In this study, each positive statement is rated using a Likert scale of 1-4, where 1 indicates “Strongly Disagree,” 2 indicates “Disagree,” 3 indicates “Agree,” and 4 indicates “Strongly Agree.” Negative statements are coded oppositely, where 1 indicates “Strongly Agree,” 2 indicates “Agree,” 3 indicates “Disagree,” and 4 indicates “Strongly Disagree.” The SPSQ questionnaire was distributed via the Google Forms platform to ensure efficient and quick data collection.

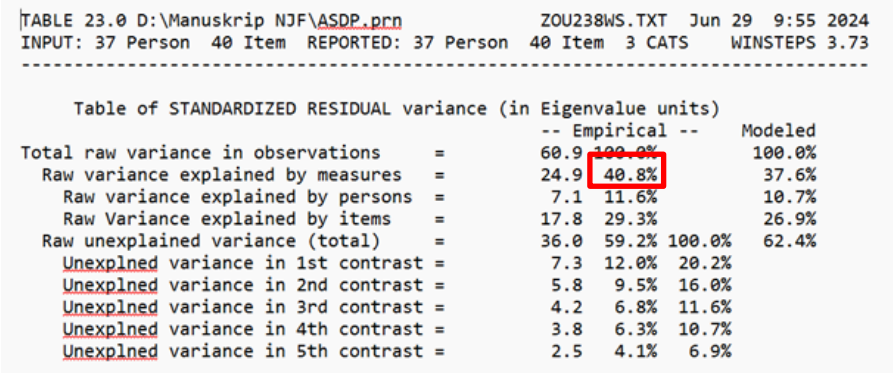
For the validity and reliability tests of the SPSQ instrument, several tests were carried out using Rasch modeling. According to Sumintono (2018), construct validity testing is used in research to determine the extent to which test items or components correspond to the construct being measured (Sumintono, 2018). In this study, the interpretation of the construct validity of the research instrument was conducted using Rasch modeling with Winstep software version 4.5.0. The criteria values used are shown in Table 1 below.

Table 1. Instrument Unidimensionality Value Criteria

Raw Variance Explained by Measures Value (%)	Criteria
> 60	Excellent
> 40	In accordance
> 20	Fulfilled

(Sumintono, 2018)

The results of the Rasch analysis indicate that the raw variance explained by measures is greater than 40%, reflecting that the SPSQ instrument used in this study is “valid”, as shown in Figure 1 below.



```
TABLE 23.0 D:\Manuskrip NJF\ASDP.prn            ZOU238WS.TXT  Jun 29  9:55 2024
INPUT: 37 Person  40 Item  REPORTED: 37 Person  40 Item  3 CATS    WINSTEPS 3.73
-------------------------------------------------------------------------------

     Table of STANDARDIZED RESIDUAL variance (in Eigenvalue units)
                                              -- Empirical --    Modeled
Total raw variance in observations     =         60.9 100.0%          100.0%
  Raw variance explained by measures   =         24.9  40.8%           37.6%
    Raw variance explained by persons  =          7.1  11.6%           10.7%
    Raw Variance explained by items    =         17.8  29.3%           26.9%
  Raw unexplained variance (total)     =         36.0  59.2% 100.0%    62.4%
    Unexplned variance in 1st contrast =          7.3  12.0%  20.2%
    Unexplned variance in 2nd contrast =          5.8   9.5%  16.0%
    Unexplned variance in 3rd contrast =          4.2   6.8%  11.6%
    Unexplned variance in 4th contrast =          3.8   6.3%  10.7%
    Unexplned variance in 5th contrast =          2.5   4.1%   6.9%
```

Figure 1. The SPSQ instrument validity test results

In this study, the reliability analysis of the SPSQ instrument was conducted using Rasch modeling with Winstep software version 4.5.0. This analysis includes person reliability, item reliability, and Cronbach's Alpha. Person reliability indicates the consistency of participants' responses, item reliability reflects the quality of the items in the SPSQ instrument, and Cronbach's Alpha is used to measure the interaction between persons and items overall. The interpretation of these three reliability tests is shown in Tables 2 and 3.

Table 2. Interpretation of Person Reliability and Item Reliability Values

Range of Person Reliability and Item Reliability Values	Interpretation
> 0,94	Excellent
0,91 – 0,94	Very good
0,81 – 0,90	Good
0,67 – 0,80	Enough
< 0,67	Weak

(Sumintono, 2018)

Table 3. Interpretation of Cronbach Alpha Values

Cronbach Alpha Value Range	Interpretation
> 0,80	Very good
0,71 – 0,80	Good

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0,61 – 0,70	Enough
0,50 – 0,60	Bad
< 0,50	Very bad

(Sumintono, 2018)

The analysis of the reliability of the SPSQ instrument using the Rasch model is shown in Figure 2. The interpretation of the person reliability of the Student Perception towards Statistics Questionnaire (SPSQ) falls into the "good" category with a value of 0.83, and the item reliability is 0.92, which is in the "very good" category. Furthermore, the Cronbach's Alpha value is 0.95, which is categorized as "excellent." It can be concluded that the SPSQ instrument used in this study is "reliable".

```
TABLE 3.1 D:\Manuskrip NJF\ASDP.prn              ZOU238WS.TXT  Jun 29  9:55 2024
INPUT: 37 Person  40 Item  REPORTED: 37 Person  40 Item  3 CATS    WINSTEPS 3.73
-------------------------------------------------------------------------------

     SUMMARY OF 37 MEASURED Person

-------------------------------------------------------------------------------
|          TOTAL                          MODEL         INFIT        OUTFIT    |
|          SCORE     COUNT     MEASURE   ERROR      MNSQ   ZSTD   MNSQ   ZSTD |
|-----------------------------------------------------------------------------|
| MEAN      78.2      37.6         .33     .53       .88    -.4    .93    -.4 |
| S.D.       8.0       1.6        1.39     .06       .60    1.8    .84    1.8 |
| MAX.      98.0      40.0        3.30     .59      2.54    4.4   3.22    4.2 |
| MIN.      59.0      35.0       -3.04     .40       .16   -3.0    .09   -2.7 |
|-----------------------------------------------------------------------------|
| REAL RMSE    .57 TRUE SD    1.27  SEPARATION  2.22  Person RELIABILITY  .83 |
|MODEL RMSE    .53 TRUE SD    1.29  SEPARATION  2.43  Person RELIABILITY  .85 |
| S.E. OF Person MEAN = .23                                                   |
-------------------------------------------------------------------------------
Person RAW SCORE-TO-MEASURE CORRELATION = .82
CRONBACH ALPHA (KR-20) Person RAW SCORE "TEST" RELIABILITY = .95

     SUMMARY OF 40 MEASURED (EXTREME AND NON-EXTREME) Item

-------------------------------------------------------------------------------
|          TOTAL                          MODEL         INFIT        OUTFIT    |
|          SCORE     COUNT     MEASURE   ERROR      MNSQ   ZSTD   MNSQ   ZSTD |
|-----------------------------------------------------------------------------|
| MEAN      72.3      34.8        -.80     .65                                 |
| S.D.      10.5       6.3        2.84     .42                                 |
| MAX.      95.0      37.0        4.63    1.93                                 |
| MIN.      42.0      14.0       -8.38     .38       .35   -2.2    .16   -2.2 |
|-----------------------------------------------------------------------------|
| REAL RMSE    .81 TRUE SD    2.72  SEPARATION  3.36  Item   RELIABILITY  .92 |
|MODEL RMSE    .77 TRUE SD    2.74  SEPARATION  3.53  Item   RELIABILITY  .93 |
| S.E. OF Item MEAN = .46                                                     |
-------------------------------------------------------------------------------
Item RAW SCORE-TO-MEASURE CORRELATION = .33
1329 DATA POINTS. LOG-LIKELIHOOD CHI-SQUARE: 972.96 with 1256 d.f. p=1.0000
Global Root-Mean-Square Residual (excluding extreme scores): .3169
```

Figure 2. The SPSQ instrument reliability test results

The data collected from distributing the SPSQ instrument to pre-service physics teachers were subsequently analysed using Wright Map in Rasch modeling. This technique allows researchers to comprehensively map students' perceptions based on their level of agreement with each statement in the questionnaire. Wright Map analysis plots participants' responses against the difficulty scale of the statements. By using Wright Map Analysis, researchers can identify perception patterns and areas where participants feel less confident or have lower understanding. This facilitates a more accurate assessment of teaching needs for more effective and relevant instruction.

Additionally, the percentage of agreement regarding prospective physics teachers' perceptions of the application of statistics in education before taking the ASE course is categorized into four aspects: (1) attitude towards statistics; (2) the importance of statistics in daily life and profession; (3) ability to process statistical data using data analytics tools; and (4) ability to apply statistics in education. The obtained data are then analysed and interpreted with reference to Table 4.

Table 4. Interpretation of Student Responses

Percentage Value (%)	Interpretation
76 – 100	Very good
51 – 75	Good
26 – 50	Bad
0 – 25	Very bad

RESULTS AND DISCUSSION

This study aims to analyse prospective physics teachers' perceptions of the application of statistics in education using Wright Map Analysis. The results of the Wright Map are shown in Figure 3.

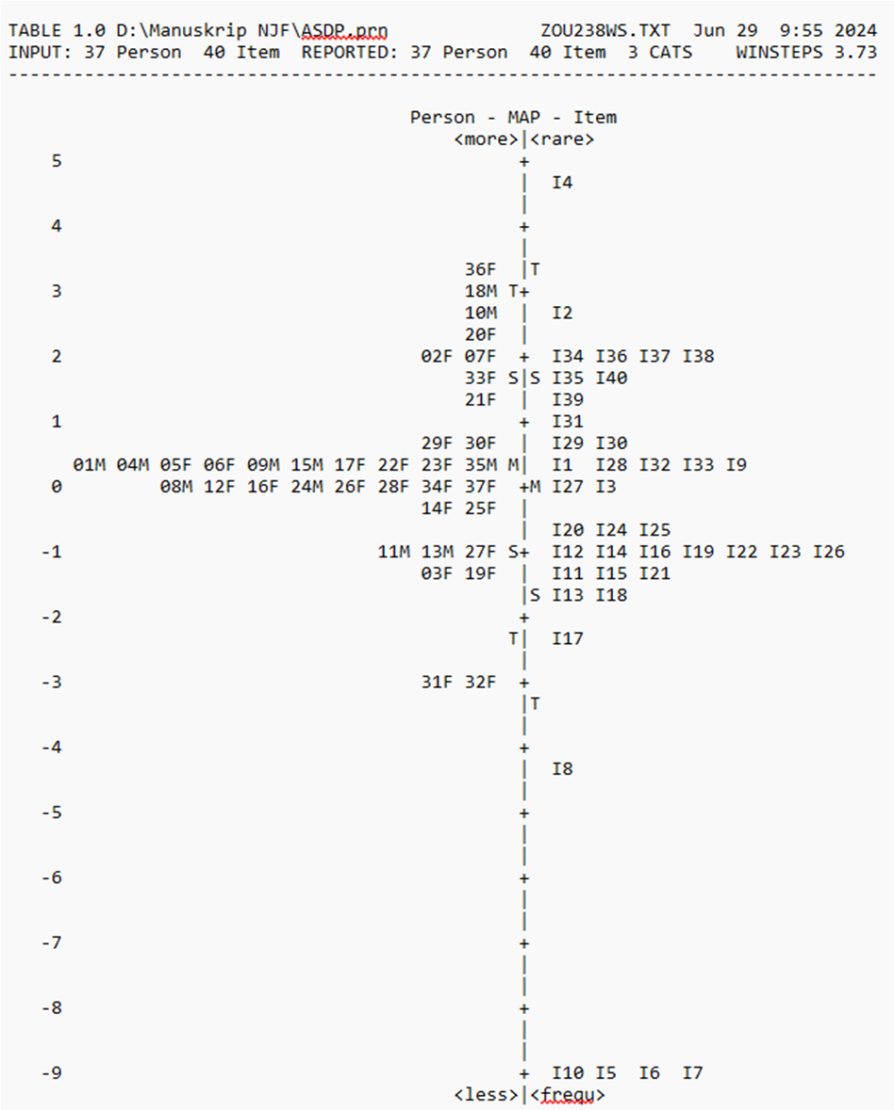

Figure 3. Results of Wright Map Analysis

Based on the data analysis results, several key findings can be identified from the students' responses to the SPSQ questionnaire, which consists of 40 statements (items). Wright Map Analysis depicts the distribution of items (I) on the right and the distribution of people or participants (F for female and M for male) on the left. According to Figure 3, the five statements most agreed upon by all participants are I5, I6, I7, I8, and I10.

Statement I5 is "I am interested and want to gain more knowledge about how statistical applications are used in education." Students' interest in the application of statistics in education indicates a high motivation to

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understand and master this material. Statement I6 is "I want to study the application of statistics in education because it will help me become an independent researcher." Students view statistics as a tool that can support them in becoming independent researchers, showing an understanding of the importance of statistical data processing and analysis in research. Statement I7 is "I want to study the application of statistics in education because it will help me become a quality educator or teacher." This statement emphasizes that prospective physics teacher students see mastery of statistical material as an integral part of being a quality educator and researcher. Statement I8 is "I can process complex statistical data and create diagrams using Excel software." This statement indicates that most students feel confident in processing statistical data using Excel, a crucial skill in data analysis. Finally, statement I10 is "Statistics is important for the profession I choose in the future." Students recognize the importance of statistics in their careers as educators, highlighting the relevance of statistics in the educational profession.

Based on Figure 3, statement I4, which reveals "Understanding and being able to apply statistics in education is not important for an educator or teacher," is the most disagreed upon by all pre-service physics teachers involved in this study. This indicates that all participants strongly disagree with the notion that statistics is not important for educators. Conversely, they recognize the importance of being able to understand and apply statistics in educational contexts. Another statement, I2, which reveals "Mastering statistics is not important for daily life," is also largely disagreed upon by almost all students, except participants 36F and 18M. This finding shows that the majority of students consider statistics to be important for their daily lives.

Other statements that were mostly disagreed upon by the majority of participants include I34, I36, I37, and I38, which relate to the understanding and application of statistical concepts such as Correlation and Regression, Analysis of Variance (ANOVA), and Multivariate Analysis of Variance (MANOVA). These statements were disagreed upon by almost all students, except for a few individuals such as 36F, 18M, 10M, and 20F. This indicates that pre-service physics teachers face difficulties in understanding and applying more complex statistical concepts. These findings are consistent with previous studies indicating that students often struggle to understand advanced statistical material when not supported by proper instruction (Yang, 2017).

Furthermore, in item I39, "I have a good understanding of the concept of effect size," was also one of the statements that almost all students disagreed with, except for 36F, 18M, 10M, 20F, 02F, 07F, and 33F. This shows that the concept of effect size also poses a significant challenge for many students, aligning with previous research indicating students' difficulties in understanding and applying the concept of effect size. Statements I31, I29, and I30, related to participants' understanding and ability to apply hypothesis tests using non-parametric tests such as the Wilcoxon Test and the Mann-Whitney U Test, were also mostly disagreed with by almost all students, except for some participants, namely 36F, 18M, 10M, 20F, 02F, 07F, 33F, and 21F. This indicates that the understanding of advanced statistical tests is still uneven among students. This finding is in line with previous studies revealing that students face difficulties in understanding the Z-Test and Wilcoxon Test and their applications, thus requiring a more interactive and practice-based teaching approach.

Other statements, including I1, I28, I32, I33, and I9, related to participants' attitudes and abilities in processing statistical data, were also among the statements that almost all students disagreed with, except for a few participants: 36F, 18M, 10M, 20F, 02F, 07F, 33F, 21F, 29F, and 30F. This finding reflects that many students continue to struggle with comprehending and implementing various statistical techniques, as well as utilizing data processing tools such as SPSS.

Interestingly, statements I27 and I3 showed a different pattern. Statement I27, "I have a good understanding of the material on N-gain," and I3, "Statistics is a difficult and hard-to-understand subject, making me feel uncomfortable and reluctant to study it," received almost balanced agreement and disagreement from students, with 20 students agreeing and 17 students disagreeing. This shows a significant difference in opinion among students regarding their recognition of understanding the material on N-gain and different views on statistics being a difficult and hard-to-understand subject.

On the other hand, statements I20, I24, I25, I12, I14, I16, I19, I22, I23, I26, I11, I15, I21, I13, I18, and I17 were agreed upon by almost all participants, except for seven students, as shown in Figure 3. These statements include the ability to understand and apply statistics in various contexts, such as Descriptive and Inferential Statistics, Data Levels and Presentation, Sampling Techniques and Sampling Distributions, Normality Tests, Homogeneity Tests, and hypothesis testing using parametric tests. These findings indicate that most participants are confident in their understanding and ability to apply various statistical concepts in data processing, even though this confidence does not necessarily reflect the actual condition.

The results of the analysis for the average percentage of students' agreement with the statements on the SPSQ questionnaire for each aspect are as follows: (1) attitude towards statistics at 97.3%, categorized as very good, (2) the importance of statistics in daily life and profession at 97.3%, categorized as very good, (3) the

ability to process statistical data using data analytics tools at 37.84%, categorized as poor, and (4) the ability to apply statistics in education at 8.8%, categorized as very poor.

The study results demonstrate that students' attitudes towards statistics, including their interest in studying statistical material, are already very good. In fact, 86.49% of participants like statistics material, although 89.19% of students agree that statistics is a difficult and hard-to-understand subject. Furthermore, all students involved in this study expressed their interest in gaining knowledge about the application of statistics in education, since it may help them become independent researchers and excellent instructors. 91.89% of students agree that statistics are relevant in daily life, and all students agree that learning statistics is important to support their future profession, especially as educators or teachers. This is in line with Cahyo & Habibullah (2023), who stated that understanding statistics significantly impacts the quality of research in education and teaching. However, the condition of participants involved in this study shows that not all of them have good skills in processing statistical data using data analytics tools (Cahyo & Habibullah, 2023). Specifically, only 8.1% of participants agree that they can analyse statistical data using SPSS software. Regarding the last aspect, which is related to the ability to apply statistics in education, the average percentage of students' agreement with the statements on the SPSQ questionnaire is very low at 8.8%. This result reflects that students do not yet have an adequate understanding of statistics or the ability to apply it in data processing and interpreting the results, especially on topics such as Descriptive Statistics, Inferential Statistics, Data Levels and Presentation, Sampling Techniques and Sampling Distributions, Normality Tests, Homogeneity Tests, hypothesis testing using parametric and non-parametric tests, Correlation and Regression, and others. This aligns with Firmansyah (2017), who revealed that the main challenge in mastering statistics among students lies in understanding and applying advanced statistical techniques. In addition, no participant claimed that they had a thorough comprehension of statistics or that they can apply it to data processing and interpretation, particularly in themes such as Analysis of Variance (ANOVA), Multivariate Analysis of Variance (MANOVA), and effect size (Firmansyah, 2017).

This situation serves as a warning and a challenge for educators to provide instruction that can facilitate pre-service physics teachers in mastering and applying statistical material to solve research data processing problems through appropriate statistical analysis. There is a need to consider appropriate and effective pedagogical strategies and teaching materials, as well as create a supportive learning environment in order to develop pre-service physics teachers' abilities to become independent researchers and quality educators in the future.

CONCLUSION

Based on the research conducted, it can be concluded that the perceptions of pre-service physics teachers towards the application of statistics in education, collected through the Student Perception towards Statistics Questionnaire (SPSQ), show positive responses and interest in learning and deepening their knowledge. They recognize the importance of mastering and being able to apply advanced statistical concepts in educational and research contexts, as well as in everyday life. However, the majority of participants agree that they do not have adequate skills in processing statistical data using data analytics tools, such as Excel and SPSS. Additionally, the research findings indicate that participants do not have good understanding and skills in performing complex statistical analyses, including hypothesis testing using parametric and non-parametric tests, Analysis of Variance (ANOVA), and Multivariate Analysis of Variance (MANOVA).

To address the challenges faced by pre-service physics teachers, it is recommended that the statistics curriculum be designed with a more interactive, innovative approach that is directly connected to students' practical experiences, such as using application-based projects and simulations. This approach has been proven effective in helping students understand complex statistical concepts in a more practical and enjoyable way. Furthermore, it is important to implement more personalized and adaptive teaching methods so that each student can receive support tailored to their needs and learning styles. Providing more opportunities for students to engage in research projects will deepen their understanding and better prepare them to apply statistical techniques in professional contexts. With these measures, it is hoped that pre-service teachers can develop into more competent and confident educators and researchers in applying more complex statistics.

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