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STUDENT'S PERCEPTIONS, LEARNING CHALLENGES, AND ACADEMIC PERFORMANCE IN UNDERGRADUATE STATISTICS EDUCATION

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ABSTRACT

Students in undergraduate statistics education must somehow acquire quantitative competence amidst attitudinal and instructional challenges. In this study, relationships among students' perceptions, learning difficulties and academic achievement were explored through quantitative, cross-sectional secondary analysis of data from a survey of 378 students in various academic disciplines. Ten five-point Likert items were used to measure perceptions, questionnaires indicators to measure learning challenges, and self-reported examination marks to measure performance. The following statistical tools were used: descriptive statistics, Pearson correlations and multiple linear regression. The mean of the perceptions of the students was 3.48/5 which was moderately favourable and the average examination score was 76.33/100. Overall engagement was positively correlated with the examination performance ($r = 0.454$, $p < .001$), reporting perceptions ($r = 0.255$, $p < .001$), but not reporting learning challenges ($r = -0.372$; $p < .001$). A regression model with 372 complete cases accounted for 31.2% of the variation in examination scores. There were significant positive correlations between perception score and marks, and between engagement score and marks, and a significant negative correlation between challenges reported and marks. Some of the common problems were reported as 'Not enough practice tasks', 'Not enough use of computer software for statistical analysis', and 'Issues with the teaching methods'. The results confirm the need for better practical learning opportunities and supportive teaching, but are limited by self-reported marks, inconsistent responses to challenges, and a cross-sectional design. Further studies should confirm academic achievement and use standardized assessment tools.d there are no individual assessment components, which limits the interpretation of the results.

Keywords – Undergraduate Statistics Education; Students' Perceptions; Learning Challenges; Academic Performance; Student Engagement

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1. Introduction

Undergraduate education in statistics is essential for cultivating analytical thinking, quantitative literacy, and evidence-based decision-making in the student body. Statistical knowledge helps students understand research results, analyse numerical data and use analysis in academic areas. Statistics, however, is often considered difficult as it is both mathematically challenging, conceptually difficult and practically difficult. Attitude towards Statistics has been emphasized in medical students' research (Althubaiti, 2021). The contemporary teaching methods increasingly focus on the supportive learning environment and the use of technology in teaching to enhance the learning experience (Al-Haddad et al., 2024; Da Silva & Moura, 2020).

Students' perceptions can have a significant effect on their motivation, confidence, engagement and willingness to learn the statistical concepts. There is a relationship between positive perceptions and active classroom participation, as well as between negative perceptions and avoidance behavior and decreased classroom engagement. The teaching methods and classroom environment have been analyzed as being important related factors to students' attitudes toward introductory statistics (Bateiha et al., 2020). Differences in statistical attitudes may also be due to individual characteristics, such as mathematical background and personality traits (Chiesi & Bruno, 2021). In addition, students' perceived engagement is based on their experiences in introductory statistics courses (Lawton & Taylor, 2020). As a result, educational strategies based on the use of low-stakes assignments have been studied as ways to enhance students' attitudes toward statistics (Herman & Kerby-Helm, 2022).

Students at the undergraduate level often have learning challenges with respect to mathematical anxieties, statistical interpretation, computational processes, and unknown terms. It is important that statistics anxiety is a psychological hurdle that can present a challenge to concentration, confidence, and academic participation. There have been several findings in previous studies that indicate that students enrolled in social statistics courses are prone to feel anxious from a variety of sources (Condron et al., 2018). The relationship between statistical anxiety and students' attitude, self-efficacy, academic performance and procrastination has also been explored (Dodeen & Alharballeh, 2025). Cross-national studies also highlight the link between statistics anxiety and students' attitudes toward statistics (Korolkiewicz et al., 2025). It is known that innovative teaching methods, such as using animated microlearning materials, can be used to improve statistical learning and create positive attitudes (Huang & Janakiraman, 2025).

It's possible that the attitudes, motivation, engagement, confidence, and learning behaviors of students are correlated with their academic performance in statistics. Achievement-related beliefs and academic self-regulation are important factors in undergraduates' performance in statistics (Corwyn & McGarry, 2020). Studies that have employed structural equation modeling have examined the interrelations between statistical attitudes, mathematical competence, engagement and academic achievement (Lavidas et al., 2020). Likewise, the influence of statistical

performance on attitudes has been studied as a potential mediator between attitudes and anxiety about statistics and/or academic procrastination (Lethbridge et al., 2024). In addition, project-based teaching methods have been explored in their impact on students' perceptions of the relevance of statistics (Huang et al., 2023). Taken together, these results suggest a need to consider psychological and educational aspects along with examination performance.

The present study is intended to examine students' perceptions, learning problems and academic achievement in undergraduate statistics teaching and learning quantitatively by analyzing the students' individual data. In particular, it aims to investigate students' attitudes towards learning statistics, learning problems that are frequently reported, their scores on examinations and statistical relationships between their perceptions, learning problems, and their examination scores. Further, the study will look into the factors that contribute to differences in academic achievement and present recommendations based on evidence to enhance the teaching of undergraduate statistics.

2. Materials and Methods

2.1. Research Design and Approach

The study employed a quantitative and cross-sectional research design to explore the interactions between the perception of students, learning barriers and performance in undergraduate courses in statistics education (Mohamed et al., 2024). Descriptive and inferential statistical tests were applied to secondary survey data to analyze the data. The research was directed towards finding associations and not causal relationships.

2.2. Dataset Description and Study Participants

The data consisted of 378 records of students and 33 variables, such as demographic, learning experiences, perceptions, challenges, and performance on exams. All the respondents said that they studied statistics. The respondents were of varied academic fields and years of study though the fifth and sixth-year respondents had to be verified as undergraduates.

2.3. Research Variables and Measurement Instruments

The measure of the academic performance was self-reported statistics examination marks (TOTAL_MA), with a total of 0 to 100. The perceptions of students were measured with the help of ten Likert-scale five-point items (S1–S10) and a composite perception score (PERCEPTI). The overall challenge indicator (ISTHEREC) and specific indicators of the challenges associated with the teaching practices, learning resources, using software, and solving practical assignments were used to investigate the challenges in learning. The supporting variables were statistics-related anxiety (STRESS_L) and student engagement (OVERAL

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2.4. Data Collection and Dataset Preparation

The research utilized the already gathered survey data, and no primary data was collected. The data set was reviewed according to the missing data, duplication, inconsistent data, and measurement validity. Rating-scale variables had out-of-range values which were considered missing. Differences between the overall challenge indicator and the individual responses to challenges were assessed by measuring them individually. Only valid observations were used to perform statistical analysis.

2.5. Statistical Analysis Techniques

Student characteristics and variables of the study were summarized using descriptive statistics such as frequencies, percentages, means and standard deviations. The internal consistency of the perception scale was measured with the help of Cronbach's alpha. The correlation analysis was used to analyze the relationships between perceptions, anxiety, engagement, and academic performance using Pearson or Spearman correlation analysis as deemed suitable. There is a model of factors which were investigated using multiple linear regression based on the assumption of the model, and depending on the examination scores. The level of statistical significance was considered at $p < .05$ with confidence intervals of 95%.

3. Results

3.1. Demographic Characteristics of Undergraduate Students

The sample size of the respondents who studied statistics was 378. There was almost equal gender representation with 49.7% of the students being male and 50.3% female. The majority of the respondents were 18-24 years old (66.9%), with the biggest academic-year group being the fourth-year (44.7) and third-year (32.5) student groups. The largest percentage of faculty (31.0) belonged to applied sciences, with business administration (18.0) and engineering (15.9) coming in second and third, respectively. The demographic features of 378 students are provided in Table 1, and they are almost evenly balanced regarding gender and there is a high number of students in the age group of 18-24 years, especially in the third and fourth year of study.

Table 1. Demographic Characteristics of Students (N = 378)

Characteristic	Category	Frequency	Percentage (%)
Gender	Male	188	49.7
	Female	190	50.3
Age	18–24 years	253	66.9

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	25–34 years	125	33.1
Academic year	First year	22	5.8
	Second year	37	9.8
	Third year	123	32.5
	Fourth year	169	44.7
	Fifth year	24	6.3
	Sixth year	3	0.8
Faculty	Applied sciences	117	31.0
	Business administration	68	18.0
	Computer science	11	2.9
	Education	9	2.4
	Engineering	60	15.9
	Medicine and health sciences	52	13.8
	Economics	42	11.1
	Social sciences and humanities	17	4.5
	Veterinary and agriculture	2	0.5

Note. Percentages are calculated using 378 respondents. Undergraduate status for fifth- and sixth-year respondents requires confirmation.

The demographic findings indicate representation across multiple academic disciplines, although the sample was concentrated in third- and fourth-year students. This distribution provides a basis for examining statistics learning experiences across different educational backgrounds.

3.2. Descriptive Analysis of Students' Perceptions Toward Statistics

The general perceptions of the students about statistics were moderately favourable (overall perception score 3.48 ± 0.51). The item with the highest level of agreement was the need to make statistics part of each faculty's curriculum (mean = 4.32), while the next was the need to make statistics important across academic fields (mean = 4.05). The statistical formulas were the lowest mean-rated area (3.01), reflecting weaker confidence in this area. The scale of perception had a moderate internal consistency (Cronbach's $\alpha = 0.60$). The differences in each of the ten perception statements are shown in Figure 1. Overall, students had a positive perception of the educational value of statistics, while perceptions about understanding and liking of formulas were in contrast.

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This indicates that perceived usefulness and confidence in learning are two different aspects of students' experiences.

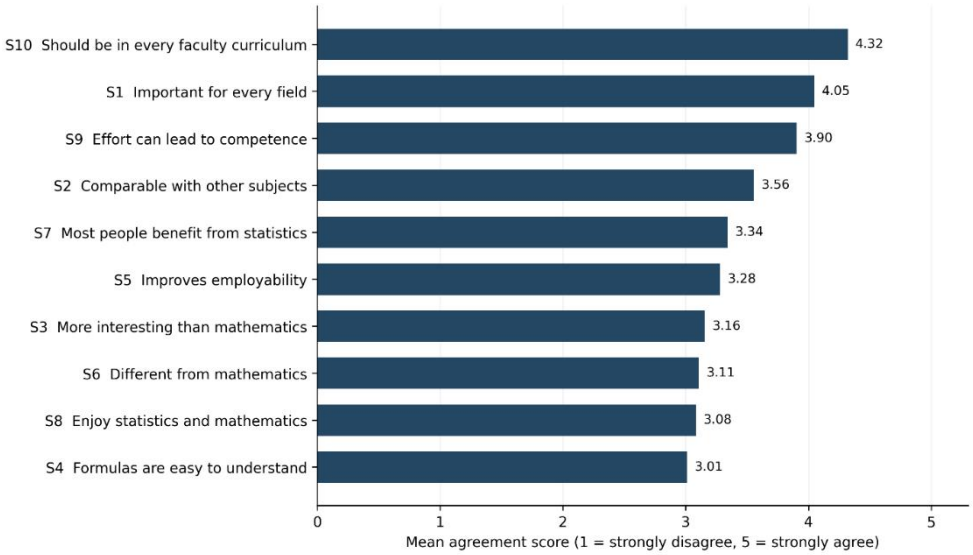

Figure 1. Mean Scores of Students' Perceptions Toward Statistics

3.3. Identification of Major Learning Challenges in Statistics Education

Out of 378 respondents, 111 pupils (29.4%) stated that learning statistics was difficult while 267 (70.6%) pupils responded negatively. The challenge category indicators, however, reported significantly greater frequencies with the most commonly chosen concerns being inadequate practical assignments and lack of statistical software use. The main learning difficulties expressed by the students are summarized in Table 2, with the lack of practical tasks (54.8%) and lack of statistical software use (43.8%) being the most common learning challenges.

Table 2. Reported Learning Challenges in Statistics Education

Learning challenge or response	Frequency	Percentage (%)
Reported statistics learning as challenging	111	29.4
Did not report overall difficulty	267	70.6
Lack of practical assignments	207	54.8
Non-use of statistical software	165	43.8
Inappropriate teaching practices	119	31.5
Disliked statistics lectures	96	25.4
Seeking help from statistics lecturers	93	24.6

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Insufficient learning resources	92	24.3
Other reported concerns	12	3.2

The findings identify limited practical exposure, software-related difficulties, and instructional practices as prominent concerns. Importantly, 266 respondents who answered "No" to the overall challenge question nonetheless selected at least one specific category. This inconsistency requires cautious interpretation of the challenge measures and further validation of the original questionnaire coding.

3.4. Analysis of Academic Performance and Examination Scores

The average mark students reported as being achieved in their exams was 76.33 ± 12.70 (median = 80; range 8-100). The average score was 75 with the majority of scores being in the 60 to 90 range. The subjective performance assessment was based on the self-assessment by students, with 39.2% of them evaluating their performance as good and 16.7% as very good. The average overall engagement was 6.69 ± 1.85 on a ten-point scale, and the average statistics-related anxiety was 4.87 ± 2.12 on a ten-point scale. Figure 2 shows that the marks given in examinations were clustered in the middle band of scores with relatively few at the bottom. Students also rated mean engagement scores of 4.21 prior to the course and 7.59 following the course, but this is a retrospective rating of engagement and cannot be used to provide independent evidence of improvement due to instruction.

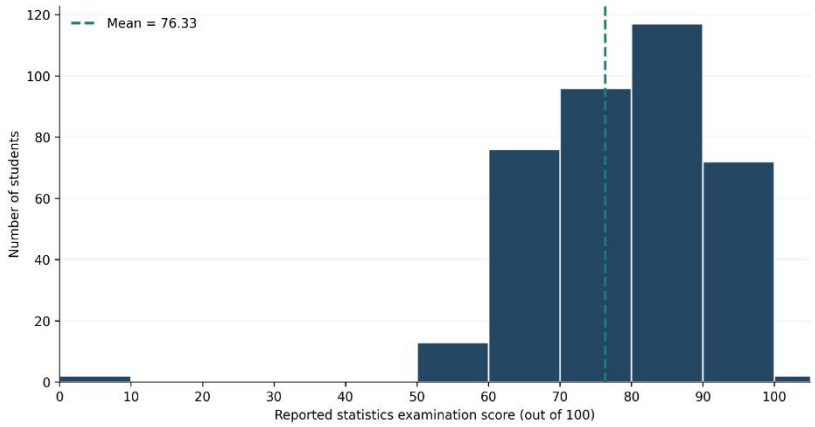

Figure 2. Distribution of Students' Statistics Examination Scores

3.5. Correlation Between Students' Perceptions, Learning Challenges, and Academic Performance

The results showed that academic performance was significantly correlated with most of the learning-related variables using the Pearson correlation analysis. Overall engagement had a

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moderate positive correlation of .454 ($p < .001$) with the examination marks, and with favorable perceptions a weaker positive correlation of .255 ($p < .001$) was observed. The associations with overall learning problems for marks were negative and significant ($r = -0.372$, $p < .001$). Table 3 shows positive significant correlations between academic performance and students' perceptions and engagement, and negative significant correlations between their reported learning challenges and their anxiety related to statistics.

Table 3. Pearson Correlations Between Learning-Related Variables and Academic Performance

Variable	Valid N	Pearson's r	p-value
Students' perceptions	378	0.255	< .001
Reported learning challenges (Yes = 1)	378	−0.372	< .001
Overall engagement	375	0.454	< .001
Statistics-related anxiety	374	−0.125	.016
Engagement before course (retrospective)	375	0.535	< .001
Engagement after course (retrospective)	376	0.472	< .001

Note. Academic performance was measured using examination marks. The correlation involving the binary challenge indicator is a point-biserial correlation, equivalent to Pearson's r with 0/1 coding. Sample sizes differ because of missing or invalid responses.

Retrospectively reported engagement prior to the course was the most positive correlation ($r = 0.535$). There was a weak negative association between statistics anxiety and examination performance. Such correlations show a correlation but not that there were changes in achievement due to perceptions or engagement. Figure 3 shows there is a positive but relatively weak linear relationship between the perception scores and the examination marks. There is a considerable amount of variation among students who have similar perception scores, suggesting that differences in academic performance are not explained by differences in perception.

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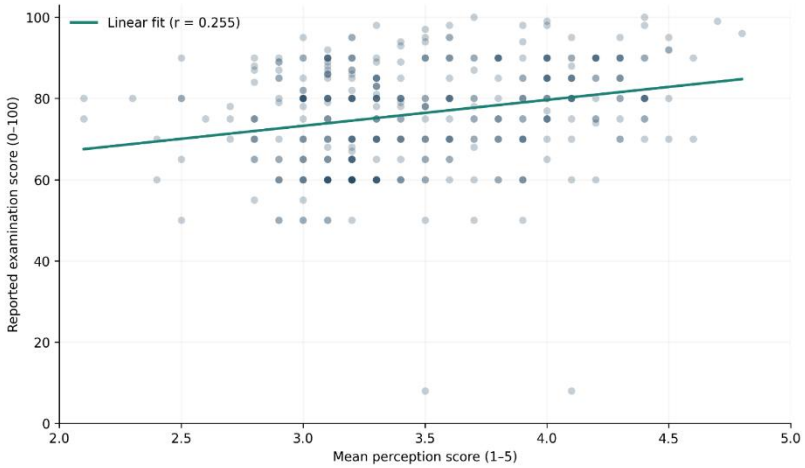

Figure 3. Relationship Between Students' Perceptions and Academic Performance

3.6. Regression Analysis of Factors Associated With Academic Performance

Multiple linear regression was used to look at factors associated with examination performance, controlling for gender, age group and academic year. There were 372 complete observations used for the analysis. The overall model was statistically significant, $F(7, 364) = 23.62$, $p < .001$, explaining 31.2% of the variation in examination scores ($R^2 = 0.312$; adjusted $R^2 = 0.299$). The regression results are shown in Table 4, which shows that students' perceptions and engagement were positively related to examination scores while reported learning challenges were negatively related to examination scores. The model accounted for 31.2% of the variation in performance.

Table 4. Multiple Linear Regression Results for Academic Performance

Predictor	B	95% Confidence Interval	p-value
Intercept	52.722	[42.076, 63.369]	< .001
Students' perceptions	3.862	[1.638, 6.086]	< .001
Reported learning challenges	−6.757	[−9.287, −4.227]	< .001
Overall engagement	2.345	[1.709, 2.981]	< .001
Statistics anxiety	−0.321	[−0.849, 0.207]	.233
Gender (female vs. male)	−0.264	[−2.555, 2.026]	.821
Age (25–34 vs. 18–24 years)	−2.278	[−4.909, 0.354]	.090
Academic year	−0.340	[−1.540, 0.861]	.578

Note. Dependent variable: examination marks out of 100. B represents the unstandardized regression coefficient. Academic year was treated as an ordered numerical predictor. Values are

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based on ordinary least-squares regression.

After adjustment, students' perceptions, general involvement, and reported learning difficulties remained statistically significant predictors. For every one-point increase in perception, there was a corresponding 3.86 one-point increase in examination scores; for every one-point increase in reporting overall challenges, there was a corresponding 6.76 one-point decrease in examination scores. In the adjusted model, there were no statistically significant differences in anxiety, gender, age, or academic year. The positive associations with students' perceptions and engagement, and the negative association with reported learning challenges are depicted in Figure 4. The confidence intervals for the anxiety and demographic variables included zero. Heteroscedasticity and problematic multicollinearity were not apparent, but residual asymmetry and/or inconsistencies in the challenge responses suggest caution in interpretation of the estimates.

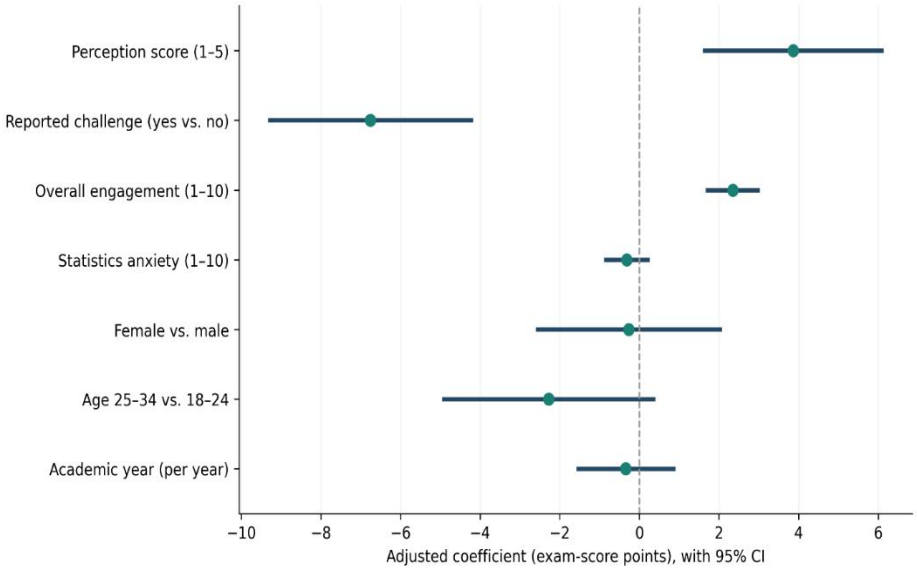

Figure 4. Adjusted Regression Coefficients and 95% Confidence Intervals for Academic Performance

4. Discussion

The results offer insights into students' perceptions, difficulties in learning and performance in undergraduate statistics education. The students' perceptions were moderately favorable (M = 3.48) and their examination scores were relatively high (M = 76.33). There was a positive correlation between overall engagement and academic achievement, while a negative association was found between reported learning challenges and academic achievement. The regression

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model accounted for 31.2% of the variance in examination scores indicating that learning-related characteristics play a role in the variation of academic outcomes. The results are consistent with the studies that highlight motivational beliefs, instructional experiences, and statistical attitudes as factors affecting students' achievement in statistics (Razali et al., 2023).

The perceptions of the students were statistically significantly correlated with performance in the examination ($r = 0.255$, $p < .001$). The regression analysis also showed that after controlling for other variables, higher perception scores correlated with higher academic performance. This finding corroborates past studies that found statistical attitudes related to examination success and to students' expectations for statistical knowledge (MacArthur & Santo, 2023). Observational design does not allow causal inferences, but positive perceptions can foster participation in learning and academic confidence. Other studies have also focused on interventions for enhancing students' attitudes toward statistics and intergroup differences in learning experiences (Condron et al., 2018). However, the relatively low internal consistency of the perception scale is a cautionary note for interpretation.

Higher levels of learning challenges were significantly associated with lower examination scores ($r = -0.372$, $p < .001$). The overall difficulties score was found to be about 6.76 points lower when other regression variables were held constant. Frequently reported were the lack of practical assignments and limited use of software, as well as difficulties with teaching. This is consistent with other studies of instructional barriers, statistical problem-solving challenges, and software-related anxiety (Makwakwa et al., 2024; Miller & Pyper, 2024). Psychological barriers can also be a factor in learning experiences, as evidenced by research on statistics anxiety and related factors (March et al., 2025; McCaughey et al., 2022; Peiró-Signes et al., 2021). Interpretations of responses to overall and specific challenges, however, are limited by the inconsistencies.

The positive correlation found between perceptions and academic performance corroborates earlier studies on statistical attitudes, engagement, and achievement (Lavidas et al., 2020; Lethbridge et al., 2024). This negative relationship was not very strong and was not statistically significant in the adjusted regression model. This distinction illustrates the need to take several factors into account related to learning. There have been other studies that have explored the relationships between statistical anxiety, attitudes, and self-efficacy as well (Mendes et al., 2024; O'Bryant et al., 2021). Students' diversity is also a focal point of research, as is the need for context-specific interpretation. Together, these comparisons provide a multi-faceted perspective on statistics education.

Based on the results, it is recommended that undergraduate statistics education be more practical, involve more use of statistical software, and be supported by more supportive pedagogies. Experiential learning methods might enhance students' conceptual knowledge and the real-world relevance of statistical concepts (Shatzkin et al., 2024). Other strategies to enhance classroom participation and learning feedback include formative assessment and interactive student-response

systems (Muir et al., 2020; Pai, 2025). The use of technology in teaching and a supportive educational setting can also help overcome challenges with statistical concepts (Al-Haddad et al., 2024). Practical lessons, available learning materials, and planned academic support are some of the learning strategies that should be added to the educational program. But the impact of these recommendations needs testing by specifically designed educational interventions.

This cross-sectional design does not allow for causation to be inferred and measurement may be biased by self-reported examination marks. These data cannot independently determine the sampling methods nor the status of respondents as undergraduates. This is further limited by inconsistent challenge responses, inaccurate rating entries, and low perception-scale reliability. Moreover, the regression model resulted in significant residual variation. Future studies should utilize validated questionnaires, verified examination records, and longitudinal or experimental designs. The larger samples in the educational institutions would contribute to generalizability and allow for further examination of instructional practices, statistical anxiety, learning engagement, and academic achievement.

5. Conclusion

This study examined students' perceptions, learning challenges, and academic performance in undergraduate statistics education using survey data from 378 respondents. Statistical perceptions were rated moderately positively by students (mean = 3.48/5) with a mean exam score of 76.33/100. The total engagement had a positive correlation with the examination performance ($r = 0.454$), but reporting learning problems had a negative relationship ($r = -0.372$). There was also a positive correlation between marks and the perception of students ($r = 0.255$). Multiple regression model revealed that 31.2% of the variation in examination scores was explained by the perceptions of students and engagement that were positive predictors, and challenges reported by students were a negative predictor. Among the most commonly reported challenges were the inadequate practical tasks, the insufficient use of statistical software, and the worry regarding the teaching practices. These findings demonstrate the importance of the availability of learning materials, hands-on activities, facilitated learning, and active learning experience in undergraduate statistics courses. Nevertheless, a cross-sectional design, self-administered test scores on the examination, inconsistent responses to challenge questions, and moderate reliability of the perception scale weaken the conclusions. Moreover, the undergraduate status of certain participants should be checked. Validated instruments, confirmed academic records, and longitudinal or intervention-based designs should be used in future studies to elucidate these relationships. Overall, the enhancement of the learning experiences of students and the management of the practical barriers can contribute to the increased outcomes of statistics education.

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