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Student perceptions of online statistics and mathematics learning: A multi-dimensional analysis based on feedback

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Abstract: This study investigates the factors that influence students' perceptions of online learning in statistics and mathematics courses. Using a 28-item survey with a 4-point Likert scale (Cronbach's alpha = 0.9), we analysed seven dimensions of the online learning experience: course textbooks, virtual and physical classes, Learning Management System, utilization, teaching materials, recorded YouTube lectures, PPT, and the role of English as the language of instruction. Key findings reveal that 62% of students are satisfied with virtual classes, 84% prefer YouTube lectures over pre-recorded sessions, and 90% find PPTs helpful. Hypothesis testing (using t-tests and ANOVA) revealed significant differences in student perceptions regarding gender, GPA, university branch, specialization, enrolled course, and employment status. Employed students showed a preference for virtual classes over physical classes and greater confidence in their English language skills. Based on these findings, we recommend improving assessment feedback, enhancing English language support, and strategically using visual aids, particularly in mathematics courses.

Keywords: *English as medium of instruction, Mathematics and statistics education, Online learning, Student perceptions, Teaching tools, Virtual vs physical classes.*

1. Introduction

The increasing demand for accessible and flexible higher education has led to a rapid expansion of online learning, particularly in the fields of Science, Technology, Engineering, and Mathematics (STEM). While online learning offers numerous benefits, ensuring the quality and effectiveness of online STEM courses, especially in quantitative disciplines like statistics and mathematics, remains a significant challenge.

Understanding student perceptions of the online learning environment is crucial for identifying areas of strength and weakness and developing strategies to enhance learning outcomes. Student feedback provides valuable insights into the factors that contribute to student success and satisfaction in online courses, offering a direct pathway for course improvement. However, effectively utilizing student feedback requires a robust and systematic approach.

This research aims to provide a comprehensive understanding of student perceptions in online statistics and mathematics courses, particularly within the context of the Arab Open University in Saudi Arabia. This study investigates the following research questions:

1. What is the validity and reliability of student evaluations in assessing online statistics and mathematics course quality?
2. How do different aspects of the online learning environment (textbooks, PPTs, LMS, etc.) influence student perceptions of statistics and mathematics courses?

To address these questions, this study analyses student feedback collected through a 28-item survey of 460 students from the Faculty of Business Studies, focusing on seven key dimensions of the online learning experience, including course materials, teaching methods, and the role of English as the language of instruction. Participants included students enrolled in online statistics and mathematics

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courses, with data collected on variables such as gender, GPA, specialization, and employment status. The findings of this research will provide valuable insights for instructors, course designers, and administrators seeking to improve the quality and effectiveness of online STEM education.

2. Literature Review

Student feedback plays a vital role in evaluating and improving the quality of higher education. In the online learning context, where interaction between students and instructors can be limited, student perceptions become even more critical. Research has shown that student feedback can provide valuable insights into various aspects of the online learning experience, including course content, instructional strategies, technology utilization, and student support services. Subramanian and Vidalis [1] indicate that there is no proven method to justify whether student evaluations are sufficient for course improvement. It emphasizes the need for effective evaluation rubrics that align with course enhancement.

Caldwell, et al. [2] conducted a qualitative content analysis of student feedback from SETs to identify themes related to teaching effectiveness. Responses analysed to prompts like "Describe the strongest aspect of the instructor's teaching" and "What could the instructor do to improve their teaching effectiveness?" Five key themes emerged: clarity in instruction and activities, alignment of assessments, use of relevant examples, fostering engagement, and demonstrating concern for student learning and success.

However, there are also challenges associated with collecting and interpreting student feedback in online environments, such as low response rates, concerns about anonymity, and the potential for bias (citing studies that discuss these challenges).

Online learning in STEM fields, particularly in quantitative disciplines like statistics and mathematics, presents unique challenges. Students often struggle with abstract concepts and require personalized support to develop problem-solving skills. Li and Pitts [3] found no significant differences in learning outcomes between online and print textbooks but noted higher student satisfaction with online versions due to their ease of access.

Furthermore, the effective use of technology and interactive tools is crucial for engaging students and facilitating their understanding of complex material. Huang and Liu [4] highlighted that interactive features such as multimedia, quizzes, and simulations significantly affect engagement and learning outcomes.

However, some research also suggests that students may prefer print versions or may face challenges in navigating online resources. Jones and Williams [5] reported that while students valued the flexibility of online textbooks, some preferred printed versions for specific subjects. Overall, online textbooks are widely appreciated and extensively utilized by students.

Research suggests that student perceptions of online STEM courses are influenced by factors such as the clarity of instruction, the availability of instructor support, the quality of online resources, and the effectiveness of assessment methods. Bartsch and Cobern [6] reported that students appreciated PPT for content organization and note-taking. Baker, et al. [7] conducted a meta-analysis of 48 studies and found no overall difference in learning between traditional and PPT approaches, with a positive effect on students' cognitive learning. They recommend how specific PPT features support learning.

Online textbooks and learning materials play a crucial role in student learning. Studies have shown that accessibility, interactivity, and multimedia features of online textbooks can positively impact student engagement and satisfaction. The use of virtual classes and recorded lectures has become increasingly common in online learning. Research comparing online and face-to-face instruction in STEM fields has yielded mixed results. In contrast, Arias, et al. [8] compared online and physical class delivery for mathematics and statistics, finding that students in physical classes scored significantly higher on exams and showed greater improvement on instructor-specific questions than their online counterparts.

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Some studies have shown that virtual classes can be as practical as traditional classes, while others have found that students in face-to-face courses tend to perform better. The effectiveness of these modalities likely depends on factors such as the instructional strategies used, the quality of the technology, and the level of student engagement. The use of virtual classes and recorded lectures has become increasingly common in online learning. Research comparing online and face-to-face instruction in STEM fields has yielded mixed results. Sun [9] found that virtual classes are as practical as physical ones in achieving learning outcomes, depending on the instructional strategies and technology used. Some studies have shown that virtual classes can be as helpful as traditional classes, while others have found that students in face-to-face courses tend to perform better. The effectiveness of these modalities likely depends on factors such as the instructional strategies used, the quality of the technology, and the level of student engagement.

Learning Management Systems (LMS) are crucial tools in online and blended learning, offering students convenient access to materials and facilitating instructor interaction. Gupta and Ramesh [10] indicate that practical LMS usage correlates with improved learning outcomes, skill development, and higher course completion rates. Key features, such as discussion forums and online quizzes, contribute to increased student engagement, as noted by Jones and Williams [5]. However, usability and navigation issues can pose challenges, underscoring the importance of user-friendly design. Wang and Hannafin [11] show that LMS platforms are particularly vital in blended learning, supporting communication, collaboration, and providing essential tools for discussion and grade tracking.

Recorded lectures on platforms like YouTube offer students valuable flexibility and the ability to review material at their own pace, which can enhance learning outcomes. Digital platforms, including YouTube, can facilitate interactive and self-paced learning within LMS environments. Joo, et al. [12] in their research suggest that simply providing access to these resources is not enough. Shoufan and Mohamed [13] extensive review of 647 publications demonstrates that YouTube's effectiveness as a learning tool hinges on guided, instructor-led use. Their findings underscore the importance of instructor involvement in ensuring content quality and maximizing the positive impact on student learning.

Midterms and online exams are viewed positively by many students, who report increased motivation and a stronger understanding of the material. This suggests that well-structured assessments can be valuable tools for reinforcing learning and gauging student progress. Carlton [14] highlights several key strategies for adequate midterm preparation, including early planning, detailed notetaking, and utilizing available support resources. The positive impact of frequent quizzes on midterm and final exam performance, as reported by Sotola and Crede [15] further strengthens the argument for incorporating regular assessment opportunities to enhance student learning and academic success.

The use of English as the teaching language in statistics and related fields presents both opportunities and challenges for students. In contrast, some students report gains in confidence, improved language skills, and a sense of global connectedness, as noted by Anderson and Thompson [16]. Others struggle with the complexities of technical vocabulary and precise language. This duality is also reflected in research on mathematics education, which emphasizes the challenges associated with language in quantitative disciplines, as noted by Jourdain and Sharma [17]. Therefore, practical strategies for supporting students in navigating the linguistic demands of online statistics and mathematics courses are essential for maximizing learning and ensuring equitable access to education.

3. Methodology

Data processing and analysis were conducted using SPSS to explore student perceptions of online learning in statistics and mathematics courses. Descriptive statistics, including frequencies and percentages, were calculated, and a correlation matrix was used to examine the relationships among the independent variables. Cronbach's alpha coefficient was used to assess the internal consistency of the 28 study questions.

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Hypothesis Testing, including T-tests and one-way ANOVA, was used to determine if there were significant differences in student perceptions based on selected independent variables (gender, GPA, specialization, employment status).

3.1. Data Collection

Data collection was conducted using an online questionnaire distributed via email to students enrolled in statistics and mathematics courses at the Faculty of Business Studies (FBS) of the Arab Open University. The questionnaire employed a 4-point Likert scale by Likert [18] to assess student perceptions of various aspects of the online learning environment. To ensure content validity, the questionnaire underwent face validation by FBS colleagues, who reviewed the items and suggested adjustments to align with the study objectives. An initial sample of 650 students was surveyed; however, after excluding incomplete responses, a final sample of 460 complete questionnaires was used for analysis during the 2024 academic year.

3.2. Study Participants

Gender distribution (37% male, 63% female).
Course enrolment (57% in BUS101, 43% in BUS102).
Employment status (36% employed, 64% not employed).
Distribution across FBS departments (40% Marketing, 40% Systems, 20% Accounting).
GPA distributions (30% below 2.5, 38.5% GPA between 2.50 and 3.00, and 31.7% higher than 3), while the MTA distribution (37% between 10 and 19.9, and 49% got grades 20-30). These percentages provide an overview of the sample's academic performance.

3.3. Instrument

The questionnaire consisted of 28 items designed to assess student perceptions across seven dimensions of the online learning experience: Statistics and mathematics online textbooks, PowerPoint presentations (PPTs), Virtual and physical classes, Learning Management System (LMS), recorded classes on YouTube, Midterm exams, and English as a teaching language.

4. Data Analysis

4.1. Student Satisfaction

Table 1 presents student satisfaction with different online learning resources. A generally positive trend is evident across all resources, with most students reporting satisfaction (combining the "Very satisfied" and "Somewhat satisfied" categories). However, the degree of satisfaction varies considerably across the different learning resources.

Several key observations can be made. Firstly, students reported the highest levels of satisfaction with the LMS and PPTs, with a combined satisfaction rate of over 86%. This suggests that these tools are particularly effective in supporting student learning in the online environment. The high satisfaction with the LMS likely reflects its role as a central hub for course materials and communication, as noted by Gupta and Ramesh [10]. Similarly, the positive perception of PPTs aligns with research highlighting their value for organizing course content and facilitating notetaking, as noted by Bartsch and Cobern [6] and Baker, et al. [7].

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Table 1.
Student Satisfaction with Online Learning Resources.

Answer	Very Satisfied	Somewhat Satisfied	Somewhat Dissatisfied	Very Dissatisfied
Virtual and Physical classes	46.5	28.1	17.9	7.6
Using LMS	53.4	33.4	11.3	2.0
Using teaching material	50.6	31.9	11.8	5.8
Using YouTube Recorded Classes	36.9	47.5	12.9	2.7
English as a teaching Language of Mathematics	46.9	36.6	12.0	4.5
Using PPT as Teaching Material	55.2	32.1	10.1	2.7

Secondly, while still positive satisfaction with virtual and physical classes was notably lower (74.6%) compared to LMS and PPTs. This difference warrants further investigation. Challenges related to interaction, engagement, or technology in the virtual classroom environment may contribute to this lower satisfaction rate as explained in Gupta and Ramesh [10]

Thirdly, the use of YouTube recorded classes received positive feedback, with a combined satisfaction rate of 84.4%, slightly lower than that of LMS and PPTs. The flexibility and self-paced learning offered by YouTube are likely contributing factors to this positive perception. However, somewhat lower satisfaction compared to LMS and PPTs might suggest that other factors, such as content quality, searchability, or integration with the course, could be further explored as given by Shoufan and Mohamed [13].

Finally, the use of English as the teaching language and teaching materials shows similar satisfaction rates. The positive, but not overwhelming, satisfaction with English as a teaching language (83.5%) may point to the need for additional language support for some students, particularly given the technical vocabulary in statistics and mathematics as explained by Jourdain and Sharma [17] which reflected on mathematics education that emphasizes the challenges associated with language in quantitative disciplines.

This analysis offers valuable insights into students' perceptions of various online learning modalities. The high satisfaction with LMS and PPTs suggests that these tools are effectively supporting student learning. However, the lower satisfaction with virtual classes and the potential challenges related to English as the teaching language highlight areas where further investigation and targeted interventions may be needed. This research will explore this issue in more detail for further analysis and discussion in the context of hypothesis testing.

4.2. Correlation Analysis

Table 2 presents correlation coefficients among the independent variables. The analysis revealed generally low to moderate correlations, suggesting that multicollinearity is not a significant concern for the subsequent analyses. The strongest correlation was between gender and employment status (r = 0.423). While this correlation is moderate, it is not high enough to suggest multicollinearity, which typically becomes a concern above r = 0.7 or 0.8.

This moderate positive correlation suggests that employed students are more likely to be of a particular gender, specifically female. The correlation between GPA and midterm grade (r = 0.405) was also moderately strong and positive, as expected. This indicates that students with higher GPAs tend to perform better on midterm exams. This finding is consistent with the general expectation that academic performance is related across different measures.

The remaining correlations were weak (below |0.2|), indicating that these variables are largely independent of each other. For example, the low correlation between specialization and other variables suggests that students from different specializations do not differ significantly in terms of gender, GPA, midterm grade, or employment status.

Similarly, the very weak correlations between employment status and GPA, specialization, and midterm grade suggest that employment status does not strongly predict or relate to these academic

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variables. The low correlations among the independent variables support the use of these variables in subsequent analyses without concerns about multicollinearity affecting the stability or interpretability of the results.

Table 2.
Correlations among study variables, independent variables.

Correlation coefficient	Gender	GPA	MTA grade	Employment
specialization	0.041	-0.033	-0.042	-0.032
Gender		-0.142	-0.060	0.423
GPA			0.405	-0.039
MTA grade				0.029

4.3. Reliability Analysis and Internal Consistency

Cronbach's alpha is a widely used measure of internal consistency, assessing the degree to which a set of items is interrelated. Values range from 0 to 1, with higher values indicating greater internal consistency. A high Cronbach's alpha suggests that the items measure the same underlying construct, thereby increasing confidence in the validity of the results. In this study, a Cronbach's alpha of 0.903 was obtained for the 28-item survey. This high value reflects excellent internal consistency among the items, indicating that they reliably measure a specific underlying construct related to students' perceptions of the online learning environment. This high reliability strengthens our confidence in the data and supports the use of these scores for subsequent analyses, including hypothesis testing.

5. Results and Discussion

This section presents the results of hypothesis tests conducted to examine differences in student perceptions based on several independent variables. For all tests, the significance level was set at $\alpha = 0.05$.

5.1. Differences Based on Student Background

These differences include gender, students' courses, student employment status, and student specialization.

Table 3.
Differences in Perceptions Between Male and Female Students (t-test).

Question	Gender	N	Mean*	SD	t	d.f.	Sig.
Usability/effectiveness of online textbook	Male	170	3.21	0.771	2.814	458	0.005
	Female	290	2.99	0.824			
Satisfaction with VC quality	Male	170	3.31	0.998	2.373	458	0.018
	Female	290	3.09	0.975			
Effectiveness of VC compared to physical class	Male	170	3.27	0.896	3.714	458	0.000
	Female	290	2.96	0.869			
Effectiveness of the midterm exam in assessing understanding	Male	170	3.22	0.994	3.042	458	0.002
	Female	290	2.93	0.983			
Confidence in English language skills	Male	170	3.42	0.711	6.578	458	0.000
	Female	290	2.90	0.875			
Understanding of English in lectures	Male	170	3.48	0.681	4.075	458	0.000
	Female	290	3.18	0.795			
Frequency of asking for clarification in English	Male	170	2.86	0.912	2.392	458	0.017
	Female	290	2.66	0.839			
Importance of learning math/stat in English	Male	170	3.53	0.778	2.145	458	0.032
	Female	290	3.36	0.850			

Note: *Means are on a 4-point Likert scale.

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5.1.1. Gender Differences

The hypothesis is that there is no significant difference between male and female students in their responses to the survey questions. Independent samples t-tests were conducted to compare the means of male and female students across the 28 survey items. Statistically significant differences ($p < 0.05$) were found on eight items, as shown in Table 3.

The t-test results reveal statistically significant gender differences across several dimensions of the online learning experience. Male students consistently reported more positive perceptions than female students regarding the usability and effectiveness of online textbooks, satisfaction with virtual class quality, the perceived effectiveness of virtual classes compared to traditional in-person instruction, and the perceived effectiveness of midterm exams in assessing their understanding of the material.

These findings align with some research suggesting that male students may be more comfortable and confident in online learning environments. However, it's essential to consider that other factors, such as prior experience with technology, learning styles, or self-efficacy, may also influence these differences. Further investigation is needed to disentangle these complex relationships.

A particularly striking difference emerged with English language skills. Male students demonstrated significantly higher confidence in their English language abilities and reported a better understanding of English in lectures. This difference was also reflected in the frequency of asking for clarification; male students reported asking for clarification less often than female students.

These findings raise important questions about the support provided to female students who may be less confident in their English language skills. Practical strategies for addressing language barriers, such as targeted language support, glossaries of technical terms, or opportunities for peer interaction, could be crucial for ensuring equitable access to online learning in statistics and mathematics. The greater importance placed on learning mathematics/statistics in English by male students may be linked to their higher confidence in the English language. Male students may perceive English proficiency as more critical for their future careers or academic success.

While these findings highlight significant gender differences, it's crucial to acknowledge the limitations of this analysis. The study relies on self-reported perceptions, which may not always accurately reflect actual learning experiences or outcomes. Furthermore, the cross-sectional nature of the data limits our ability to draw causal conclusions about the relationship between gender and perceptions of online learning.

Future research employing more diverse methodologies, such as qualitative interviews or analysis of learning analytics data, could provide a more nuanced understanding of these complex issues. Additionally, exploring the interaction between gender and other demographic factors, such as prior academic performance or socioeconomic status, could provide further insight into the factors contributing to these observed differences. The remaining 20 survey items did not reveal statistically significant differences between male and female students.

5.1.2. Students Course Differences

This hypothesis posits that there is no significant difference between students enrolled in Mathematics (BUS101) and Statistics (BUS102) in their responses to study questions. A t-test was conducted to compare the means of the two groups across the 28 survey items. While significant differences were found on five items ($p < 0.05$), only these statistically significant results are presented below in Table 4.

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Table 4.
Differences in Perceptions Between Mathematics and Statistics Students (t-test).

Question	Course	N	Mean*	SD	t	d.f.	Sig.
Effectiveness of course assessments	BUS101	260	2.81	1.414	-2.724	458	0.007
	BUS102	200	3.15	1.189			
Confidence in English language skills	BUS101	260	2.95	0.846	-4.357	458	0.000
	BUS102	200	3.29	0.830			
Understanding of English in lectures	BUS101	260	3.19	0.757	-3.113	458	0.002
	BUS102	200	3.42	0.765			
Helpfulness of English textbooks and materials	BUS101	260	3.08	0.852	-2.216	458	0.027
	BUS102	200	3.26	0.770			
Helpfulness of visual aids when learning English	BUS101	260	3.40	0.698	-2.122	458	0.034
	BUS102	200	3.53	0.633			

* **Note:** Means are on a 4-point Likert scale.

The results of the t-tests indicate statistically significant differences between mathematics and statistics students on five key aspects of the online learning experience. Statistics students reported higher ratings than mathematics students for the effectiveness of course assessments, confidence in English language skills, understanding of English in lectures, helpfulness of English textbooks and materials, and helpfulness of visual aids.

These findings suggest that statistics students have a more positive perception of the online learning resources and their English language abilities compared to mathematics students. This could be because the Mathematics course is a prerequisite for the Statistics course. Statistics students tend to be more motivated and have stronger English skills to begin with. The remaining 23 survey items did not reveal statistically significant differences between the two groups.

5.1.3. Employment Status Differences

This hypothesis proposed that there is no significant difference between employed and non-employed students in their responses to the survey questions. Independent samples t-tests were conducted to compare the means of the two groups across the 28 survey items. Statistically significant differences ($p < 0.05$) were found on three items, as shown in Table 5.

Table 5.
Differences in Perceptions Between Employed and Non-Employed Students (t-test).

Question	Employ	N	Mean*	SD	t	df	Sig.
Effectiveness in VC compared to an in-person class	Yes	165	3.25	0.902	3.326	458	0.001
	No	295	2.97	0.870			
Confident in English language skills to understand math or statistics	Yes	165	3.24	0.849	2.772	458	0.006
	No	295	3.01	0.849			
Ask for clarification when you do not understand math or statistics	Yes	165	2.91	0.916	3.285	458	0.001
	No	295	2.63	0.830			

* **Note:** Means are on a 4-point Likert scale.

The t-test results indicate statistically significant differences between employed and non-employed students on three aspects of the online learning experience. Employed students rated virtual classes as more effective than in-person classes, expressed greater confidence in their English language skills for understanding mathematics/statistics concepts, and reported asking for clarification more frequently when confused.

The higher rating of virtual class effectiveness by employed students could be related to the flexibility that online learning offers. Employed students may find it easier to balance their work and study commitments with the flexible scheduling of virtual classes. This finding aligns with the growing recognition of the importance of flexibility in online education, particularly for non-traditional students.

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The greater confidence in English language skills among employed students could be due to several factors. Employed students may have had more opportunities to use English in professional settings, leading to greater proficiency. Alternatively, students with stronger English skills may be more likely to be employed in the first place.

The finding that employed students ask for clarification more frequently, while also reporting higher confidence in their English skills, might seem counterintuitive. However, this proactive approach to learning could reflect their experience in managing multiple responsibilities and their commitment to academic success. Employed students may be more likely to seek clarification promptly to avoid falling behind in their studies. The remaining survey items did not reveal statistically significant differences between employed and non-employed students.

5.1.4. Students' Specialization Differences

This hypothesis stated that there is no significant difference among students in different specializations (Marketing, Systems, and Accounting) in their responses to the survey questions. A one-way ANOVA was conducted to examine differences in perceptions across the three specializations. Statistically significant differences ($p < 0.05$) were found on three survey items, as shown in Table 6.

Table 6.
Differences in Perceptions Among Specializations (One-Way ANOVA).

Specializations	Source of variation	SS	d.f.	F	Sig.
Quality of recorded classes on YouTube compared to MS Teams	Between Groups	8.082	2	7.107	0.001
	Within Groups	259.840	457		
	Total	267.922	459		
Preference for hybrid classes (online and on-campus)	Between Groups	7.954	2	5.455	0.005
	Within Groups	333.176	457		
	Total	341.130	459		
Importance of learning math/stat in English	Between Groups	7.039	2	5.236	0.006
	Within Groups	307.144	457		
	Total	314.183	459		

The one-way ANOVA results reveal statistically significant differences among student specializations on three aspects of the online learning experience. Perceptions of the quality of recorded classes on YouTube compared to MS Teams varied significantly across specializations. To determine which specializations are substantially different from each other, Tukey's HSD is used as a post-hoc test, which revealed a significant difference in online learning experiences based on student specialization.

System students rated the quality of YouTube-recorded classes lower and preferred hybrid learning more than students in Marketing and Accounting. Marketing students also emphasized the importance of learning math/statistics in English more than accounting students. These results underscore the need for tailored online learning approaches that cater to the distinct needs of various specializations.

5.2. Differences Based on Academic Performance

This includes GPA group differences and MTA group differences.

5.2.1. Students' GPA Group Differences

This hypothesis proposed that there is no significant difference among students in different GPA groups (>3.0, 2.5-3.0, <2.5) in their responses to the survey questions. A one-way ANOVA was conducted to examine differences in perceptions across the three GPA groups. Statistically significant differences ($p < 0.05$) were found on twelve survey items, as shown in Table 7. The remaining 16 items did not reveal statistically significant differences among the GPA groups.

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Table 7.
Differences in Perceptions Among GPA Groups (One-Way ANOVA).

GPA		SS	df	F	Sig.
User-friendliness of online textbooks	Between Groups	7.414	2	5.317	0.005
	Within Groups	318.627	457		
	Total	326.041	459		
Comparison of an online textbook to a physical textbook	Between Groups	4.586	2	3.530	0.030
	Within Groups	296.901	457		
	Total	301.487	459		
Clarity and helpfulness of teaching materials	Between Groups	5.838	2	4.845	0.008
	Within Groups	275.336	457		
	Total	281.174	459		
Usefulness of recorded classes in understanding material	Between Groups	9.066	2	7.508	0.001
	Within Groups	275.932	457		
	Total	284.998	459		
Quality of recorded classes (YouTube vs. MS Teams)	Between Groups	4.812	2	4.179	0.016
	Within Groups	263.109	457		
	Total	267.922	459		
Midterm exam to assess understanding of the course material	Between Groups	12.657	2	6.532	0.002
	Within Groups	442.786	457		
	Total	455.443	459		
Instructor encouragement of participation	Between Groups	7.412	2	4.637	0.010
	Within Groups	365.238	457		
	Total	372.650	459		
Confidence in English language skills	Between Groups	20.292	2	14.697	0.000
	Within Groups	315.499	457		
	Total	335.791	459		
Understanding of English in lectures	Between Groups	19.747	2	17.991	0.000
	Within Groups	250.799	457		
	Total	270.546	459		
Effect of PPTs on understanding math/stat concepts	Between Groups	7.188	2	6.940	0.001
	Within Groups	236.673	457		
	Total	243.861	459		

The one-way ANOVA results reveal statistically significant differences among GPA groups on twelve aspects of the online learning experience. Post-hoc (Tukey HSD) tests are used for every significant variable, which reveals several statistically significant differences between groups based on their responses to various survey questions.

Participants are categorized into three groups (presumably based on a pre-existing score or categorization): "Less than 2.50," "2.50 to 3.00," and "More than 3.00."

Generally, the "More than 3.00" group tends to report more positive experiences and perceptions across various aspects of online learning, while the "Less than 2.50" group often reports less favourable views. The "2.50 to 3.00" group typically falls in between, sometimes significantly different from one group or both other two groups. These findings suggest a potential relationship between the grouping variable and perceptions of online learning effectiveness and resources.

5.2.2. Students' Midterm Exam (MTA) Group Differences

This hypothesis stated that there is no significant difference among students in different MTA score groups (<10, 10-19.9, 20-30) in their responses to the survey questions. A one-way ANOVA was conducted to examine differences in perceptions across the three MTA groups. Statistically significant differences ($p < 0.05$) were found on 21 survey items, as shown in Table 8.

Table 8.
Differences in Perceptions Among MTA Groups (One-Way ANOVA).

MTA groups		SS	d.f.	F	Sig.
How user-friendly is the online textbook	Between Groups	27.291	2	20.873	0.000
	Within Groups	298.750	457		
	Total	326.041	459		
Usability/effectiveness of online textbook	Between Groups	7.029	2	5.455	0.005
	Within Groups	294.457	457		
	Total	301.487	459		
Satisfaction with VC quality	Between Groups	27.636	2	14.995	0.000
	Within Groups	421.138	457		
	Total	448.774	459		
Virtual class sessions engaging	Between Groups	16.281	2	9.089	0.000
	Within Groups	409.293	457		
	Total	425.574	459		
The virtual class facilitates communication with the instructor	Between Groups	19.006	2	11.316	0.000
	Within Groups	383.785	457		
	Total	402.791	459		
Instructors encourage students to participate in class or via VC	Between Groups	4.851	2	3.014	0.050
	Within Groups	367.799	457		
	Total	372.650	459		
LMS user-friendly	Between Groups	2.853	2	3.308	0.037
	Within Groups	197.095	457		
	Total	199.948	459		
Teaching materials are clear and helpful in aiding your understanding	Between Groups	34.626	2	32.091	0.000
	Within Groups	246.548	457		
	Total	281.174	459		
Course assessments help improve understanding of the course material	Between Groups	13.098	2	3.745	0.024
	Within Groups	799.117	457		
	Total	812.215	459		
Recorded classes help you understand the course material	Between Groups	10.806	2	9.006	0.000
	Within Groups	274.191	457		
	Total	284.998	459		
The midterm exam assesses your understanding of the course material	Between Groups	93.357	2	58.915	0.000
	Within Groups	362.086	457		
	Total	455.443	459		
Rate the overall quality of the recorded classes on YouTube?	Between Groups	7.611	2	8.022	0.000
	Within Groups	216.772	457		
	Total	224.383	459		
Confident in English for understanding math or statistics concepts	Between Groups	33.078	2	24.969	0.000
	Within Groups	302.713	457		
	Total	335.791	459		
Understand the English language used in class discussions and lectures	Between Groups	24.503	2	22.756	0.000
	Within Groups	246.042	457		
	Total	270.546	459		
How helpful do you find English-language math or statistics textbooks?	Between Groups	15.898	2	12.377	0.000
	Within Groups	293.517	457		
	Total	309.415	459		
Helpful visual aids when learning math or Statistics in English	Between Groups	10.694	2	12.382	0.000
	Within Groups	197.347	457		
	Total	208.041	459		
Asking for clarification when not understanding a math or stat concept in English	Between Groups	5.126	2	3.415	0.034
	Within Groups	342.985	457		
	Total	348.111	459		
How important do you feel it is to learn math or statistics in English	Between Groups	9.271	2	6.948	0.001
	Within Groups	304.912	457		
	Total	314.183	459		
Effect of PPT in helping understand math concepts	Between Groups	31.231	2	33.562	0.000

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MTA groups		SS	d.f.	F	Sig.
	Within Groups	212.630	457		
	Total	243.861	459		
Importance of instructors to create and use PPT in teaching math or statistics	Between Groups	5.781	2	6.042	0.003
	Within Groups	218.619	457		
	Total	224.400	459		
To what extent does PPT help you prepare for the Math or Stat courses?	Between Groups	4.800	2	5.671	0.004
	Within Groups	193.415	457		
	Total	198.215	459		

The one-way ANOVA results reveal statistically significant differences among MTA score groups on a large number (21) of aspects of the online learning experience. post-hoc tests (Tukey's HSD).

These findings strongly suggest a relationship between the grouping variable (likely reflecting academic performance or a similar metric) and perceptions and experiences in online learning. Students in the higher-performing group ("More than 3.00") generally report more positive experiences and greater satisfaction with online learning resources and their language skills. Conversely, students in the lower-performing group ("Less than 2.50") tend to report more challenges and less favourable perceptions.

These results emphasize the importance of considering individual learning needs and potentially providing targeted interventions or support for students who may be struggling in the online learning environment.

Findings suggest that students' academic performance may influence how they perceive the effectiveness of different teaching methods and materials, which could guide educators in tailoring approaches to better support students across various MTA groups.

6. Conclusions and Recommendations

This section presents key findings derived from data analysis and research hypotheses, highlighting the limitations of this research. These findings underscore the need for recommendations to enhance online statistics and mathematics education and resources, meeting the evolving needs of students in a digital learning landscape.

6.1. Conclusions

1. Student perceptions of online learning in statistics and mathematics are diverse and influenced by various factors. Gender, course enrollment, employment status, specialization, GPA, and midterm exam performance all contribute to shaping student experiences and satisfaction.
2. While online learning modalities are generally well-received, there are areas for improvement. Virtual classes and English language support emerged as areas where targeted interventions could enhance the learning experience.
3. Certain online learning tools, such as the LMS and PowerPoint presentations, are highly effective in supporting student learning. Continued utilization and enhancement of these tools are recommended.
4. Academic performance is linked to student perceptions of online learning. Higher-performing students tend to report more positive experiences, suggesting the need for targeted support for those facing academic challenges.

6.2. Recommendations

1. Enhance Virtual Classrooms: Improve virtual class engagement through interactive activities, peer-to-peer collaboration, and technology integration.
2. Strengthen English Language Support: Offer targeted language workshops, glossaries, and online tutoring to help students, especially non-native speakers, navigate technical terminology.

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3. Optimize Learning Tools: Continue leveraging and enhancing the LMS and PPT, exploring additional features to support learning further.
4. Provide Targeted Support: Offer academic advising, tutoring, and study skills workshops to students facing academic challenges or expressing lower satisfaction with online learning.
5. Tailor Instruction: Design and deliver online courses that consider the diverse needs and backgrounds of students, adapting teaching methods and materials accordingly.
6. Gather Ongoing Feedback: Continuously collect student feedback to monitor perceptions, identify areas for improvement, and ensure the online learning environment meets student needs.
7. Invest in Resources: Educational institutions should invest in improving the design, accessibility, and effectiveness of online textbooks and materials.
8. Promote Modern Teaching: Utilize modern teaching tools, such as recorded lectures and innovative instructional techniques, to enhance student engagement and learning outcomes.

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Transparency:
The author confirms that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

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