

# **Impact of COVID-19 Pandemic on Higher Education: Jordan Higher Education Case study**

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## **Abstract**

*In recent years, the world has been subjected to unprecedented events such as the COVID-19 pandemic. The impact of COVID-19 and its countermeasures varies depending on many factors investigated thoroughly since the pandemic breakout. In some sectors, this effect was minor and timely and was continuous in some other sectors, but to different degrees. Among those sectors is the educational technology sector, and here we mean ways and means of teaching and learning through different methods, some of which are traditional and some based on the use of computers and the Internet, such as distance learning. Most of these means are not new. For example, distance learning has existed for more than three decades. Accordingly, this study aims to answer the following question: Did the world's exposure to the pandemic make the traditional method of teaching and learning more desirable for students? If the answer is yes, the study examines that causality through a profound questionnaire formulated with high efficiency to verify and analyze the reasons that led to such outcomes. Furthermore, if online teaching and learning were more desirable for the students, the reasons and outcomes are proved thoroughly and clearly illustrated throughout our research.*

**Keywords:** *COVID-19, Higher Education, E-learning, Traditional Learning*

## **1 Introduction**

Because of the COVID-19 [1, 2] pandemic, the world has been unprecedented, with governments closing borders, prohibiting travel, and employing various measures such as social distancing [3, 4] and curfews to prevent the virus from spreading. These regulations have significantly impacted businesses and organizations worldwide [5-9] requiring them to alter and adopt new rules and processes to continue operations.

Higher education institutes (HE) are one of these industries where the COVID-19 countermeasures were immediately felt. Therefore, college and university researchers worldwide and from different specialties have conducted extensive research in various domains to determine the best approaches to halt the epidemic [10, 11] and flatten the infection curve. As a result, almost 3,000

[12] study reports, articles, and technical advice were released in the first three months after the outbreak began. Among these research findings, a spotlight has been cast on the HE organizations as they were also affected [11, 13-15] like any other businesses. HE organizations were forced to adapt to new methods and practices to deal with the abrupt transition from face-to-face teaching and learning to online and distance learning [16, 17] to ensure that students continue to receive a good education and that their education is not disrupted.

On the one hand, the COVID-19 pandemic has rushed a rapid transition toward online and remote education. This has created the potential for expanded access and flexibility in learning. On the other hand, it has also highlighted the digital gap [18] and the need to ensure all students have access to the appropriate technology and internet connectivity [19]

Notably, the influence of the pandemic on the education sector is complex and multidimensional, as it comprises a vast array of specialized institutions and programs, each with its own distinct set of criteria and implications. Literature and history students, for instance, may have had a different experience than students studying chemistry or physics. Similarly, fields that require field application practical training, such as medicine and certain areas of engineering, have been affected differently than those that may be taught in a theoretical style, mostly without requiring field applications and practical training that might lead to the breach of COVID-19 countermeasures.

Moreover, the research on the influence of the COVID-19 epidemic on higher education institutions is as diverse, multidimensional, and intricate as the institutions themselves. This highlights the significance of a nuanced and specialized approach to research on the topic and the need for an in-depth examination of the phenomena and its various implications for the education sector. As a result, thousands of research papers [20] examined the pandemic's impact on students from various disciplines and nations had been conducted.

These studies have investigated the psychological and moral effects on students [21, 22] teachers [23, 24] the financial effects [15, 25, 26] as well as the technical preparation and availability of the required capabilities for academic success [14, 27, 28] We can generally group the majority of the studies on the effect of COVID-19 on HE into the following:

1. The change to remote and online learning, including the problems and possibilities that have developed as a result of this abrupt transformation, as well as concerns of access, efficacy, and equality of digital tools and technologies utilized for distance learning.
2. Shifts in the classroom dynamic, such as how the epidemic has changed how instructors connect with students and how schools deal with the new realities of remote and online learning.
3. The digital gap, especially the epidemic's effect on students who do not have access to technology or internet connection, and the consequences for educational fairness.
4. The psychological and emotional effects on students and instructors include stress, anxiety, and loneliness.
5. The financial effect on higher education institutions, especially the economic implications of the epidemic and the H.E.s' long-term sustainability.
6. The pandemic's influence on research and academic cooperation includes how it has impacted research productivity, academic partnerships, and industrial collaborations.

7. The influence on students' academic performance, including motivation, engagement, and learning outcomes.
8. The consequences for teaching and learning in specific sectors and disciplines include the arts and sciences, engineering, and healthcare.

This study focuses on four core areas from the above list: the transition to remote and online learning, the alteration of classroom dynamics, the digital divide, and the effect on students' academic performance. These areas were selected based on a preliminary survey conducted on a sample of students. This initial analysis indicated that these areas are paramount for the research objectives and expected outcomes. Thus, this study offers an in-depth exploration of these critical areas and their effects on the higher education sector and students' preferences for learning.

We want to stress and emphasize that our research towards investigating possible methods to enhancing traditional education and learning through e-learning resources began in early 2019 before the pandemic outbreak. Our objectives of the study were to evaluate the possible benefits of e-learning tools and technology, such as accessing recorded lectures from educational institutions around the world. The study also attempted to examine how technology.

Improvements can make it easier for university professors to communicate with their students and peers by facilitating online forums. Then, after the pandemic countermeasures started to ease and campus life started to return to traditional learning (face-to-face) gradually, we expanded the research to become a comparative study of university students' learning methods and how their perspectives on traditional study versus electronic study changed between the two time periods: before and after the COVID-19 pandemic.

The following section, Methodology, discusses an approach to 1 collecting students' responses via a survey engineered specifically for this study's objectives 2 data validation and visualization. Section three focuses on Data Gathering and Data Visualization, in which we cross reference multiple features extracted from the data. Then, in section four, the Results Analysis and Discussion, we explore and discuss the outcomes of the data analyses in detail. Finally, in section five, the Conclusion and Future work based on the discussion of the data is drawn.

## 2 Methodology

The purpose of this study is to provide complete knowledge of the pandemic's influence on higher education students. To do so, the study covers two time periods: before and after the breakout of the pandemic. The following procedures are included as part of the research methodology:

- Questionnaire: The questionnaire of this study was distributed among 920 higher education students, with 460 students engaging in the questionnaire before the outbreak of COVID-19 and another 460 students participating in the questionnaire following the epidemic. Thus, a comparison is made between the experiences and perceptions of the students regarding the influence the pandemic has had on their schooling.
- Data collection: To collect data from the students, a questionnaire will contain questions about the student's gender, the program they are enrolled in, whether or not they are in their first, second, or third year...etc., their preferred method of acquiring knowledge (traditional, blended, semi- blended, or fully online), whether or not they prefer the presence of the instructor in the classroom over recorded lectures, and whether or not they have encountered any technical challenges such as lack of internet access.

- **Analysis of the Data:** The responses to the questionnaire will be examined using descriptive statistical analysis, such as frequencies and percentages. In addition, the correlation coefficient study will be utilized to look into the relationship between the various responses to the questionnaire. The strength and direction of the correlations between the group of responses are determined using the Chi-square test, Pearson's, and Spearman's rank correlation coefficients.
- **Ethical issues:** Before any participant is allowed to complete the questionnaire, they will be asked for their informed consent, and every piece of information will remain private and unidentifiable.
- **This research is limited in that it relies on self-reported data,** which could be affected by response bias. Because there are only 920 individuals in the sample, the results may not accurately represent the whole population of students enrolled in higher education. Despite this, the study is nevertheless important since it gives full knowledge of the impact of the COVID-19 pandemic on higher education students from the perspective of both before and after the outbreak.
- **Importance of the research:** This research is significant as it spans two periods, before and after the outbreak of COVID-19, providing for a thorough examination of the influence of the pandemic on higher education students.
- **A comparison of pre-pandemic and post-pandemic data will be performed to identify any shifts or trends in the manner in which the pandemic impacts higher education students.** This comparison will be performed using the data collected from the pre-pandemic and post-pandemic questionnaires. This will provide beneficial insight into the longer-term effects that COVID-19 will have on higher education institutions.

### **3 Data Gathering and Data Visualization**

The increasing reliance of university students and faculty on digital resources for education inspired the initiation of this research study at the start of 2019. To acquire full knowledge of this tendency, a questionnaire with four key sections was distributed to university students.

1. The initial parts gathered information, such as the gender, academic year, and major of the student.
2. The second section offered students five options for choosing their preferred learning modality: traditional, e-learning, and blended learning.
3. The third section assessed students' exposure to various electronic methods and media, such as recorded lectures, online publications, and educational platforms.
4. **Perceptions and attitudes regarding e-learning and blended learning:** The final sections of the questionnaire assessed students' opinions, preferences, and overall attitudes toward blended education, traditional education, and total e-learning.

Our research attempted to identify the most effective teaching and learning techniques in a comparison study in two periods (pre-COVID and post-COVID). We surveyed the seventy-seven factors mentioned in the questionnaire to accomplish this objective. The correlation coefficient was utilized to determine the correlations between these variables. After examining the results, we determined that twenty-two questions had the highest correlation coefficient and were most

aligned with the study's aims. These variables were picked from the total number of questionnaire questions in Table (1).

The twenty-two questions (Features' F' for short) collected data on numerous elements of students' learning experiences, including their gender, academic level, field of study, preferred type of learning, and knowledge source (F1- F5). In addition, the questionnaire questions explored students' perspectives on online learning (F9-F12), their use of online communication with instructors (F13-F15), and their usage of online resources for their homework (F16-F18) (F6-F8). As shown in Table 1, the questionnaire also assessed students' attitudes on the legitimacy of online material (F16-F18), their preferences for traditional learning techniques (F16-F18), and the problems they confront when engaging in online learning (F19-F22). The survey results gave valuable insights into students' choices and use of digital learning aids, which will be studied further in the following sections of this study.

### 3.1 Data Gathering

The questionnaire was distributed electronically through the University of Petra using various methods. A link to the questionnaire was also sent to students at the University of Jordan and Hashemite University to reach more university students. For both periods, the pre-pandemic and post-pandemic, the tables (Table 1 and 2) contain general statistics about the number of students who participated in the study and their gender distribution in three education tracks: the scientific track (Faculty of Pharmacy, Faculty of Information Technology, and Faculty of Engineering), the administrative track (Faculty of Economics, Administrative, and Financial Sciences), and the literature track (Faculty of Arts and Humanities).

Table 1: The mapping between the features used during the study and the features index

Features Key	Feature
F1	Gender
F2	Academic Level
F3	Programs
F4	My preferred type of learning
F5	I use computerized resources to obtain knowledge.
F6	When I am absent, I learn from online resources.
F7	Learning from online resources distracts my focus.
F8	I learn better from smartphones Apps.
F9	I get nervous when I learn something through computer applications.
F10	I feel happy when I learn from online resources.
F11	I can control learning when I use computer applications.
F12	I prefer learning using online resources.
F13	Communication with professors online is more effective.
F14	I prefer traditional learning methods.
F15	I find no difference between traditional and online learning.
F16	I prefer learning from textbooks.
F17	Using computer applications improve my academic and career skills
F18	I face many obstacles when I use online resources for learning.
F19	The online lectures lack discipline.
F20	To check for the authenticity of information on the net is time-consuming.
F21	I think the lecturer must be present in the online lectures.

F22 Traditional learning takes into account differences in individual skills among students.

Table 2: Post-Covid19 statistics of students distributions who participated in the research after the pandemic

Gender	Programs	# Participants
Female	Faculty of Pharmacy and Faculty of IT	185
	Faculty of Administrative Sciences	23
	Faculty of Literature	118
Male	Faculty of Pharmacy and Faculty of IT	103
	Faculty of Administrative Sciences	21
	Faculty of Literature	10

Furthermore, the students' distributions based on gender and the preferred learning method are in the Table (Table 3). Table 3 provides an overview of the gender, specialization, and preferred learning method statistics. The data in the Table shows a significant difference between the genders and specializations for the pre-pandemic and post-pandemic periods. To better understand this discrepancy, further statistical analysis was conducted. These additional studies helped obtain a more accurate understanding of the students' perspectives and experiences during the pre-pandemic and post-pandemic periods, leading to more informed conclusions about the differences.

Table 3: students distribution percentage according to their gender and preferred type of learning in both times: before the pandemic and after the pandemic

	Gender	Preferred Type of Learning	% Participants
Pre-Covid	Female	Traditional	4.8%
		Barely Blended	13.0%
		Mostly Blended	7.2%
		Entirely Blended	24.1%
		Entirely online	17.8%
	Male	Traditional	3.5%
		Barely Blended	3.9%
		Mostly Blended	3.3%
		Entirely Blended	10.7%
		Entirely online	8.5%
Post-Covid	Female	Traditional	7.2%
		Barely Blended	20.5%
		Mostly Blended	22.0%
		Entirely Blended	4.4%
		Entirely online	3.7%
	Male	Traditional	5.5%
		Barely Blended	13.0%
		Mostly Blended	13.7%
		Entirely Blended	4.0%
		Entirely online	6.3%

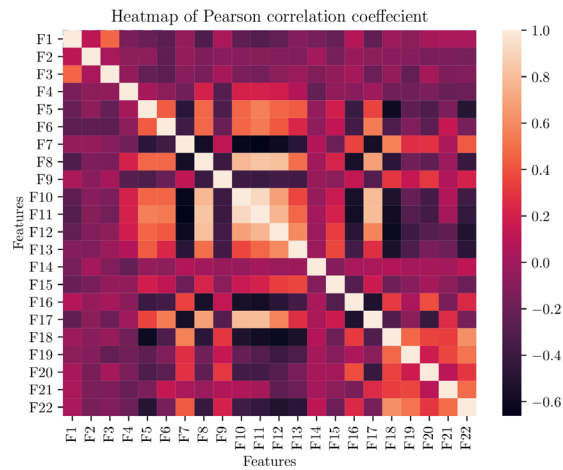
### 3.2 Data visualization

After collecting the data, we conducted an analytical analysis that comprised sequential steps. As a preliminary step, we checked the data to ensure no missing values and that the numbers of participants, their academic level, gender, and university programs were similar in both periods (prior and post the COVID-19 pandemic).

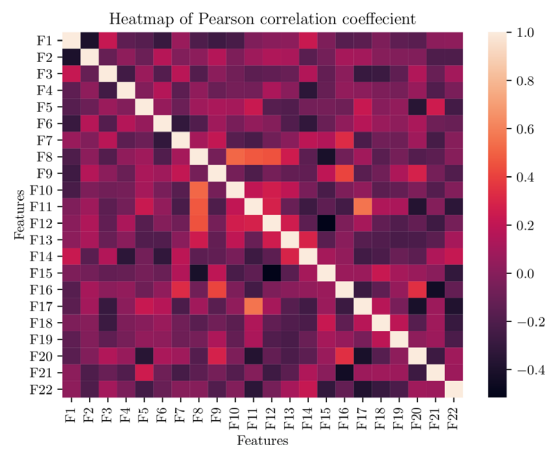
Next, we performed a Pearson correlation coefficient on the two data sets (the pre-covid data set and the post-covid data set) to get a full picture of how the features in our study were related. The results are visualized in the heat-maps for both data sets in Figures ((a) and (b)). Using heat-maps in our research is a key part of understanding how the different features from the questionnaire data relate to each other. Our research utilized heat-maps to find both highly correlated elements and those with low or no correlation.

The heat-map illustrates how two features are correlated; in other words, if a cell's color is black, there is a significant negative correlation between the two features, which implies that if one feature increases, the other decreases. Likewise, if the cell is white, it indicates a significant positive correlation between the two features, i.e., if one feature increases, so does the other. The darker the cell's color, the stronger the correlation. It is essential to remember that the heat-map only depicts a linear correlation between the two features and does not consider nonlinear correlations. Also, the relationship between two features does not imply that one causes the other. However, the visualization of Pearson correlation coefficients as heat-maps reveals with a fair degree of certainty whether the features are correlated, which is a necessary step to proceed to the next step of using a more robust test, such as the Chi-squared test, to gain additional insight into the correlations between the features.

Utilizing the Chi-squared test in our research is essential for gaining a more profound knowledge of the relationships between the various questionnaire data features. By visually presenting the correlation coefficients using a heat map, we first understood the relationships between the features. We used a p-value threshold of 0.05 for our analysis because we were interested in studying traits with strong correlations, whether they were positive or negative. The significance of the p-value in determining the relationship between features information can be used to identify the most significant features to analyze in greater depth. The heat-map provides a visual representation of the relationships between all pairs of features (Features X and Feature Y, where x and y are in 1, 2, ..., 22) and the p-value is set to  $\leq 0.05$ , indicating the significance of the relationship.



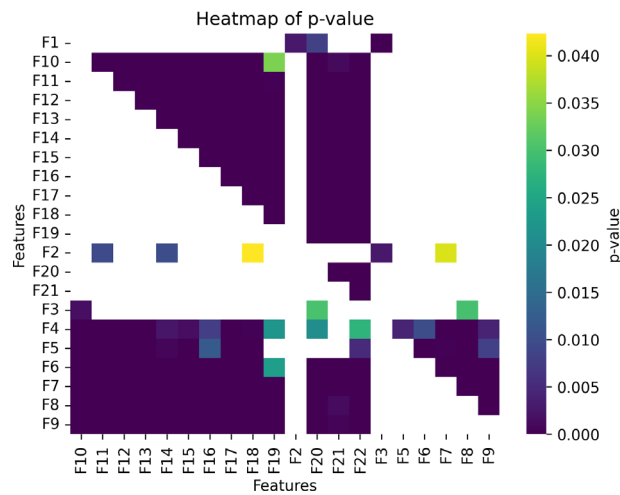
(a) Pre covid-19 Pearson correlation coefficient



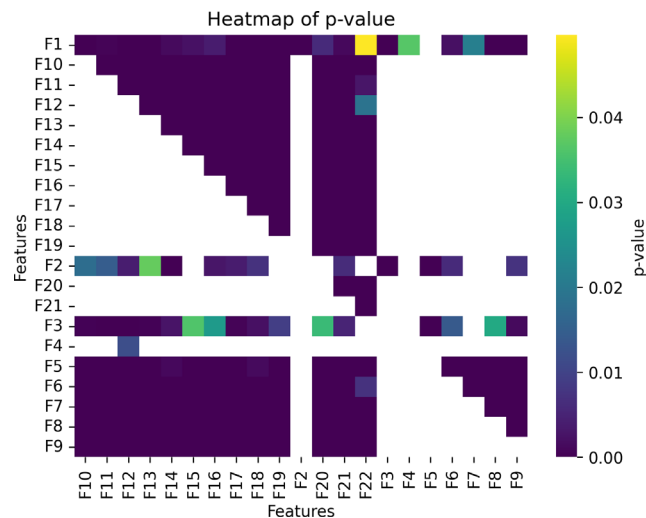
(b) Post covid-19 Pearson correlation coefficient

Fig. 1: heat-maps of Pearson correlation coefficient on the 22 features of Table 1. The darker the color the stronger the relationship between features. The subfig (a) illustrates prior covid-19 results and subfig (b) for the post covid-19 results.





(a) Pre covid-19



(b) Post covid-19

Fig. 2: heat-maps of p-value 0.05 after performing the Chi-square test ( $\chi^2$ ) on the 22 features of Table 1. The smaller the p-value the stronger the relationship is. The subfig (a) illustrates prior covid-19 results and subfig (b) for the post covid-19 results

## 4 Results Analysis and Discussion

Table 4, lists the statistics of the collected responses from students' participation before and after the pandemic. The column 'Feature key' refers to the features listed in Table 1, the Table column 'Answer' is the participant's answers to the corresponding feature, and the percentage is the record of the maximum collected answers. We have noticed significant participant perspectives and preferences shifts in some features. In contrast, the responses were similar for some other features in both periods (pre-covid and post-covid). The following list discusses the key findings and the outcome of the research:

Table 4: A comparative table that illustrates the statistics of the twenty-two features frequency distribution two-time points (pre-covid and post-covid). The features are listed using the feature keys of Table 1. The column 'Answer' records the maximum number of answers observed by the 460 participants of both periods.

Features key	Pre-Covid Answer	%	Post-Covid Answer	%
F1	Female	70.21%	Female	57.60%
F2	Third Year	28.91%	Second Year	32.60%
F3	Pharmacy and IT	63.26%	Pharmacy and IT	53.47%
F4	Entirely Blended	34.78%	Mostly Blended	35.65%
F5	Very highly	57.82%	Highly	34.34%
F6	Agree	48.69%	Agree	40.00%
F7	Agree	27.82%	Disagree	32.17%
F8	Agree	28.04%	Agree	33.47%
F9	Disagree	32.39%	Disagree	31.08%
F10	Agree	45.00%	Agree	43.04%
F11	Agree	41.52%	Agree	41.95%
F12	Agree	22.82%	Agree	24.34%
F13	Disagree	28.26%	Agree	23.04%
F14	Strongly agree	31.30%	Agree	34.56%
F15	Disagree	28.69%	Disagree	32.39%
F16	Agree	27.17%	Agree	27.39%
F17	Agree	48.04%	Agree	45.65%
F18	Agree	38.47%	Agree	27.60%
F19	Agree	29.56%	Agree	33.04%
F20	Disagree	27.17%	Not sure	25.43%
F21	Strongly agree	41.30%	Agree	43.91%
F22	Agree	38.69%	Agree	39.78%

1. The majority of participants were female students, indicating that they were more likely to respond to the questionnaire. This is a significant conclusion, especially considering that the study spanned two time periods: before and during the pandemic.
2. Before the epidemic, the most active participants were third-year students, but after the pandemic, the most active participants were second-year students. This could be because first-year students lacked the appropriate experience to complete the questionnaire, while fourth- and fifth-year students may have been less motivated as graduation approached.
3. A considerable shift was seen in the favoured learning styles of students. 57.82% of students favored electronic and automated resources before the epidemic. Following the epidemic, however, the percentage of students who chose electronic resources dropped to 34.34%.
4. The epidemic affected student perceptions of the possible distractions of e-learning (F7). Before the epidemic, 27.82% of students indicated that e-learning was distracting, but 32.17% reported that e-learning was not distracting after the pandemic.

5. The epidemic also influenced students' perceptions of online communication with university professors and instructors (F13). Before the epidemic, 28.26% of students disagreed that internet communication was more successful; however, 23.04% of students agreed with this statement after the pandemic.
6. In addition, student perceptions of the time required to check the integrity of information gained from websites (F20) changed. Before the pandemic, 27.17% of students stated that checking the accuracy of material required a considerable amount of time; however, after the pandemic, this percentage reduced to 25.44%.
7. Notably, the findings of our statistical study reveal that all twenty-two of the seventy features we examined are substantially connected. This conclusion was reached after using the Pearson correlation and chi-squared test correlation coefficient functions and examining the associated heat-maps. The responses to the twenty-two features demonstrate that the answers and percentages for the pre- and post-pandemic periods were comparable, demonstrating that these features are equally relevant for measuring students' perspectives and attitudes toward different learning methodologies.

As indicated in Table 5 last point, we aggregated the responses from both timeperiods (pre- and post-COVID) of the 920 participants and their answers and percentages to comprehensively understand the student's opinions. The findings of the combined data are as follows:

- F1 Gender: This feature measures the gender of participants, with 63.91 percent being female.
- F2 The academic level of the participants was documented; 29.78% were in their second academic year.
- F3 This feature reveals the programs in which participants are enrolled, with 58.48% of participants enrolled in programs provided by the Faculty of Pharmacy or the Faculty of Information Technology.
- F4 This feature evaluates the preferred ways of acquiring information with 25.22% of participants choosing online resources.
- F5 Use of Computerized Resources: This characteristic assesses the use of computerized resources for knowledge acquisition, with similar findings for both pre-and post-COVID eras.
- F6 Absence Learning from Online Resources: This feature examines the amount to which absent individuals learn from online resources, with similar results for both pre-and post-COVID periods.
- F7 Distraction from Online Resources: These characteristic gauges how much online resources divert participants' attention, with 28.70% of respondents disagreeing the most. The results were comparable for the post-COVID period but different from the pre-COVID period.
- F8 to F12 - Learning through Smartphone Apps, Nervousness, Happiness, Control, and Preference for Online Learning: These characteristics test many online learning facets, with consistent findings before and after COVID-19.
- F13 This feature assesses the efficacy of online contact with academics, with comparable findings for the post-COVID era and differing outcomes for the pre-COVID period.
- F14 - Preference for Conventional Learning Techniques: This characteristic reflects how individuals prefer traditional learning methods, with 32.39% of participants strongly preferring traditional methods and consistent results during pre- and post-COVID periods. Item F15 to F19 Comparison of Traditional and Online Learning, Textbook Preference, Skill Improvement, Obstacles in Online Learning, and Lack of Discipline in Online

Lectures: During both the pre-COVID and post-COVID periods, the results for these facets of traditional and online education are comparable.

- F21 "I believe the instructor must be present during online lectures," the results indicated that a comparable proportion of participants held this view before and after the implementation of COVID-19. This indicates that most students feel it is essential for the instructor to be physically present during online lectures.
- F22 "Traditional learning accounts for variances in students' unique talents," the results were consistent for both the pre-and post-COVID eras. Students believe that conventional learning techniques accommodate individual variances in skills and abilities more effectively than online learning approaches.

Table 5: Summary of the participant distribution and their total count for all the features of Table 1

Features	Answer	Percentage
F1	Female	63.91%
F2	Second Year	29.78%
F3	Pharmacy and IT	58.48%
F4	Barely Blended	25.22%
F5	Very highly	43.80%
F6	Agree	44.35%
F7	Disagree	28.70%
F8	Agree	30.76%
F9	Disagree	31.74%
F10	Agree	44.02%
F11	Agree	41.74%
F12	Agree	23.59%
F13	Disagree	25.43%
F14	Agree	32.39%
F15	Disagree	30.54%
F16	Agree	27.28%
F17	Agree	46.85%
F18	Agree	33.04%
F19	Agree	31.30%
F20	Disagree	25.98%
F21	Agree	41.74%
F22	Agree	39.24%

The findings of this study have several practical implications that could inform policies and practices at universities:

- The shift in students' preferences toward more traditional learning methods after the COVID-19 pandemic suggests that universities may need to recalibrate their strategies around online and blended learning. While maintaining availability and flexibility of online options, universities may need to prioritize enhancing the quality of in-person teaching and on-campus experiences post-pandemic.
- The decreased student preference for online resources implies that university administrators and faculty should re-evaluate the role and integration of educational technologies when designing curricula, courses, and instructional materials. Blended and online components should complement rather than replace face-to-face interactions.
- The differences in perspectives across genders, academic levels, and fields of study

highlights the importance of taking an inclusive, differentiated approach to teaching and learning. Universities could provide specialized support and resources tailored to the needs of specific student demographics.

- Policies and initiatives to broaden access to technology and improve digital literacy are essential to addressing the digital divide. Ensuring all students can equitably participate in digitally-enabled learning is key.
- Ongoing collection of student feedback and perspectives on learning modalities should inform institutional policies and teaching practices. Regular assessments of student preferences and experiences can allow universities to be responsive to evolving needs.

The findings imply that universities may need to recalibrate educational technology integration and prioritize high-quality on-campus learning experiences as students return to in-person modes. Administrators must take an inclusive approach accounting for needs across demographics and disciplines when shaping policies and curriculum. However, the self-reported questionnaire data has inherent biases. Reliance on a small sample also reduces generalizability of the conclusions. Developing a scientifically validated instrument and expanding to a larger, more diverse sample would strengthen the research. Comparing findings to other studies would provide useful perspective. Overall, these initial results offer helpful insights into pandemic impacts on students, laying groundwork for further investigation. Ongoing assessment of evolving perspectives must guide universities in supporting student needs.

While this study provides valuable insights into shifts in students' perspectives before and after the COVID-19 pandemic, the sample size of 920 students across two time periods is relatively small. This limits the generalizability of the findings, as the sample may not fully represent the broader population of students enrolled in higher education. To further validate the conclusions drawn here, larger-scale studies across more universities and geographic regions are needed. Ideally, future research would incorporate thousands of student participants from diverse academic settings and backgrounds. With a larger sample size, the trends observed in this study could be confirmed and expanded upon with greater confidence. Broader sampling would also allow for more nuanced analysis of differences across demographic factors like gender, discipline, and academic level. Nevertheless, the questionnaire data collected even from this limited sample is useful for understanding how dramatic events like the COVID-19 pandemic may influence student attitudes and preferences. The findings provide a useful starting point to guide further investigation and inform university policies.

An additional limitation of this study is the reliance on self-reported data from the questionnaire, which can be prone to biases. The way the questions were framed and answer options structured may have inadvertently influenced student responses. Furthermore, the questionnaire was not formally validated, so the ability of the instrument to accurately measure student perspectives and preferences is unclear. Developing a scientifically validated questionnaire tailored to the research questions could strengthen the reliability of the results. The subjective nature of self-reported data means conclusions should be interpreted with caution. Going forward, mixed methods utilizing focus groups, interviews, and behavioral observations could provide more objective insights to complement the self-reported findings. Triangulating data from multiple collection approaches could help offset the weaknesses of any single method. Rigorously examining the psychometric properties of the questionnaire would also be beneficial. Despite these limitations, the large sample size offers a helpful initial characterization of changes in student views following a major disruption event. But enhancements to the questionnaire

design and data collection methodology could certainly augment the integrity and generalizability of the findings.

Based on the findings and limitations of this study, the following recommendations are proposed for future research:

- Utilize a scientifically validated questionnaire tailored to the research objectives to improve reliability of the results.
- Expand the sample size substantially to make the findings more generalizable across the student population. Students from multiple universities and geographic regions should be represented.
- Employ a mixed methods approach combining self-reported data with focus groups, interviews, and observational techniques to offset biases and gain more objective insights.
- Examine how perspectives differ across various demographic factors like gender, academic level, discipline, age, and socioeconomic status using disaggregated analysis.
- Conduct longitudinal studies to track how student attitudes evolve over time, both during and after the pandemic disruption.
- Compare findings to other empirical studies to identify consistencies and discrepancies in how COVID-19 has impacted student perspectives across contexts.
- Share results with university administrators and faculty to inform policies and teaching practices that align with changing student needs and preferences.

## **5 Conclusion and Future Work**

The study analyzed the perspectives and preferences of students before and after the COVID-19 pandemic concerning different learning methodologies. Most participants were female students, with the most active participants being second-year students after the pandemic. After the pandemic, the results showed a shift in preferred learning styles, with decreased electronic and automated resources. The COVID-19 pandemic also influenced students' perceptions of the possible distractions of e-learning, the success of online communication with university professors, and the time required to verify information gained from websites. Furthermore, the statistical analysis of the responses revealed that all 22 features are connected and provide insight into students' perspectives and attitudes toward different learning methodologies. The findings showed that the answers and percentages for the pre- and post-pandemic periods were comparable for all 22 features. The results generally indicate a trend toward traditional learning methods and a decreased preference for online resources after the COVID-19 pandemic. It will be interesting to continue this study to watch the growing patterns in students' viewpoints and preferences and incorporate all 70 obtained features. It is also suggested that more studies be conducted with a large sample size and from other regional locations to have more insights. Universities may utilize these data to alter their teaching methods and learning materials to match students' requirements and preferences better.

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