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Sustainability of Digital Education: Impact on College Students' Well-being and E-Classroom Dynamics

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Abstract

The present quantitative study examines the attitudes of 390 commerce undergraduate students toward digital education, with a focus on sustainability implications. Using self-reported questionnaires administered through SMART software, data were collected to assess perceived ease of use, usefulness, psychological well-being, and e-classroom interaction. Stratified random sampling ensured representativeness across different academic years and demographics in the Madhya Pradesh region. Descriptive statistics, correlation analysis, and regression analysis were conducted using Smart Pls-4. Results highlight varying perceptions among students regarding digital education, with most finding it user-friendly and useful, yet concerns persist regarding e-classroom interaction and psychological well-being. The study identifies predictors of attitudes toward digital education, emphasizing the importance of tailored approaches to promote sustainability and meaningful engagement. Ethical considerations were prioritized, ensuring participant confidentiality and adherence to ethical guidelines. These findings contribute insights for educators, policymakers, and institutions seeking to enhance digital learning practices sustainably in the 21st century.

Keywords: Digital Education, Perceived Ease of Use, Perceived Usefulness, Psychological Well-being, and E-Classroom Interaction

Introduction

The integration of digital technologies into educational settings has transformed the landscape of teaching and learning, particularly in the wake of the COVID-19 pandemic. With the sudden and widespread adoption of online learning platforms, virtual classrooms, and digital resources, digital education has become synonymous with contemporary pedagogy. As education transitions further into the digital era, it is imperative to consider not only the benefits but also the sustainability implications of digital education practices. The concept of sustainability in education extends beyond environmental concerns to encompass principles of social equity, economic viability, and ethical responsibility. In the context of digital education, sustainability encompasses efforts to minimize environmental impact, promote equitable access to digital resources, and foster socially responsible behaviors among learners and educators. The sustainability of digital education is essential for ensuring that educational practices align with broader societal goals of sustainability and responsible stewardship of resources. The digital era, characterized by rapid technological advancements, ubiquitous connectivity, and evolving socio-cultural norms, has fundamentally reshaped the way education is accessed, delivered, and experienced.

Digital technologies offer unprecedented opportunities for enhancing accessibility, flexibility, and innovation in learning, yet they also pose unique challenges related to the digital divide, screen time, and mental health.

Students' Attitudes towards Digital Education:

Students' attitudes play a significant role in shaping their engagement, motivation, and overall learning experiences in digital environments (Lampoltshammer et al., 2021). Exploring students' perceptions, preferences, and concerns regarding digital education is essential for informing educational practices and policies that align with their needs and aspirations (Antonietti et al., 2022).

One key dimension of students' attitudes towards digital education is their perceived ease of use of digital tools, platforms, and resources. Perceived ease of use refers to the degree to which students perceive digital technologies as user-friendly, intuitive, and easy to navigate (Kancharla & Dadhich, 2021). Students' perceptions of ease of use can significantly impact their willingness to engage with digital learning resources and their overall satisfaction with the digital learning experience (Sultan et al., 2011). Factors such as interface design, accessibility features, and technical support mechanisms can influence students' perceptions of ease of use and, consequently, their attitudes toward digital education.

Another important dimension of students' attitudes towards digital education is their perceived usefulness of digital technologies in facilitating learning and achieving educational goals (Akcil & Bastas, 2021). Perceived usefulness refers to students' beliefs regarding the effectiveness, relevance, and utility of digital resources and tools in supporting their learning objectives. Students are more likely to engage with digital education practices that they perceive as useful and relevant to their academic needs and goals. Therefore, understanding students' perceptions of the usefulness of digital education is essential for designing effective digital learning experiences that meet their learning needs and preferences (Solberg, 2012). Students' attitudes towards digital education also encompass their psychological well-being in digital learning environments (Alberola-Mulet et al., 2021). Digital education practices can have both positive and negative impacts on students' mental health and well-being. On one hand, digital technologies can provide opportunities for flexibility, autonomy, and personalized learning experiences, which can enhance students' overall well-being (Anuar et al., 2019). On the other hand, excessive screen time, digital overload, and feelings of isolation in virtual learning environments can contribute to stress, anxiety, and social disconnect among students (McGuinness & Fulton, 2019). Therefore, assessing students' psychological well-being in the context of digital education is crucial for promoting healthy and supportive learning environments that prioritize students' mental health and well-being (Lazar et al., 2020).

Students' attitudes towards digital education are closely linked to their experiences of e-classroom interaction. E-classroom interaction refers to the quality and effectiveness of student-student and student-instructor interactions facilitated by digital platforms (Basu et al., 2022). Meaningful interaction and collaboration are essential components of the learning process, and digital technologies play a central role in enabling communication, collaboration, and engagement in virtual learning environments. Therefore, understanding students' experiences of e-classroom interaction is essential for assessing the effectiveness of digital education practices in promoting active learning, collaboration, and knowledge sharing among students. Students' attitudes toward digital education encompass multiple dimensions, including perceived ease of use, perceived usefulness, psychological well-being, and e-classroom interaction (Khan & Thomas, 2022). By examining these dimensions, educators and policymakers can gain valuable insights into students' perceptions, preferences, and concerns regarding

digital learning practices and design strategies to optimize digital learning experiences that promote sustainability, enhance student well-being, and foster meaningful e-classroom interaction.

Against this backdrop, this research aims to explore the sustainability of digital education within the context of the digital era and its impact on college students' experiences. The study investigates four key dimensions: perceived ease of use, perceived usefulness, psychological well-being, and e-classroom interaction (Arora et al., 2020). By examining these dimensions, the research seeks to provide insights into the multifaceted dynamics of digital education and its implications for educational practices and policies in the 21st century. Through a comprehensive analysis of students' perceptions, experiences, and attitudes toward digital education, this research aims to contribute to the ongoing discourse on the sustainability of digital education and inform strategies for optimizing digital learning experiences to promote sustainability, enhance student well-being, and foster meaningful e-classroom interaction (Ocaña-Fernández et al., 2020). By addressing these considerations, educators and policymakers can harness the transformative potential of digital education to create inclusive, equitable, and sustainable learning environments for all students, thereby advancing the goals of education in the digital era (Ahmad Qolfathiriyus, 2021).

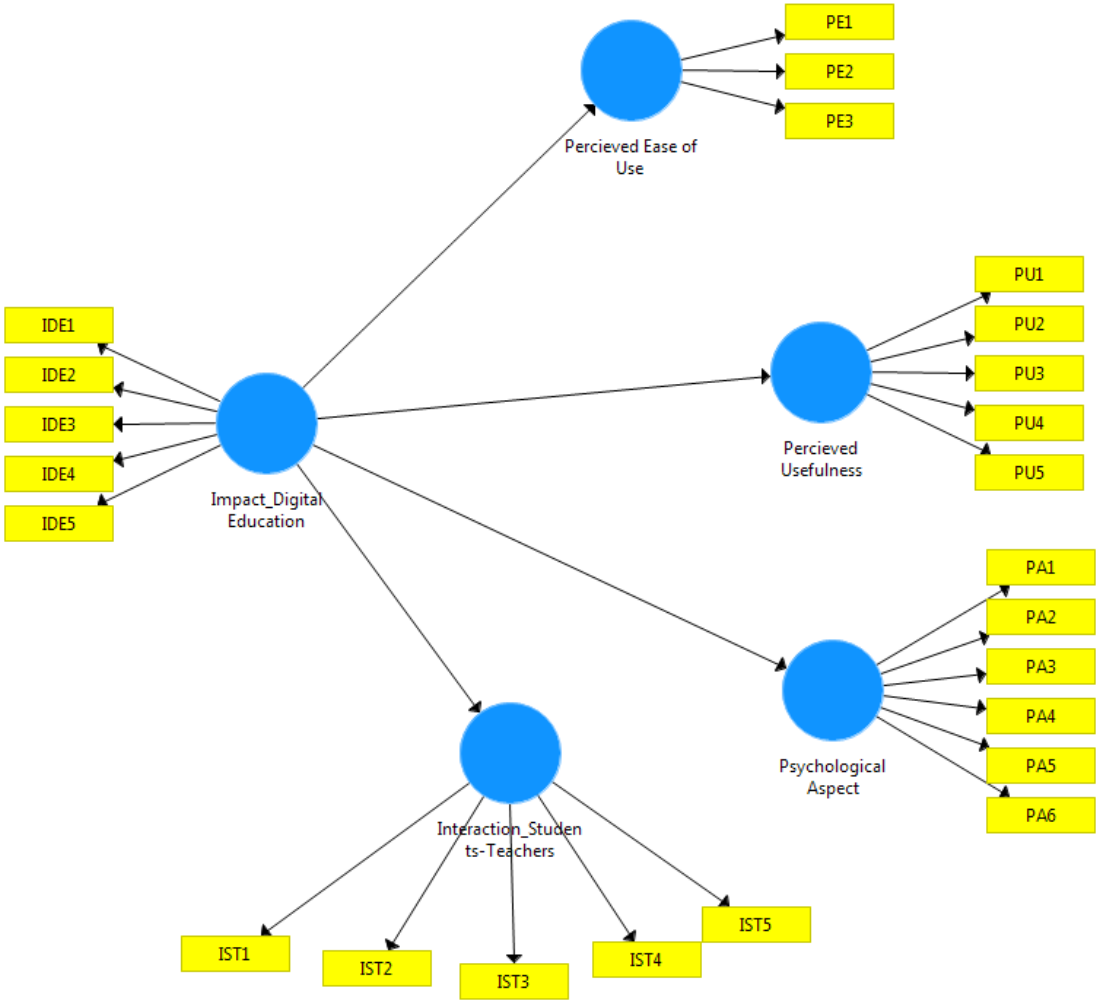
Despite the increasing prominence of digital education, there remains a gap in the literature regarding the sustainability dimensions of digital learning practices and their impact on student experiences. While previous studies have explored various aspects of digital education, few have specifically focused on the sustainability implications of digital learning practices and their effects on student outcomes. Therefore, there is a need for research that examines the interplay between digital education, sustainability, and student experiences, providing insights into how digital learning practices can be optimized to promote sustainability, enhance student well-being, and foster meaningful e-classroom interaction. This research aims to address this gap by investigating the sustainability of digital education and its impact on college students' attitudes, perceptions, and experiences, thereby contributing to a more comprehensive understanding of digital education in the 21st century.

Method and Measures

A quantitative research approach was employed to examine the attitudes of commerce undergraduate students toward digital education. Quantitative methods allow for the collection and analysis of numerical data, enabling researchers to identify patterns, trends, and relationships within the data set. By employing a quantitative approach, this research aims to provide empirical evidence on students' attitudes towards digital education and assess the sustainability implications of digital learning practices. The study's population consists of commerce undergraduate students enrolled in colleges within the Madhya Pradesh region. A sample size of 390 students will be recruited for the study, selected through stratified random sampling to ensure representativeness across different academic years and demographic characteristics. The sample size was determined based on considerations of statistical power, precision of estimates, and feasibility of data collection within the study's constraints primary data collection tool for this study was a self-reported questionnaire administered to the participants. The questionnaire was designed to assess various dimensions of students' attitudes toward digital education, including perceived ease of use, perceived usefulness, psychological well-being, and e-classroom interaction. The questionnaire consisted of validated scales and items adapted from existing research instruments, ensuring the reliability and validity of the data collected.

Conceptual Framework

Structural Equation Modelling (SEM) which is a set of techniques for exploring the relationships between the constructs. A version of the same, Partial Least Squares (PLS) regression, enables the testing for a small sample and leads to the prediction of indicators. It allows putting forward hypotheses for the constructs with the impact on the aspects of the model.



Development of Research Hypothesis

Hypothesis 1 (H1): Digital Education has a positive impact on perceived usefulness among learners of higher education

Hypothesis 2 (H2): Digital Education has a positive impact on the perceived use of ease among learners of higher education.

Hypothesis 3 (H3): Digital Education has a positive impact on E-Classroom Interactions among learners of higher education

Hypothesis 4 (H4): Digital Education has a positive impact on psychological well-being among learners of higher education.

The process of evaluation of results of the partial least squares structural equation modelling (PLS-SEM) involves two steps. In step 1, the examination of

reflective and formative measurement models is conducted. This is a necessary part of the evaluation because it provides support for the measurement quality. When quality is confirmed, the structural model evaluation is conducted in step 2. While in step 1, the measurement theory is examined, step 2 covers the structural theory that involves testing the proposed hypotheses and that addresses the relationships among the latent variables. Our model contains only reflective measures.

Table: 1.1: Construct Reliability and Validity

Constructs	Cronbach's Alpha	rho_A	Composite Reliability
Impact Digital Education	**0.904**	**0.905**	**0.929**
Interaction: Students-Teachers	**0.920**	**0.926**	**0.939**
Perceived Ease of Use	**0.891**	**0.891**	**0.932**
Perceived Usefulness	**0.908**	**0.91**	**0.931**
Psychological Aspect	**0.721**	**0.785**	**0.842**

Interpretation: The provided data offers insights into the reliability of constructs measured within a survey or study, encompassing various aspects of digital education. These constructs, including the Impact of Digital Education, Interaction: Students-Teachers, Perceived Ease of Use, Perceived Usefulness, and Psychological Aspect, are evaluated through three reliability measures: Cronbach's Alpha, rho_A, and Composite Reliability. Among these constructs, Impact Digital Education and Interaction: Students-Teachers exhibit notably high levels of internal consistency, with all reliability measures surpassing the threshold of 0.9. This suggests that the items measuring these constructs yield highly reliable and consistent results, emphasizing their robustness in assessing the impact of digital education and the interaction dynamics between students and teachers. Similarly, constructs such as Perceived Ease of Use and Perceived Usefulness also demonstrate commendable reliability, with all measures comfortably exceeding 0.89. This implies that the items measuring perceptions regarding usability and usefulness maintain consistency and reliability across respondents.

The construct of the Psychological Aspect presents a somewhat contrasting scenario, with lower reliability scores compared to the other constructs. While Cronbach's Alpha and Composite Reliability still meet the acceptable threshold (>0.7), rho_A falls relatively lower at 0.785. This suggests that there might be some variability or inconsistency among the items measuring psychological aspects, potentially warranting further investigation or refinement of measurement items to enhance reliability.

The majority of constructs under examination showcase strong internal consistency, indicating the reliability and consistency of the items measuring these constructs. The findings also underscore the importance of scrutinizing constructs with comparatively lower reliability, such as the Psychological Aspect, to ensure robust and accurate measurement in future studies or surveys.

Table 1.2. PLS-SEM assessment results of measurement models.

Latent Variable	Indicators	Convergent Validity	
		Loadings	AVE
		>0.70	>0.50
IDE	IDE1	0.851	0.722
	IDE2	0.875	
	IDE3	0.870	
	IDE4	0.794	
	IDE5	0.858	
IST	IST1	0.871	0.756
	IST2	0.881	
	IST3	0.863	
	IST4	0.846	
	IST5	0.885	
PA	PA2	0.831	0.645
	PA5	0.913	
	PA6	0.640	
PEU	PEU1	0.910	0.822
	PEU2	0.921	
	PEU3	0.888	
PU	PU1	0.853	0.645
	PU2	0.844	
	PU3	0.851	
	PU4	0.835	
	PU5	0.890	

Interpretation: The provided table outlines the results of the Partial Least Squares Structural Equation Modeling (PLS-SEM) assessment for the measurement models, focusing on latent variables and their associated indicators, along with measures of convergent validity.

- Firstly, concerning the Impact Digital Education (IDE) construct, all indicators display strong loadings, with values exceeding 0.70, indicating a robust relationship between the latent variable and its corresponding indicators. Additionally, the Average Variance Extracted (AVE) for IDE is above the recommended threshold of 0.50, suggesting satisfactory convergent validity.
- Interaction: Students-Teachers (IST) construct, all indicators exhibit substantial loadings, indicative of a reliable relationship with the latent variable. Moreover, the AVE for IST surpasses the acceptable threshold, confirming the convergent validity of the construct.
- Psychological Aspect (PA) construct presents a slightly different scenario. While some indicators demonstrate strong loadings, the AVE falls slightly below the recommended threshold. This suggests that although individual indicators may be reliable measures of the latent

variable, further examination is warranted to ensure adequate convergent validity for PA.

- Perceived Ease of Use (PEU) and Perceived Usefulness (PU) constructs, all indicators display robust loadings, indicating strong relationships with their respective latent variables. Additionally, the AVE values for both constructs exceed the recommended threshold, affirming their satisfactory convergent validity.

The majority of latent variables in the measurement models exhibit strong convergent validity, supported by substantial indicator loadings and AVE values. However, the PA construct requires closer scrutiny to ensure adequate convergent validity. These findings provide valuable insights into the reliability and validity of the measurement models, thereby enhancing the understanding of the underlying constructs in the study.

The last step in reflective measurement is to assess discriminant validity. This analysis reveals to which extent a construct is empirically distinct from other constructs both in terms of how much it correlates with other constructs and how distinctly the indicators represent only this single construct.

Table 1.3: Discriminant Validity

Constructs	Impact_Digital Education	Interaction_Students-Teachers	Perceived Ease of Use	Perceived Usefulness	Psychological Aspect (Weii-Being)
Impact_Digital Education	0.850				
Interaction_Students-Teachers	0.697	0.869			
Percieved Ease of Use	0.729	0.776	0.906		
Percieved Usefulness	0.747	0.790	0.816	0.855	
Psychological Aspect	0.718	0.668	0.673	0.745	0.803

Interpretation: The provided table offers insights into the Discriminant Validity analysis, aiming to ascertain the distinctiveness of various constructs within the study. Discriminant Validity is crucial in ensuring that the constructs under investigation measure unique concepts rather than overlapping or redundant ones.

The Impact Digital Education construct exhibits moderately high correlations with other constructs, ranging from 0.697 to 0.747. These correlations suggest some level of shared variance between Impact Digital Education and other constructs, possibly indicating that aspects of digital education's impact are intertwined with factors like interaction dynamics, perceived ease of use, usefulness, and psychological well-being.

Interaction: Students-Teachers construct also demonstrates moderately high correlations with other constructs, ranging from 0.668 to 0.790. This suggests that the quality of interaction between students and teachers might overlap with factors related to digital education's impact, perceived ease of use, usefulness, and psychological well-being.

The Perceived Ease of Use and Perceived Usefulness constructs also show moderately high correlations with other constructs, ranging from 0.673 to 0.816 and 0.745, respectively. This implies that perceptions regarding the ease of use and usefulness of digital education technologies may be intertwined with broader constructs related to digital education's impact, interaction dynamics, and psychological well-being.

Psychological Aspect (Well-Being) construct demonstrates moderately high correlations with other constructs, ranging from 0.668 to 0.745. This

suggests that psychological well-being might be influenced by or intertwined with factors related to digital education's impact, interaction dynamics, perceived ease of use, and usefulness.

The correlations between constructs are not excessively high, the moderately high values suggest some degree of overlap or shared variance between them. This raises questions regarding the distinctiveness of the constructs and highlights the potential need for further refinement or clarification in the measurement model to ensure robust Discriminant Validity. Further investigation into the relationships between these constructs may provide deeper insights into the complex interplay among various factors in the context of digital education.

The data for research were collected through a survey in Google Forms. The survey allowed collecting 385 responses. The table outlines the distribution of gender within the surveyed population. Of the total respondents, 183 individuals, accounting for 47.6% of the sample, identified as female, while 202 individuals, comprising 52.4% of the sample, identified as male. Cumulatively, these figures sum up to 100.0%, indicating the entirety of the population under consideration. This data provides a clear snapshot of the gender composition within the studied cohort, with a slightly higher representation of males compared to females. Understanding such demographic characteristics is fundamental for contextualizing research findings and ensuring representative sampling in statistical analyses and interpretations.

Next, the data were screened. There were no missing values since it was guaranteed by the structure of the survey. We excluded 18 answers because respondents marked the same answer for each question and the calculated variance was 0. Finally, 367 data rows were used for calculation. This sample size is sufficient for the PLS path model estimation. After the pilot researcher found some items in the construct psychological aspect (wellbeing) were not connected with the study so PA1, PA3, and PA4 were taken as outlier items thus that will be not included in final analysis, Figure 2 shows the PLS-SEM results. The numbers on the path relationships represent the standardized regression coefficients, while the numbers displayed in the circles of the constructs represent the R 2 values.

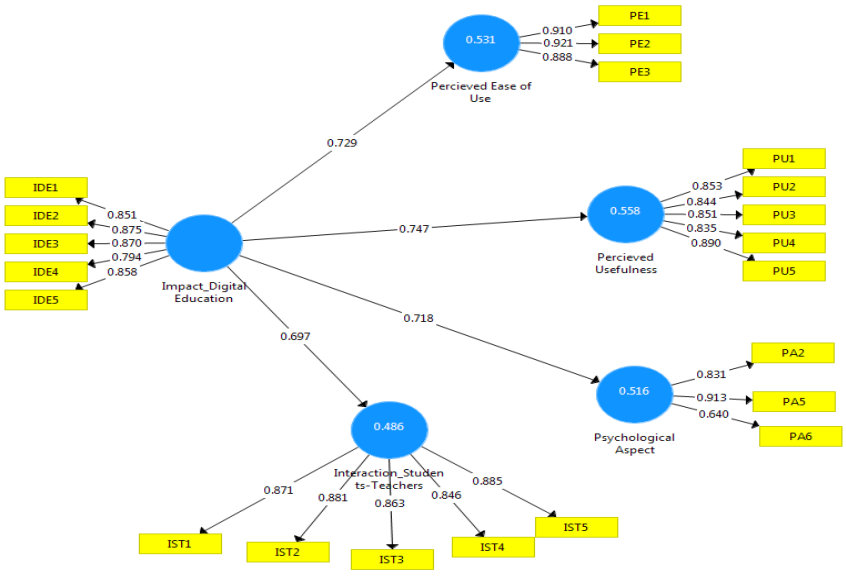


Table 1.5: Path coefficient of the structural model and significance testing results

Constructs Connections	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values
Impact_Digital Education -> Interaction_Students-Teachers	0.697	0.699	0.059	11.918	**0.000**
Impact_Digital Education -> Percieved Ease of Use	0.729	0.728	0.053	13.625	**0.000**
Impact_Digital Education -> Percieved Usefulness	0.747	0.746	0.052	14.324	**0.000**
Impact_Digital Education -> Psychological Aspect	0.718	0.719	0.053	13.545	**0.000**

Interpretation: The provided data examines the connections between "Impact Digital Education" and several other constructs, including "Interaction: Students-Teachers," "Perceived Ease of Use," "Perceived Usefulness," and "Psychological Aspect," utilizing various statistical measures. Across all relationships, the original sample correlation coefficients between "Impact Digital Education" and the respective constructs are notably strong, ranging from 0.697 to 0.747. This indicates a robust initial association between digital education's impact and the measured constructs. Moreover, the sample mean correlation coefficients consistently hover around these original sample values, suggesting stability in the relationships across multiple samples.

The standard deviation values, measuring the dispersion of correlation coefficients, are relatively low, indicating consistency in the strength of associations across various samples. The T statistics, calculated by dividing the original sample correlation coefficients by the standard deviation, underscore the significance of these relationships. The high T statistics values, ranging from approximately 11.918 to 14.324, signal the substantial and statistically significant connections between "Impact Digital Education" and the other constructs. The low P values, all recorded as 0.000, emphasize the statistical significance of these relationships, implying that the observed correlations are highly unlikely to have occurred by chance. The data indicates strong and significant associations between "Impact Digital Education" and constructs related to interaction dynamics, perceived ease of use, usefulness, and psychological well-being. These findings underscore the multifaceted nature of digital education's impact, encompassing various dimensions that are integral to understanding its effectiveness and implications for learners and educators alike.

Discussion & Conclusions

The research described, this study was conducted in the period of the coronavirus pandemic, which has covered the whole world and has not left a single country uninvolved. All educational institutions were caught by surprise and had to throw all their efforts toward adjusting to the new reality as quickly as possible. The survey "caught" the students of colleges in the middle of the period of distance learning, to which they all had to switch. Such timing allowed getting the most state-of-the-art feedback from students as for the methods and tools used in the process and exploring their emotions while they were still experiencing them. The authors consider picturing such state-of-the-art students' attitude to be one of the contributions of this research.

The research, conducted in this paper, is based on a survey conducted among commerce students of the Madhya Pradesh, when the entire education system shifted to digital because of the coronavirus outbreak. The survey has allowed for analysing

students' acceptance of digital However, despite the positive opinions about digital education, the students would like to go back to traditional education. This research is a valuable contribution to policy-making in case the COVID-19 situation forces HEIs to continue working online. Nevertheless, this work has limitations since only one stream (Commerce) was observed. The realization of comparative research would be reasonable to get a wider picture of the impact of a pandemic on higher education.

Future Study Directions:

Future research should consider conducting comparative analyses across diverse student populations and educational contexts to gain a comprehensive understanding of the impact of digital education during the COVID-19 pandemic. Longitudinal studies tracking changes in students' attitudes and perceptions over time can provide insights into the evolving nature of digital learning experiences. Additionally, qualitative research methods such as interviews and focus groups can offer nuanced insights into the factors influencing students' preferences and experiences with digital education. Comparative analyses of pedagogical approaches, exploration of the relationship between digital education and learning outcomes, and investigations into technological integration and accessibility are essential areas for further exploration. Understanding teachers' and institutions' perspectives on digital education will also be crucial for informing strategies to optimize digital learning environments and support student success in the post-pandemic era.

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