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Study And Analysis of Implementing Innovative Technology in Engineering Education for Creating Productive Learning Environment

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Abstract

The goal of innovation technology is to make certain that each and every student is provided with an education that is of the highest possible calibre, is distributed fairly, and is welcoming to everyone. The use of digital technology has emerged as an essential resource for reaching this objective in recent years. The use of these technologies permits the localization of emission sources, the reduction of environmental harm via the introduction of alternatives to fossil fuels that are both energy-efficient and low-carbon, and the possible extraction of surplus greenhouse gases from the atmosphere. The use of digital technology should result in an increase in production and efficiency while simultaneously reducing or eliminating waste and pollution as much as possible. It has been noted that the educational system is being significantly impacted by these technological advancements. The COVID-19 epidemic has resulted in an increased focus on the incorporation of digital technology into the curriculum of educational institutions. The paradigm of the educational system has undergone a considerable transformation as a direct result of the incorporation of digital technology. In addition to being responsible for the transmission of information, the person in question is also expected to act as a guide, an assessor, and a collaborator in the process of the development of new knowledge. Students' day-to-day lives have become less complicated as a direct result of the development of new educational technologies. In today's world, students are more likely to produce presentations and projects with the assistance of a variety of software and tools than they are with the use of conventional writing instruments. When compared to the weight of a stack of notebooks, the iPad's heft is much more manageable.

Keywords: *Big Data, Digital Technology, Regression Analysis, Sustainable Growth, Transmission, Educational Technologies, Paradigm.*

Introduction

The realisation of sustainable development is predicated on the existence of social well-being, which, in turn, is predicated on a level of education that is of a very high standard (Almuhatresh et al., 2022). The rise of information technology as a channel via which knowledge may be disseminated is a major factor that is driving the push for educational system changes (Malnaad

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et al., 2022). It is to everyone's benefit if this trustworthy technique is used to include an educational experience of the highest possible quality for them all (Osman et al., 2022).

As opined by Almusharraf & Khahro (2020), companies who are active in the educational technology business are always searching for innovative methods in order to improve educational accessibility for those who do not have access to a sufficient educational infrastructure. The use of social media platforms like Facebook and Twitter as instructional resources has made great headway in recent years (Pathmanathan et al., 2022). The usage of social media by both instructors and students as part of the e-learning process has developed into an essential component of that process (Chawdhury et al., 2022). At the moment, it plays an important role as a platform for the distribution of information about important subjects (Araújo, Knijnik, & Ovens, 2021). Platforms for social media provide a vital route for building professional contacts, boosting social interaction, and even exploring fresh career pathways. These are all important goals that may be accomplished via the use of social media. In addition to this, they make the ease of information distribution in any location possible.

Background of the Study

It has been noticed that traditional classroom education does not facilitate learning in a timely manner, does not stimulate assessments, and does not heighten involvement. The possibilities of more conventional instructional methods are outclassed by the efficiency made available by various technologies. One example of this trend is the rise of the BYOD (bring your own device) movement (Bedir, 2019). It has been found that the malleability and non-invasive qualities of modern technology increase the attractiveness of learning among the younger people. However, it has been noted that conventional educators display a certain degree of trepidation towards the incorporation of cutting-edge technology and equipment in the educational environment. These educators believe that these innovations pose a possible risk to the learning process rather than acting as a helpful tool. As a result, putting this strategy into practise can result in some early difficulties (Biletska et al. 2021). Students' preparation for class may be improved if they use an online calendar to see the schedule of courses, assignments, field excursions, guest lecturers, examinations and breaks over the semester. The use of student response tools, such as smartphones and clicker devices, provides teachers with a rapid and straightforward method to assess the pace at which students are learning the content that is being delivered and to decide whether or not more elaboration is required.

As said by Bilotta et al. (2021), the consequences of the coronavirus outbreak have received a significant amount of coverage in the media. It has been noted that the exploitation of digital technologies may give help in sustaining the operation of the educational system despite the crisis that is now taking place. Students have access to an atmosphere that is conducive to their success in their academic endeavours when they live on campus (Büyükbaykal, 2015). The use of cutting-edge technical tools in the classroom, such as computers, projectors, and other similar equipment, has the potential to improve the educational experience that students have by making it more interesting and entertaining for them. Within a classroom environment, the deployment of assignments that include digital resources, oral presentations, and group interaction may possibly improve the dynamic nature of student learning and increase the level of engagement experienced by students (Camilleri, & Camilleri, 2017).

Research Aim and Objectives

The main aim of this study is to investigate the effective implementation of innovative

technology in engineering education to enhance the creation of a productive learning environment.

- To evaluate the existing technological infrastructure in engineering education institutions to identify strengths and weaknesses for the integration of innovative technology.
- To investigate strategies to facilitate faculty training and provide ongoing support to promote the successful adoption of innovative technology in teaching.
- To examine the impact of technology integration on student access and equity, identifying ways to minimize disparities in learning opportunities.
- To analyze the alignment between technology integration and pedagogical goals, ensuring that technology enhances, rather than detracts from, the learning experience.

Problem Statement

As stated by Castro (2019), one of the foremost challenges is the significant financial investment required to implement cutting-edge technology in education. Universities and institutions need to purchase the hardware, software, and infrastructure necessary for these technologies to work effectively. This financial burden can be prohibitive, especially for smaller institutions or those with limited budgets.

Faculty and staff often resist incorporating new technologies into their teaching methods. There may be a lack of familiarity with the tools, fear of obsolescence, or concerns about the additional workload required for training and implementation. Overcoming this resistance and ensuring faculty buy-in is crucial for successful integration (Corrall & Jolly, 2019). Not all educational institutions have the necessary technological infrastructure to support innovative technology. Outdated network systems, inadequate Wi-Fi coverage, and limited IT support can hinder the seamless integration of new tools and platforms into the learning environment. Integrating technology can inadvertently create disparities in access and equity among students (Darius, Gundabattini, & Solomon, 2021). Not all students may have access to the same devices, software, or high-speed internet connections, leading to unequal learning opportunities. It is essential to ensure that the benefits of technology do not exclude any students.

Faculty and students need proper training and ongoing support to effectively use innovative technology. A lack of training resources and technical support can result in frustration and underutilization of the technology, diminishing its impact on the learning environment. Institutions must safeguard sensitive student information and ensure that the technology used complies with relevant privacy regulations (Dörnyei, 2020). Failure to do so can lead to data breaches and legal consequences. Integrating technology should enhance pedagogical goals, not replace them. Ensuring that technology aligns with educational objectives and enhances the learning experience can be challenging. The risk is that technology may become a distraction rather than a tool for learning. The availability of vast online resources does not guarantee high-quality educational content (Ellis, Souto-Manning, &Turvey, 2019). It can be challenging for instructors to curate and integrate reliable, up-to-date, and relevant digital materials into their courses effectively.

Significance of the Study

A potential pitfall is the overreliance on technology, neglecting the importance of human interaction and traditional teaching methods. Striking the right balance between technology and

traditional pedagogies is essential for creating a productive learning environment. Technology evolves rapidly, leading to challenges in keeping educational tools and platforms up to date (García-Morales, Garrido-Moreno, & Martín-Rojas, 2021). Institutions need to allocate resources for regular updates, maintenance, and adaptation to emerging technologies. Assessing student performance in technology-integrated courses can be complex.

As said by GarzónArtacho et al. (2020), while technology can enhance engagement, it can also lead to distractions. Students may be tempted to use devices for non-educational purposes during class. Maintaining student focus and ensuring active participation is an on-going challenge. Integrating innovative technology into engineering education has the potential to create a more productive learning environment. However, the process is fraught with challenges, including financial constraints, resistance to change, infrastructure limitations, and concerns about access and equity (Guan, Mou, & Jiang, 2020).

Review of Literature

As said by Guardia et al. (2019), the integration of innovative technology in engineering education has become a focal point in academia, aiming to create productive and enriched learning environments. This review of literature examines key research findings and insights into the implementation of innovative technology in engineering education, shedding light on its impact, challenges, and future prospects.

Innovative technology, including digital resources, simulations, and online platforms, has the transformative potential to reshape engineering education. Several studies highlight its positive impact on student engagement, knowledge retention, and problem-solving skills (Marra et al., 2011; Sams& Bergmann, 2013). One of the key advantages of technology integration is its ability to enhance student engagement. Research by Picciano (2012) indicates that online collaborative platforms and interactive tools can significantly increase student participation and motivation in engineering courses. The dynamic and interactive nature of technology-driven learning environments encourages active learning, which is essential in engineering education. Innovative technology offers opportunities to bridge the gap between theoretical knowledge and practical application. Simulations and virtual laboratories enable students to experiment and solve real-world engineering problems, as observed in the study by Devedžić (2015). This approach provides students with valuable hands-on experience, better preparing them for their future careers.

Despite its benefits, the implementation of innovative technology in engineering education presents challenges (Henderson &Yeow, 2012). Educator readiness and adequate training are also crucial aspects, as faculty members may need support to effectively integrate technology into their teaching methods (Kebritchi et al., 2017). To mitigate the digital divide, research by Al Lily et al. (2018) emphasizes the importance of ensuring equitable access to technology and the internet for all students. Institutions must adopt inclusive strategies, such as providing loaner devices and offering support for students facing connectivity challenges. Educators play a pivotal role in the success of technology implementation. They must embrace technology as a tool to enhance their teaching methods. A study by Becker et al. (2017) underscores the significance of faculty development programs tailored to technology integration, enabling educators to effectively use technology to improve student learning outcomes.

Measuring the impact of technology in engineering education is essential. Research by Means et al. (2013) suggests that technology-enhanced learning positively influences student

achievement, with improved test scores and deeper understanding of complex engineering concepts. Engaging in assessment practices to gauge the effectiveness of technology is vital for educators and institutions (Haque & Srivastava, 2014). Looking ahead, the literature emphasizes the need for adaptability in response to emerging technologies and pedagogical trends. Collaboration between educators, institutions, industry partners, and policymakers is essential to continually refine and enhance engineering education (Johri& Olds, 2011).

The process of globalisation has brought about the need that education must increasingly include various forms of digital technology. Within academic institutions, online platforms have been made accessible for the purposes of teaching, resource sharing, assessment, and management of day-to-day operations. The platforms that were in issue were used in a proactive way throughout this process. In order to ensure the continued viability of the educational system in the wake of the COVID-19 epidemic, educational institutions were mandated to make the shift towards a more centralised focus on online instruction. It would seem that industrialised countries have shown that they are prepared to confront the issue at hand (Hernandez-de-Menendez & Morales-Menendez, 2019). Emerging countries, on the other hand, have made tremendous strides in fulfilling this requirement in recent years. At this crucial juncture, digital technologies have been singled out as a potentially useful answer to the problems that are being experienced in the educational sector Hernandez-de-Menendez & Morales-Menendez, 2019).

The present worldwide crisis brings into more focus the significance of incorporating a global perspective into the educational system. As opined by Hero & Lindfors (2019), the creation of thinking structures and the understanding of processes that is required for students to successfully operate in a professional capacity. These abilities are essential for students to be able to function in a professional capacity. In addition, preparations are being made for a future that is becoming more unpredictable and is constantly shifting, and technology will play a crucial role in this future (Javaid et al. 2020). It has been discovered that incorporating digital learning tools and instructional resources into the classroom may have a beneficial effect, not only on the atmosphere of the classroom but also on the teaching and learning process Hernandez-de-Menendez & Morales-Menendez, 2019). In addition, the availability of these resources enables educational institutions to have a higher degree of autonomy and flexibility in the customization of their curricular offerings to meet the specific needs of individual students.

There is a possibility that increasing students' exposure to and interest in using technology in the classroom would encourage them to become more engaged in and motivated by their academic endeavours. Because of the widespread availability of electronic gadgets among youngsters, there has been some discussion about the possibility of bringing them into schools as a way to increase student involvement and participation (Kamaruzaman *et al.* 2019). It has been discovered that the use of technology in the classroom may improve the overall learning experience for students, leading to a higher level of engagement and a more sustained attention to the subject matter (Ramalingam et al., 2024). The use of cutting-edge technical tools in the classroom, such as computers, projectors, and other gadgets, has the potential to improve the quality of the educational experience that students have by making it more interesting and fun for them to study. The incorporation of digital resources, oral presentations, and group interaction into assigned classroom work has the potential to improve student learning by creating a more dynamic and engaging learning experience (Keengwe & Bhargava, 2014). This might result in increased knowledge retention among the class's participants. It's also possible to count nonverbal communication as a sort of involvement in the conversation.

In this specific instructional approach, the teacher plays the function of a guide and is vested with the responsibility of determining whether or not the information being imparted is indeed useful. According to Kostopoulos & Kotsiantis, (2022), people who are interested in expanding their knowledge have access to a wide variety of digital sites where they may receive the necessary information or produce their own material. Learners are able to communicate with one another, assess one another's work, and make strides towards co-learning with the help of these technologies. Learners may also produce and share material. The use of digital technology in educational settings has made it simpler to put into practise productive pedagogical strategies like gamification and flipped courses, both of which have been shown to improve the results of students' educational experiences (Kryukov & Gorin (2016). The usage of learning landscapes as an instructional tool has evolved in recent years as a means of incorporating diverse pedagogical techniques. This allows for the provision of tailored learning routes to individual learners. It has been shown that the use of technology increases both the importance of educational information as well as the motivation of students.

A said by Kumar et al. (2022), there is a possibility that the deployment of cutting-edge technical tools that enable better planning, simplified and pragmatic pedagogy, rapid assessments, expanded resources, unique proficiencies, and other similar measures might increase teaching productivity. As a result of developments in technology, the proliferation of online libraries has led to a reduction in the need for physical space and has made it easier for students, teachers, and researchers from across the world to communicate with one another.

According to Kwangmuang et al. (2021), In order to assess the educational programme, the pedagogical approach, and the evaluation methodologies, a group of subject matter experts have gotten together in virtual forums to have a discussion about certain issues and evaluate those aspects of the programme (Muhamad et al., 2024). A learning environment that is inclusive ensures that all students, regardless of their current academic standing, are provided with equal opportunity to study in the same location. Other comparable resources include. Additionally, teachers are able to acquire useful data on the performance of their students thanks to these technologies (Yang et al., 2025). Students work together to address existing issues in the educational system by using the tools available online. Hackathons have been shown to be effective in tackling a wide variety of complicated issues, according to empirical research (Lara-Prieto et al. 2023). Students are able to express themselves and work together on projects because of the sharing of ideas that takes place among them.

Methodology

This study used a survey technique with a descriptive approach. Data collection involved the use of questionnaires. Descriptive research is a type of analysis that focuses on outlining the features of the group of people or issue under study. 173 respondents have been selected for the research, out of which 100 people and 73 are female by using random sampling method. The respondents are the teachers from private schools, government schools and also from government-aided schools. The data was analysed using SPSS Programme for Windows OS 22.0 software. Both the standard deviation and the mean were employed in descriptive statistical methods. In addition, frequency statistics were employed to interpret the demographic information. To further evaluate the hypothesis, the researcher further utilised "inferential statistics" (Frequency analysis, Regression Analysis, Cross tabulation and chi-square test).

Constraints Considered for the Study

Hypothesis 1: There is no significant difference between enhancing teaching productivity and application of innovative technology for productive learning among school students

Hypothesis 2: There is no significant difference between developing online libraries and application of innovative technology for productive learning among school students

Hypothesis 3: There is no significant difference between creating inclusive environment and application of innovative technology for productive learning among school students

Hypothesis 4: There is no significant difference between solving educational challenges and application of innovative technology for productive learning among school students

Analysis of Results

The section is involved in providingdata analysis using SPSS, the major analysiscovered are frequency analysis, regression and chi square analysis.

Gender	Frequency	Percent
Male	100	57.8
Female	73	42.2
Age	Frequency	Percent
Less than 30 years	57	32.9
31 - 40 years	46	26.6
41 - 50 years	24	13.9
Above 50 years	46	26.6
Role	Frequency	Percent
PG Teachers	58	33.5
Junior Teachers	69	39.9
Others	46	26.6
Currently living in	Frequency	Percent
Metro City	92	53.2
Non-Metro City	81	46.8
Occupation	Frequency	Percent
Private schools	97	56.1
Goververnment schools	50	28.9
Goververnment aided schools	26	15
Experience	Frequency	Percent
Less than 3 years	50	28.9
3 - 6 years	38	22
6 - 9 years	28	16.2
9 - 12 years	41	23.7
Above 12 years	16	9.2
Total	173	100

Table 1: Frequency Analysis

(Source: Prepared by Authors)

The above table 1 provides a snapshot of key demographic factors:

Gender: Of the respondents, 57.8% identified as male. This skew towards male participation in the study is noteworthy and could have implications for understanding gender disparities in technology-related education (Ifedi et al., 2024). The significant predominance of male respondents in the study raises questions about gender equity in engineering education. Further research is needed to explore whether gender disparities exist in the access to and utilization of innovative technology in teaching. Initiatives to encourage more female educators to engage with technology should be considered (Mitchell et al. 2021).

Age and Teaching Experience*:* Approximately 32.9% of respondents were less than 30 years old. This suggests a substantial presence of younger educators in the study, who may be more familiar with and receptive to technology integration. Nearly 39.9% of respondents were junior-level teachers. This suggests that educators at the early stages of their careers are actively engaging with the implementation of innovative technology. The presence of a substantial number of younger educators with less than 3 years of experience suggests that newer generations of teachers are actively embracing technology (Miranda et al. 2021). Their openness to technology could pave the way for innovative teaching methods.

Location: A majority, 53.2%, were living in metro cities. Urban environments may offer more resources and infrastructure conducive to adopting technology in education. The high representation of respondents from metro cities may indicate a correlation between urban infrastructure and technology integration. Rural areas may face challenges in terms of infrastructure and resource availability, which could affect their ability to implement technology effectively (Oke & Fernandes, 2020).

Institution Type: A significant portion, 56.1%, worked in private schools. Private institutions may have greater flexibility and resources to invest in technology, potentially driving innovation in their classrooms. Private schools, with their financial autonomy, may have an advantage in adopting innovative technology. Policymakers should consider strategies to ensure that technology integration is equitable across all types of educational institutions (Oke & Fernandes, 2020).

Experience Level: A notable 28.9% possessed less than 3 years of teaching experience. This group represents educators who are relatively new to the profession and may bring fresh perspectives to technology adoption. Educators with less than 3 years of experience bring fresh perspectives but may also require targeted support and training to make the most of technology in the classroom. Mentorship programs and professional development opportunities can be tailored to their needs (Oke & Fernandes, 2020).

This demographic analysis sheds light on the diverse group of educators engaged in the study of innovative technology in engineering education. Understanding these demographics provides valuable insights into the landscape of technology integration in education, offering opportunities to address disparities and tailor support to different groups of educators (Soliman et al., 2025). As technology continues to evolve, it is essential to ensure that all teachers, regardless of their background or experience, have the tools and knowledge to create productive learning environments for their students.

Regression Analysis

The next part of the analysis is involved in understanding the critical relationship between the independent variables: enhancing teaching productivity, developing online libraries, creating inclusive environment and solving educational challenges with the dependent variable application of innovative technology for productive learning.

R	R Squred	Adj R sqd			
.943a	0.89	0.89			
Data	n of Squa	df	lean Squa	F	Sig.
Regression	228.35	4.00	57.09	336.50	.000b
Residual	28.50	168.00	0.17		
Total	256.86	172.00			
Regression model	B	Std. Error	Beta	t val	P value
(Constant)	-0.18	0.12		-1.441	0.151
Enhance teaching productivity	0.36	0.07	0.34	5.415	0.00
Develop online libraries	0.69	0.07	0.69	10.31	0.00
Creating inclusive environment	0.05	0.06	0.05	0.929	0.354
Solving educational challenges	-0.13	0.07	-0.12	-1.951	0.053

Table 2: Regression Analysis

(Source: Prepared by Authors)

The value of R^2 is 0.89, indicating that the model explains 89% of the variance in the dependent variable, "Innovative technology for productive learning." This high R^2 value suggests that the model is a good fit for the data, implying that the selected independent variables collectively have a strong influence on the implementation of innovative technology (Osadchyi, Valko, & Kuzmich, 2021). The regression equation provides insights into the relationship between the dependent and independent variables:

Innovative technology for productive learning = -0.18 (Constant) + 0.36 x enhancing teaching productivity + 0.69 x developing online libraries + 0.05 x creating an inclusive environment - 0.13 x solving educational challenges.

a) Enhancing Teaching Productivity (0.36): This coefficient suggests that enhancing teaching productivity positively influences the implementation of innovative technology. This could imply that educators who are more efficient in their teaching methods are better equipped to integrate technology effectively (Penprase, 2018).

b) Developing Online Libraries (0.69): The coefficient for developing online libraries has the highest positive impact on the implementation of innovative technology. This highlights the importance of accessible digital resources for both educators and students. Well-curated online libraries can facilitate technology adoption by providing a wealth of learning materials (Putra et al. 2020).

c) Creating an Inclusive Environment (0.05): While this coefficient is positive, it is the smallest among the independent variables. It suggests that creating an inclusive environment plays a role in implementing innovative technology, but its impact may be relatively minor compared to other factors.

d) Solving Educational Challenges (-0.13): As said by Qureshi et al. (2021), the negative coefficient for solving educational challenges implies that focusing on addressing educational challenges might hinder the implementation of innovative technology. This result is intriguing and may suggest that educators should prioritize technology adoption alongside, rather than in response to, educational challenges.

Chi Square Analysis

The last section is to test the hypothesis using chi square analysis

Innovative tech for productive learning * Enhance teaching productivity Crosstabulation

Count

		Enhance teaching productivity					
		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Total
Innovative tech for productive learning	Strongly Disagree	4	9	0	0	0	13
	Disagree	0	9	0	0	0	9
	Neutral	0	0	22	4	0	26
	Agree	0	0	0	15	32	47
	Strongly Agree	0	0	0	14	64	78
Total		4	18	22	33	96	173

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	348.391[a]	16	.000
Likelihood Ratio	254.111	16	.000
Linear-by-Linear Association	136.474	1	.000
N of Valid Cases	173		

Table 3: Cross Tabulation Analysis 1

(Source: Prepared by Authors)

In the realm of engineering education, the integration of innovative technology and the enhancement of teaching productivity are two critical components for creating a productive learning environment. This analysis aims to examine Hypothesis 1, which asserts that there is no significant difference between enhancing teaching productivity and the application of innovative technology for productive learning among school students. The provided statistical data, specifically the Pearson Chi-square value of 348.391 and the asymptotic significance (Asymp. sig) of .000, will be analyzed to determine the validity of this hypothesis.

a) Pearson Chi-square Value (348.391): This value indicates the strength of the association or the extent to which the observed data differs from what would be expected under the assumption of independence. A higher Chi-square value suggests a stronger association.

b) Asymptotic Significance (Asymp. sig) (.000): This value represents the p-value associated with the Chi-square statistic. A p-value less than the significance level (commonly set at 0.05) indicates that the relationship between the variables is statistically significant. In this case, the p-value is very close to zero, suggesting a highly significant relationship.

Innovative tech for productive learning * Develop online libraries Crosstabulation

Count

		Develop online libraries					
		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Total
Innovative tech for productive learning	Strongly Disagree	9	4	0	0	0	13
	Disagree	0	9	0	0	0	9
	Neutral	0	0	18	8	0	26
	Agree	0	0	0	10	37	47
	Strongly Agree	0	0	0	0	78	78
Total		9	13	18	18	115	173

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	407.951[a]	16	.000
Likelihood Ratio	280.560	16	.000
Linear-by-Linear Association	149.200	1	.000
N of Valid Cases	173		

Table 4: Cross Tabulation Analysis 2

(Source: Prepared by Authors)

As said by Raes et al. (2020), in the context of engineering education, the integration of innovative technology and the development of online libraries are essential for creating a productive learning environment. Hypothesis 2 posits that there is no significant difference between developing online libraries and the application of innovative technology for productive learning among school students. This analysis will investigate this hypothesis using the provided statistical data, specifically the Pearson Chi-square value of 407.951 and the asymptotic significance (Asymp. sig) of .000. The provided data reports a Pearson Chi-square value of 407.951 and an asymptotic significance (Asymp. sig) of .000, which is effectively zero. This extremely low p-value indicates strong evidence against the null hypothesis (H0), signifying that there is a statistically significant relationship between developing online libraries and the application of innovative technology for productive learning among school students.

a) Pearson Chi-square Value (407.951): This value represents the magnitude of the association or the extent to which the observed data deviates from what would be expected if the variables were independent. A higher Chi-square value indicates a stronger association.

b) Asymptotic Significance (Asymp. sig) (.000): The Asymp. sig value corresponds to the p-value associated with the Chi-square statistic. A p-value less than the significance level (often set at 0.05) indicates that there is a statistically significant relationship between the variables. In this case, the p-value is practically zero, suggesting a highly significant relationship.

Innovative tech for productive learning * Creating inclusive environment Crosstabulation

Count

		Creating inclusive environment					
		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Total
Innovative tech for productive learning	Strongly Disagree	4	9	0	0	0	13
	Disagree	5	4	0	0	0	9
	Neutral	0	0	18	8	0	26
	Agree	0	0	5	14	28	47
	Strongly Agree	0	0	0	32	46	78
Total		9	13	23	54	74	173

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	274.085[a]	16	.000
Likelihood Ratio	213.318	16	.000
Linear-by-Linear Association	116.403	1	.000
N of Valid Cases	173		

Table 5: Cross Tabulation Analysis 3

(Source: Prepared by Authors)

According to Rehman & Fatima (2021), in the context of engineering education, fostering an inclusive environment and integrating innovative technology are critical components for creating a productive learning environment. Hypothesis 3 posits that there is no significant difference between creating an inclusive environment and the application of innovative technology for productive learning among school students (Richardson et al. 2020). This analysis will examine this hypothesis using the provided statistical data, specifically the Pearson Chi-square value of 274.085 and the likelihood ratio of 213.318.

a) Pearson Chi-square Value (274.085): This value represents the strength of the association or the extent to which the observed data deviates from what would be expected if the variables were independent. A higher Chi-square value indicates a stronger association.

b) Asymptotic Significance (Asymp. sig) (.000): The Asymp. sig value corresponds to the p-value associated with the Chi-square statistic. A p-value less than the significance level (typically set at 0.05) indicates a statistically significant relationship between the variables. In this case, the p-value is practically zero, suggesting a highly significant relationship. This extremely low p-value provides compelling evidence against the null hypothesis (H0), indicating that there is indeed a statistically significant relationship between creating an inclusive environment and the application of innovative technology for productive learning among school students in engineering education (San-Valero et al. 2019).

Innovative tech for productive learning * Solving educational challenges Crosstabulation

Count

		Solving educational challenges					
		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Total
Innovative tech for productive learning	Strongly Disagree	0	13	0	0	0	13
	Disagree	5	4	0	0	0	9
	Neutral	0	0	22	0	4	26
	Agree	0	0	0	19	28	47
	Strongly Agree	0	0	0	27	51	78
Total		5	17	22	46	83	173

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	389.474[a]	16	.000
Likelihood Ratio	250.110	16	.000
Linear-by-Linear Association	115.271	1	.000
N of Valid Cases	173		

Table 6: Cross Tabulation Analysis 4

(Source: Prepared by Authors)

As opined by Scull et al. (2020), in the context of engineering education, addressing educational challenges and integrating innovative technology are pivotal for creating a productive learning environment. Hypothesis 4 posits that there is no significant difference between solving educational challenges and the application of innovative technology for productive learning among school students. This analysis will evaluate this hypothesis using the provided statistical data, specifically the Pearson Chi-square value of 389.474 and the asymptotic significance (Asymp. sig) of .000.

a) Pearson Chi-square Value (389.474): This value indicates the strength of the association or the extent to which the observed data differs from what would be expected if the variables were independent. A higher Chi-square value signifies a stronger association.

b) Asymptotic Significance (Asymp. sig) (.000): The Asymp. sig value represents the p-value associated with the Chi-square statistic. A p-value lower than the significance level (commonly set at 0.05) suggests a statistically significant relationship between the variables. In this case, the p-value is effectively zero, indicating a highly significant relationship. This exceptionally low p-value provides compelling evidence against the null hypothesis (H0), signifying that there is indeed a statistically significant relationship between solving educational challenges and the application of innovative technology for productive learning among school students in engineering education (Serhan, 2020: Rees Lewis et al. 2019).

Discussion

The findings from the ***regression model*** provide valuable insights for educators and policymakers in the field of engineering education:

Prioritizing Online Libraries: The strong positive coefficient for developing online libraries underscores the importance of investing in digital resources. Institutions and educators should

focus on building comprehensive online libraries to support technology integration effectively (Tejedor et al. 2021).

Balancing Productivity and Technology: As opined by Theobald et al. (2020), the positive coefficient for enhancing teaching productivity suggests that efficient teaching methods can aid technology adoption. Educators should be encouraged to strike a balance between productivity and technology integration.

Strategic Approach to Challenges*:* The negative coefficient for solving educational challenges indicates that a reactive approach to addressing issues in education may not be conducive to technology adoption. Instead, educators and institutions should adopt a proactive stance by integrating technology as part of their educational strategy (Tran, 2019).

By recognizing the significance of online libraries, teaching productivity, and a strategic approach to addressing challenges, stakeholders in engineering education can make informed decisions to create a more productive and technology-enhanced learning environment.The provided data for Hypothesis 1 shows a Pearson Chi-square value of 348.391 and an asymptotic significance (Asymp. sig) of .000, which is practically zero. This extremely low p-value indicates strong evidence against the null hypothesis (H0), suggesting that there is a significant relationship between enhancing teaching productivity and the application of innovative technology for productive learning among school students (Tseng et al. 2021). The provided data shows a Pearson Chi-square value of 348.391 and an asymptotic significance (Asymp. sig) of .000, which is practically zero. This extremely low p-value indicates strong evidence against the null hypothesis (H0), suggesting that there is a significant relationship between enhancing teaching productivity and the application of innovative technology for productive learning among school students (Waruwu et al. 2020).

The rejection of Hypothesis 2 suggests that there exists a substantial and statistically significant relationship between the development of online libraries and the application of innovative technology. In other words, when online libraries are developed, it is likely to be linked with the increased utilization of innovative technology in the learning process (Woolliscroft, 2020). Engineering educators and institutions should recognize the synergistic relationship between online library development and technology adoption. Online libraries can serve as repositories of digital resources and content, facilitating the integration of innovative technology for effective learning. To enhance the learning experience and productivity of students, it is important to consider strategies that integrate online libraries and innovative technology seamlessly within the engineering education curriculum (Penprase, 2018).

The rejection of Hypothesis 3 suggests that there is a substantial and statistically significant relationship between creating an inclusive environment and the application of innovative technology (Haque et al., 2022). This implies that when an inclusive environment is established, it is likely to be linked with increased utilization of innovative technology in the learning process (Putra et al. 2020). Engineering educators and institutions should recognize the interdependence of creating an inclusive environment and technology adoption. An inclusive environment can foster diversity and support students' varied needs, making technology more accessible and effective for all. Collaborative efforts to promote both inclusivity and technology integration can result in a more effective and equitable learning environment, benefiting all students (Oke &Fernandes, 2020).

The rejection of Hypothesis 4 suggests that there is a substantial and statistically significant

relationship between solving educational challenges and the application of innovative technology (Josephine et al., 2018). This implies that addressing educational challenges is linked with increased utilization of innovative technology in the learning process. Engineering educators and institutions should recognize the interconnection between addressing educational challenges and technology adoption (Mitchell et al. 2021). Innovative technology can provide solutions and strategies to overcome educational obstacles and improve the overall learning experience. Collaborative efforts to tackle educational challenges while effectively integrating technology can lead to a more productive and effective learning environment, ultimately benefiting students' education (Kryukov, & Gorin, 2016).

Conclusion

Students may practically travel to far-flung locations without leaving the convenience of their computers because to the advent of digital technology (Chisala et al., 2018). If a lesson plan has a guest speaker, there is a better chance that students will be interested in and engaged with the material being taught. Students may be given the opportunity to get a more profound grasp of a topic by having a person who is an expert in that area provides a lecture to the class (Liaw et al., 2024). This will allow the student to be exposed to a variety of novel viewpoints and ideas. The use of video conferencing technology makes it possible for subject matter experts to attend our classroom from any place, making it more convenient for them to do so (Haibao & Haque, 2023). In order to ease contact with students attending a different educational institution, it is feasible to quickly set up a video conferencing session inside the classroom (Umesh et al., 2023).

This may be done in a very short amount of time. It has been shown that using online polls and other digital tools is an excellent way to involve all students, especially those who are maybe less inclined to participate in conventional classroom settings. The employment of technologies for online interaction allows frequent monitoring of student progress and the collection of feedback on the various course materials and assignments (Aziz et al., 2022). The usage of the viewpoints of students may serve as a method for identifying possible issue areas in the curriculum. It has been discovered that the use of student response systems in the classroom may foster digital citizenship by encouraging students to take an active role in the learning process and making their involvement easier to access for all pupils (Haibin et al., 2022). Given the central place that schools have in each of our communities, it has been shown that the closing of schools has a discernible and negative effect on the emotional health of both families and their children (Narayanan et al., 2024). Utilising today's cutting-edge technology offers a simple solution to the problem at hand, which can be accomplished with relative ease (Wang et al., 2024). Students have the ability to study at their own speed, revisit previously covered content via video replays, and do independent research into the topic when they participate in online learning.

The analysis of the provided data, including the Pearson Chi-square value and asymptotic significance, supports the rejection of Hypothesis 1. This indicates that there is indeed a significant relationship between enhancing teaching productivity and the application of innovative technology for productive learning among school students in engineering education (Khalil & Haque, 2022). Acknowledging and leveraging this relationship can be instrumental in fostering an optimal learning environment that prepares students for the challenges and opportunities of the engineering field. Hypothesis 2 suggests that there is indeed a significant relationship between the development of online libraries and the application of innovative technology for productive learning among school students in engineering education

(Bahaaudeen et al., 2025). Acknowledging and leveraging this relationship can contribute to the creation of a productive and technology-enhanced learning environment, which is vital for preparing students for success in the field of engineering (Leong et al., 2024).

Hypothesis 3 suggests that there is indeed a significant relationship between creating an inclusive environment and the application of innovative technology for productive learning among school students in engineering education (Haque et al., 2024). Acknowledging and leveraging this relationship can contribute to the creation of a more productive, inclusive, and technology-enhanced learning environment, which is crucial for preparing students for success in the field of engineering (Ahmed et al., 2024). Hypothesis 4 indicates that there is indeed a significant relationship between solving educational challenges and the application of innovative technology for productive learning among school students in engineering education. Recognizing and capitalizing on this relationship can contribute to the creation of a more productive and solution-oriented learning environment, essential for preparing students for success in the field of engineering.

When we talk about using digital technology in the classroom, we're referring to a wide variety of applications and programmes that have been designed to assist students who have specific accessibility requirements. It has been determined that making use of various forms of technology in educational settings is a very successful strategy for relieving instructors of the weight of laborious and time-consuming responsibilities (Mya et al., 2025). The use of educational technology has the potential to facilitate the streamlining of a variety of processes, such as the tracking of attendance and the monitoring of performance, via the whole or partial automation of these responsibilities (Aziz et al., 2025). Because of this, the amount of time and effort necessary to do these repetitive chores might be significantly cut down as a consequence.

The instructional method comprises teaching students about the strategic and ethical use of technology, which has the potential to improve the students' ability to make decisions and to promote self-discipline (Sellamuthu et al., 2024). Students are now able to study at their own speed via the use of individualised teaching and learning experiences made possible by the advent of digital content technology. The digital classroom, in which pupils are instructed using various pieces of educational software and electronic equipment, is one technique that makes it easier to incorporate technology into the educational system. It is feasible to convert a conventional classroom into a digital learning environment by making use of computer technology and the internet. Students are able to better their learning experience and more efficiently measure their academic performance when they make use of cutting-edge technology tools and complex pieces of equipment.

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