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Technology-enhanced learning in higher education institutions in Malaysia

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ABSTRACT

Technology has become a dominant force worldwide, influencing various fields, including education. The adoption of technologies such as artificial intelligence (AI) and digital tools has transformed teaching and learning practices, especially after the pandemic. In higher education, both instructors and students have embraced technology-based learning methods. Technology-enhanced learning aims to maintain learners' attention and engagement through active learning strategies. This study aims to assess the impact of technology-enhanced learning in higher education institutions in Malaysia, highlighting its strengths and weaknesses. A blended research approach was used, combining both quantitative and qualitative methods. Data were collected from 425 students across five higher education institutions using questionnaires as the primary research tool. The findings show that the use of smart devices in technology-enhanced learning has increased, making the learning process easier for students. The study also identifies the strengths and weaknesses of technology-enhanced learning and provides recommendations for addressing its limitations.

1. Introduction

In the present era, technology plays a dominant role in various fields due to its advanced capabilities. Artificial intelligence, digital tools, and other technological innovations have significantly influenced multiple sectors, including education. The integration of technology into teaching and learning became widespread, particularly after the COVID-19 pandemic in 2020, as both teachers and students increasingly engaged with digital technologies (Ifenthaler et al., 2024). The growing adoption of technology-enhanced learning has transformed traditional teaching and learning methods. Many educators accustomed to conventional teaching approaches have had to transition to technology-based instruction (Lundberg and Stigmar, 2024). Likewise, higher education students have adapted to technology-driven learning environments, benefiting from opportunities provided by advanced digital tools.

In contemporary education, online learning has facilitated the development of innovative, technology-supported teaching methods. Numerous digital alternatives to traditional instructional approaches now exist, incorporating recent advancements in pedagogy and creativity (Godsk and Møller, 2024). Technology-enhanced learning aims to sustain students' engagement and interest through active learning strategies. Furthermore, technology has influenced curriculum design and educational theories. In modern learning environments, digital tools can support the development of soft skills through online collaboration platforms and virtual presentations.

Artificial intelligence (AI) also plays a significant role in technology-enhanced learning. AI has the potential to bring major changes to education by enabling personalized tutoring and providing real-time feedback tailored to students' performance and learning preferences. AI-integrated classrooms can automate various instructional tasks, thereby improving the overall learning experience. To incorporate the latest technological advancements into education, it is essential to establish well-equipped technology-enhanced learning environments. Therefore, this study aims to examine the impact of technology-enhanced learning in higher education institutions in Malaysia.

Higher education is necessary in any society or country for creating knowledge. The institutions which provide higher education to the society can be termed as higher education institutions. Higher education institutions have a fundamental role in

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transforming societies aimed at a more sustainable future (Berchin et al., 2021). Knowledge is generated and disseminated through various means, including teaching and learning, research activities, the adoption of new research findings, fieldwork, discussions, and training. These processes contribute to societal development. Malaysia is among the countries actively engaged in higher education. Over time, the country's focus has shifted from nation-building to enhancing its international standing and reputation through higher education (Sirat and Wan, 2022). There are around 1.3 million students enrolled in more than 100 higher education institutions in Malaysia. Various modes of education like distance education, hybrid learning, traditional academic classes, etc. are offered through these institutions. Technology-enhanced learning in higher education institutions in Malaysia, both public and private has been growing significantly. Moreover, Malaysia has transformed the education system into future education system 4.0 due to the rapid growth of the Industrial Revolution (IR) 4.0 This impact opened a new model for the educational institution of Malaysia to ensure that all lecturers are capable of using information and communication technologies (ICT) in teaching and learning (Bujang et al., 2020).

This study is based on two objectives. They are: to identify the technology-enhanced learning in higher education institutions in Malaysia and to bring out the strengths and weaknesses of the technology-enhanced learning in higher education institutions.

2. Literature survey

Shen and Ho (2020) explored the applications and outcomes of technology-enhanced learning (TEL) in higher education. Their study examines the development of academic communities and the implementation of a hybrid approach. It also discusses the adoption of TEL and its impact on traditional learning methods. Furthermore, the researchers identify five key areas of TEL development: adoption, critique, social media, podcasting, and blended learning. The findings emphasize the significance of a hybrid approach in facilitating a comprehensive understanding of TEL advancements in higher education.

Marín et al. (2020) conducted a study from an educational perspective, focusing on student agency and decision-making in learning. Their research is grounded in theoretical frameworks that link student agency with TEL. The study includes a systematic literature review of 29 studies that analyze the micro-level aspects of learning design and self-regulated learning. The findings propose a new model that connects student agency with TEL, contributing to a deeper understanding of student-centered learning approaches.

Dunn and Kennedy (2019) investigated the impact of emotional, cognitive, and behavioral engagement with TEL on students' academic performance. Their study involved 524 students, assessing their engagement, motivation, and academic outcomes. The results indicate that while student engagement in learning is evident, the use of TEL alone is insufficient to enhance learning outcomes. The researchers caution that an exclusive focus on TEL adoption may be misleading and emphasize the need for a balanced approach to technology integration.

Flavin (2016) examined current and emerging practices in TEL within higher education using the framework of 'disruptive innovation.' Data were collected from higher education institutions and analyzed to assess the implications of TEL on instructional design and technology use. The study highlights the role of Massive Open Online Courses (MOOCs) and emerging trends such as cost structures, personal device usage, and learning analytics in shaping TEL practices.

Krapookthong (2024) conducted a survey on technology integration in higher education in Thailand. The study examined classroom management through digital platforms, the use of technology in learning media, internet services, and educational programs. The survey involved 519 undergraduate students, 17 lecturers, and three higher education experts. Data were collected through student questionnaires and semi-structured interviews with lecturers and experts, analyzed using descriptive statistics such as frequency, percentage, mean, and standard deviation. The findings identify strengths, weaknesses, opportunities, and challenges in TEL adoption. The study reveals that students are generally satisfied with the use of technology in classrooms and find their lecturers' ICT knowledge adequate. It recommends continuous technological upskilling for educators and further encouragement for the adoption of TEL.

These studies provide valuable insights into the current state of TEL research, including its practices, implications, and adoption in higher education. They highlight both the potential benefits and the challenges associated with integrating technology into teaching and learning.

3. Method of the study

This study employs a mixed-method research approach that includes both quantitative and qualitative methods. Quantitative research is a form of research that relies on the methods of natural sciences, which produces numerical data and hard facts and it also relies on data that are observed or measured to examine questions about the sample population (Ahmad et al., 2019). This method is adopted with a well-structured questionnaire as a tool. The questionnaire which consists of 25 elements is framed with input from a subject expert to ensure clarity and relevance. Moreover, a pilot study with 25 randomly selected students is conducted to assess the reliability of the questionnaire. Data are collected from 425 students from five higher education institutions across the

disciplines including Arts, Social Science, Education and Business Management, using a random sampling method. The collected samples are analyzed and presented in tables and figures. On the other hand, the qualitative research method which discovers and provides perceptions of real-world problems is implemented. With this method, the strengths and weaknesses of technology-enhanced learning in higher education institutions are exposed.

Numerous studies have been conducted on technology-enhanced learning in higher education institutions throughout the globe. Most of these studies have focused on the impacts, practices, applications, etc. Some of the previous studies are highlighted here in related studies.

4. Findings and discussions

This section presents the findings and discussion of the study. As previously stated, data were collected from 425 students across five higher education institutions. The data were analyzed, and key statistical measures, including percentage (%), mean ($\bar{x}$), standard deviation (s), and variance (s^2), were calculated. The results are displayed in tables and figures for clarity. All 425 students from higher education institutions in Malaysia participated actively by completing the questionnaire.

4.1. Demographic information

Among the 425 respondents, 320 were undergraduate students, while 105 were postgraduate students. The study sample consisted of 82% female respondents and 18% male respondents. In terms of ethnicity, the majority were Malays (74%), followed by Chinese (15%) and Indians (11%).

Among the undergraduate students, 90 were in their first year, 90 in their second year, 90 in their third year, and 50 in their fourth year. For postgraduate students, 60 were in their first year of study, while 55 were in their second year. The distribution of respondents is presented in Fig. 1.

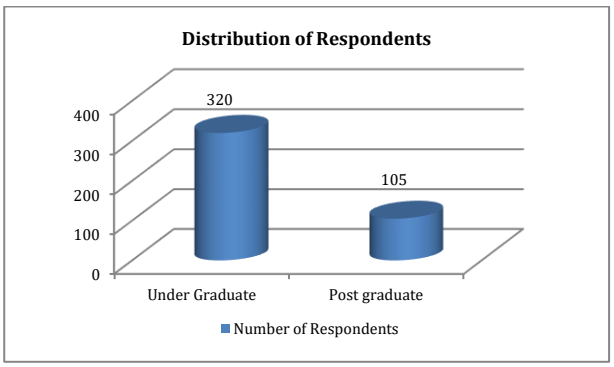

Fig. 1: Number of respondents

4.2. Elements and responses

The questionnaire consisted of 25 items, but due to specific considerations, only 12 items were disclosed and analyzed in this section. The responses were categorized into various options, including 'Yes,' 'No,' 'Whenever needed,' 'Every time,' 'Daily,' 'Not at all,' 'Excellent,' 'Good,' 'Average,' 'Mobile,' 'E-mail,' 'Internet,' 'Electronic devices,' 'Interaction,' 'Printed books,' 'Digital books,' 'PDF books,' 'Smart gadget,' 'Notebook,' and 'Writing pad.' As shown in Table 1, all 425 respondents answered 'Yes' for items 1 and 2. For items 4, 6, and 9, the number of respondents selecting 'Yes' was 198, 301, and 225, respectively. Conversely, 227, 124, and 170 respondents answered 'No' for items 4, 6, and 9. Regarding item 3, 302 respondents selected 'Whenever needed,' while 123 chose 'Every time.' Similarly, for item 5, 106 respondents answered 'Whenever needed,' 189 selected 'Daily,' and 130 responded 'Not at all.' For item 7, responses were distributed among three categories: 'Excellent' (190), 'Good' (200), and 'Average' (35). For item 8, 223 respondents selected 'Mobile,' while 202 chose 'E-mail.' Additionally, for item 10, 194 respondents selected 'Internet,' 89 chose 'Electronic devices,' and 142 opted for 'Interaction.' Responses for item 11 included 54 for 'Printed books,' 200 for 'Digital books,' and 165 for 'PDF books.' For item 12, 'Smart gadget' received 390 responses, 'Notebook' received 25 responses, and 'Writing pad' received 10 responses.

The collected responses for the 12 elements of the questionnaire were analyzed using percentage (%), mean ($\bar{x}$), standard deviation (s), and variance (s^2). The serial numbers listed in Table 2 correspond to the respective elements in the questionnaire.

For elements 1 and 2, the response rate was 100%, indicating that all students are familiar with technology and that classrooms are equipped with technological tools. Responses for the remaining elements varied. Elements 3, 4, 8, and 9 had two response categories, while elements 5, 7, 10, 11, and 12 had three response categories.

For element 3, responses were distributed as 71.1% and 28.9%, with mean values of 363.5 and 274, standard deviations of 86.97 and 213.54, and variances of 7,564.5 and 45,602. These results suggest that the use of technology-based gadgets depends on the classroom context. Similarly, for element 4, responses were 46.59% and 53.41%, with mean values of 311.5 and 326, standard deviations of 160.5 and 140, and variances of 25,764.5 and 19,602. This indicates that students use digital dictionaries to a limited extent.

For element 5, responses were divided into 44.48%, 24.94%, and 30.58%, with mean values of 307, 265.5, and 277.5, standard deviations of 166.8, 255.5, and 208.59, and variances of 27,848, 50,880.5, and 43,512.5. These findings suggest variations in students' use of digital dictionaries. In the case of element 6, responses were 70.82% and 29.18%, with mean values of 363 and 274.5, standard deviations of 87.68 and 212.83, and variances of 7,688 and 45,300.5. This indicates that students generally find technology easy to use in the classroom.

Table 1: Elements and responses

No.	Elements	Responses	Numbers
1	Are you familiar with technology-enhanced learning?	Yes	425
2	Is your classroom designed with technology?	Yes	425
3	How often do you use technology in the classroom (Mobile/laptop/LCD projector, etc.)?	Whenever needed	302
		Every time	123
4	Will you refer digital dictionary at the university?	Yes	198
		No	227
5	How often do you refer to the digital dictionary?	Daily	189
		Whenever needed	106
		Not at all	130
6	Is it easy to learn with technology?	Yes	301
		No	124
7	What is your learning performance with technology?	Excellent	190
		Good	200
		Average	35
8	How do you interact with your staff, if it is an online class?	Mobile	223
		E-mail	202
9	Are you satisfied with technology-enhanced learning?	Yes	255
		No	170
10	What improvement do you suggest regarding technology-enhanced learning?	Internet	194
		Electronic devices	89
		Interaction	142
11	How do you read in the classroom	Printed books	54
		Digital books	206
		PDF books	165
12	What is the mode of taking notes in the classroom	Smart gadget	390
		Notebook	25
		Writing pad	10

For element 7, the response distribution was 44.7%, 47%, and 8.3%, with mean values of 307.5, 312.5, and 230, standard deviations of 166.17, 159.09, and 275.77, and variances of 27,612.5, 25,312.5, and 76,050. These results highlight students' learning performance. For element 8, responses were 52.5% and 47.5%, with mean values of 324 and 313.5, standard deviations of 142.83 and 157.68, and variances of 20,402 and 24,864.5, reflecting different levels of interaction.

Regarding element 9, responses were 60% and 40%, with mean values of 340 and 297.5, standard deviations of 120.2 and 180.31, and variances of 14,450 and 32,512.5, indicating mixed opinions on satisfaction with technology-enhanced learning. For element 10, responses were 45.7%, 20.9%, and 33.4%, with mean values of 309.5, 257, and 283.5, standard deviations of 163.34, 237.58, and 200.11, and variances of 26,680.5, 56,448, and 40,044.5, showing distinct response patterns.

Similarly, for element 11, the responses were 12.7%, 48.5%, and 38.8%, with mean values of 239.5, 315.5, and 295, standard deviations of 262.33, 154.8, and 183.84, and variances of 68,820.5, 23,980.5, and 33,800. These values represent students' reading preferences. Finally, for element 12, the responses were 91.7%, 5.9%, and 2.4%, with mean values of 407, 225, and 217.5, standard deviations of 24.7, 282.84, and 293.44, and variances of 612.5, 80,000, and 86,112.5. This suggests varying preferences regarding note-taking methods in the classroom. All these findings are summarized in Table 2.

Table 2: Responses and calculations

No.	Responses	Percentage (%)	Mean ($\bar{x}$)	Standard deviation (s)	Variance (s^2)
1	Yes	100%	-	-	-
2	Yes	100%	-	-	-
3	Whenever needed	71.1%	363.5	86.97	7564.5
	Every time	28.9%	274	213.54	45602
4	Yes	46.59%	311.5	160.5	25764.5
	No	53.41%	326	140	19602
5	Daily	44.48%	307	166.8	27848
	Whenever needed	24.94%	265.5	255.5	50880.5
	Not at all	30.58%	277.5	208.59	43512.5
6	Yes	70.82%	363	87.68	7688
	No	29.18%	274.5	212.83	45300.5
7	Excellent	44.7%	307.5	166.17	27612.5
	Good	47.0%	312.5	159.09	25312.5
	Average	8.3%	230	275.77	76050
8	Mobile	52.5%	324	142.83	20402
	E-mail	47.5%	313.5	157.68	24864.5
9	Yes	60%	340	120.2	14450
	No	40%	297.5	180.31	32512.5
10	Internet	45.7%	309.5	163.34	26680.5
	Electronic devices	20.9%	257	237.58	56448
	Interaction	33.4%	283.5	200.11	40044.5
11	Library books	12.7%	239.5	262.33	68820.5
	Digital books	48.5%	315.5	154.8	23980.5
	PDF books	38.8%	295	183.84	33800
12	Smart gadget	91.7%	407	24.7	612.5
	Notebook	5.9%	225	282.84	80000
	Writing pad	2.4%	217.5	293.44	86112.5

Overall, the students' responses indicate that higher education institutions in Malaysia are well-equipped with technology. A key finding of this study is that students primarily use digital books for reading and rely on smart devices for taking notes in the classroom. However, only 12.7% of students visit the library to read books. There is a need to provide more updated books in libraries, improve access to reading materials, or establish new libraries. This finding is consistent with the study by Mohamed et al. (2020), which emphasized the importance of establishing more libraries, particularly in rural areas, to promote a reading culture.

Another important aspect of this study is student satisfaction with technology-enhanced learning. The results show that 60% of students are satisfied with this mode of learning, suggesting that technology-enhanced education can be effectively implemented in future classrooms or other learning environments. This aligns with the findings of Ramayah and Kumar (2020), who argued that their research aims to improve the delivery of online teaching, particularly during potential future pandemics. Therefore, it is evident that technology-equipped classrooms can be implemented in various situations.

Additionally, the study highlights areas that require improvement. Students reported that enhancements are needed in internet connectivity, the availability of appropriate electronic devices, and classroom interaction. Zakariah et al. (2012) also emphasized the importance of creating an interactive learning environment in modern education. Interaction is a fundamental component of teaching and learning, as effective engagement is essential for academic success.

4.3. Strength and weakness

Technology-enhanced learning in higher education institutions offers numerous advantages. One significant benefit is the flexibility of the hybrid approach, which allows students to access virtual classrooms at any time and from any location. This feature is a core aspect of technology-enhanced learning, as highlighted by Shen and Ho (2020). Another advantage is that lectures can be recorded, enabling students to revisit them multiple times for better understanding. Additionally, social media platforms such as blogs, WhatsApp, and Telegram facilitate interaction among students, enhancing engagement in the learning process. Furthermore, technology-enhanced learning provides opportunities for academic discussions and research applications, as noted by Dunn and Kennedy (2019). The integration of digital technologies also enables more advanced learning activities, making the educational experience more interactive and effective (Sailer et al., 2024).

Despite these benefits, technology-enhanced learning also presents certain challenges. One major issue is the lack of knowledge about the latest technological advancements among students and educators, which can hinder effective implementation. Moreover, sophisticated technology can sometimes be unreliable, leading to disruptions in the learning process. Another challenge is that the existing curriculum may not be fully compatible with technology-enhanced learning, necessitating adaptations to better integrate digital tools. Additionally, certain physical and practical learning experiences are difficult to replicate in hybrid classrooms, posing a limitation for subjects that require hands-on activities.

To address these challenges, several solutions can be considered. Cross-institutional collaboration can help by allowing universities to share lectures and technological resources, ensuring that students remain informed about the latest developments in technology. Furthermore, implementing self-assessment and feedback mechanisms for both lecturers and students can enhance learning outcomes, as suggested by Ebner et al. (2019). A blended learning approach that combines traditional teaching methods with technology-enhanced learning can also help mitigate issues related to technological unreliability, ensuring a more effective and adaptable educational experience.

5. Conclusion

Technology-enhanced learning is widely adopted in higher education institutions globally, including in Malaysia, and effectively meets students' learning needs. The findings of this study indicate that all students (100%) are familiar with technology-enhanced learning, and their classrooms are equipped with technological tools. Another key finding is that a significant proportion of students actively use smart gadgets in their classrooms, with 91.7% reporting regular use. Additionally, 60% of students expressed satisfaction with technology-enhanced learning, while 48.5% reported using digital books for reading.

These results contribute to the growing body of research on technology-enhanced learning by demonstrating its effectiveness in Malaysian higher education institutions, where students are actively integrating technology into their academic activities. The study identifies both the strengths and limitations of technology-enhanced learning and proposes strategies to address the challenges. To further enhance its implementation, future research should focus on student-related issues and challenges associated with technology-enhanced learning in Malaysian higher education institutions.

Compliance with ethical standards

Ethical considerations

This study was conducted in accordance with ethical research guidelines. Participants provided informed consent, and their anonymity and confidentiality were maintained throughout the research process. No sensitive personal data were

collected, and the study posed no risks to participants.

Conflict of interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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