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From Infrastructure to Interaction: How University Digital Transformation Empower AI Collaboration Quality among Malaysian University Students

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ABSTRACT

As artificial intelligence (AI) becomes increasingly embedded in higher education, universities are under growing pressure to develop institutional conditions that enable students to engage with AI tools in effective and meaningful ways. Drawing on the Job Demands–Resources (JD-R) model, this study examines how university digital transformation relates to students' work engagement, technological self-efficacy, and student–AI collaboration quality in the Malaysian higher education context. Using survey data collected from 135 Malaysian university students, the study applies regression analysis to test the proposed relationships. The findings indicate that university digital transformation is positively associated with students' work engagement and technological self-efficacy. Technological self-efficacy, in turn, contributes significantly to student–AI collaboration quality. These findings suggest that digital transformation functions as an important institutional resource that supports students' motivational and cognitive readiness for technology-enabled learning. The study extends the application of the JD-R model to AI-supported higher education and offers practical implications for university management seeking to strengthen students' technological confidence and capacity for productive AI collaboration.

Keywords: Artificial Intelligence; Digital transformation; Job Demands-Resources model; Malaysian higher education; Technological self-efficacy; Work engagement.

INTRODUCTION

Until recently, artificial intelligence (AI) was something students primarily read about in science fiction or in a handful of study areas. Today, AI has been quickly included into our daily learning as writing aids, searching tools, tutoring platforms and also rating systems (Al-Zahrani & Alasmari, 2024). The pace of this development is so fast that it is hard for many institutions to stay up. In recent years, AI has evolved from a theoretical technological concept into a widely used and powerful educational tool, changing the way students acquire, process and understand information. In modern times, this is no longer a trend that universities remain on the sidelines. Students not only need to master course content but also be equipped with critical thinking skills in order to evaluate the accuracy of AI-generation information and use these tools responsibly so as to enhance their learning effectiveness. As a result, higher education institutions worldwide are facing an urgent need to continue to adapt to their traditional pedagogical models and technological infrastructure (Slimi, 2023).

Malaysia's universities have not ignored this change. In recent years, organisations across the country have poured money into modernising the digital infrastructure. It involved not only technology improvements but also changes in the way instruction was done. Faster campus networks, cloud-based learning platforms and smart classroom technologies are no longer optional, they are becoming standard facilities. These efforts included the adoption of an enhanced learning management system, the creation of smart campuses and the provision of high-speed and stable technical resources for students (Huda, 2023). In addition to hardware improvement, educational institutions are rethinking teaching and learning approaches. Classrooms are no longer physical spaces, students are also expected to learn independently via digital tools. This transformation is not only to keep up with global trends, but also because of the practical demands. It represents the modern workforce that expects graduates to have digital literacy skills and the ability to interact with AI technologies. This is the early creation of this learning environment so that when students go to work they do not begin to scratch.

Despite the huge resources Malaysia's universities have put in digital infrastructure, a gap has been apparent in reality. Having access to advanced technology doesn't translate to kids using it well. Universities may have been effective in providing hardware, software and network connectivity, but how students use AI in their daily study is another thing (Mohamed Hashim et al., 2021). Students avoid using these tools due to habit, or they utilize them in a shallow and uncritical way, such as just duplicating the results without questioning them. At the same time, educators are not entirely comfortable with these changes. Concern about academic integrity and over-dependence on AI are real and widespread, and they affect how AI tools are encouraged in the classroom. It is increasingly clear that building infrastructure is only the initial stage. Whether students truly obtain benefit from AI depends more on how they perceive and use these tools, including their motivation and confidence and willingness to engage critically rather than passively. There is a significant gap between the availability of technology and its effective use, and the factors driving students to bridge the gap. Specifically, how university-level digital transformation affects the quality of collaboration between students and AI.

This study aims to address this gap. The main objective is to examine the factor that drives high-quality students-AI collaboration among Malaysian university students, using the Job Demands-Resources(JD-R) model as a framework. The uniqueness of this study lies in its attempts to apply the JD-R model, traditionally used in workplace settings, into the context of AI use in higher education. More specifically, this study

does not merely treat university digital transformation as a contextual factor, but rather treats it as an active institutional resource that operates through two different pathways. The first pathway is student engagement at the motivational level and the second pathway is technological self-efficacy at the cognitive level. Thus, understanding how these two pathways operate will provide practical implications for universities. Rather than increasing technological investment, universities can create more strategically enabling conditions to transform students from passive users into active and confident collaborators. At a macro level, this study directly addressed the gap between digital investment and actual learning outcomes, which is a challenge for many universities facing this issue but has not been extensively studied. The findings of this study aim to provide specific and evidence-based recommendations to ensure their digital investment does not remain at a surface-level metric but generate tangible outcomes.

LITERATURE REVIEW

Definition of University Digital Transformation

University digital transformation refers to the broad integration of digital technologies across all areas of higher education institutions. Not only changing the tools used but also reshapes how it operates and how it delivers education. This process is not just digitizing a paper record and installing basic software but rather represents a deeper structural and cultural shift. In this transformation, universities are using smart campus systems, cloud- based learning platforms and AI technology to reshape the learning environment (Benavides et al., 2020). For students, this transformation is reelected in many practical ways such as easier access to information, more attractive ways of learning and building a platform that makes collaboration more flexible (Mohamed Hashim et al., 2021). Based on the JD-R framework, university digital transformation is treated as institutional resources that help students to face complex academic demands. Rather than enable students to confront alone with the AI-driven academic environment, universities provide necessary basic infrastructure, and support will enable students more easily to adapt to the environment (Díaz-García et al., 2023). This is especially crucial in the Malaysian higher education context because the push toward digital readiness has obviously been faster in recent years. A strong digital foundation does more than modernize the institution, it enhances students' confidence and minimizes unnecessary friction in the learning process to enable students to work using AI effectively in the future.

Digital Transformation & Work Engagement

The Job Demands-Resources (JD-R) model distinguishes between the pressures students face and the resources that help them cope. In this study, university digital transformation functions as a key institutional resource — covering not just physical infrastructure like internet connectivity and devices, but also the learning platforms, AI-assisted tools, and digitally integrated systems that students rely on daily. According to the motivational path in the JD-R model, when these resources can provide services stably and operate smoothly, students are more likely to feel happy during the learning process rather than experiencing malfunctions. Most of the time, the technical difficulties that the AI systems face include the slow processing speed of the systems, restrictions on accessing the systems, and the unavailability of stable technology, all of which will hinder students' learning process. However, owing to the presence of the JD-R model, the technical difficulties will be solved to a great extent, and thus will help students concentrate on their educational tasks rather than resolving their technical difficulties (Salanova et al., 2010).

Previous research has proved that creating a well-developed digital environment will enhance engagement among students. When technology is user-friendly and easily

accessible and AI applications are also made easy, then students tend to use less time on technological aspects and concentrate more on studying and interacting with other students (Huda, 2022). This leads to three important elements of work engagement – that is, feeling energetic about learning, feeling committed towards learning and concentrating on learning. All these three feelings are put together form "work engagement". An effective digital infrastructure can enhance students' confidence when engaging in activities related to artificial intelligence. The smooth operation of the technological system will ensure that students continue to participate in learning effectively and will not disengage from it due to frustration (Slimi, 2023). Therefore, we hypothesize that:

H1. University digital transformation positively affects students' work engagement.

Digital Transformation & Self-Efficacy

The Job Demands-Resources (JD-R) theory posits that organisational resources are critical in motivating people and developing personal psychological resources such as self-efficacy. In the context of this research, the digital transformation of higher education institutions is a significant resource of organisational support for university students. When colleges and universities fully upgrade their digital campus construction including user-friendly online learning systems, stable high-speed network coverage and intelligent auxiliary teaching tools, students can get enough technical support to complete daily academic tasks smoothly.

With stable and well-functioning digital campus systems, learners can effectively complete online learning activities, which in turn boosts their overall confidence in using various digital software and online platforms (Sun & Yoon, 2025). A lot of recent empirical studies have demonstrated that building sound digital infrastructure at the campus level can effectively boost students' overall confidence in using diverse technology tools for study (Zheng & Xiao, 2024).

This targeted level of confidence is defined as technological self-efficacy in this study. The continuous and stable use of optimised educational technology with less technical errors and system malfunctions enables students to gradually recognise their own digital learning competencies and to build a strong sense of technical competence (Xu et al., 2024). Such positive self-perception is beneficial for students to adapt to the current AI-oriented social environment and accumulate core competencies for future career development (Long & Praditteera, 2026).

In short, scientific and comprehensive digital transformation in universities contributes to moulding a supportive learning atmosphere, allowing students to practise digital skills steadily and shape positive self-recognition. In the long run, students will have significantly higher technological self-efficacy, as campus digital services and infrastructure will be continuously optimised. We therefore hypothesise that:

H2. University digital transformation positively affects students' technological self-efficacy.

Digital Transformation & AI Collaboration

According to the JD-R model, sufficient resources from an organisation enable individuals to cope with challenging tasks in everyday study and work. Digital development and upgrades are one of the most important supporting resources for students for higher education institutions. Schools that offer stable learning platforms, fast campus internet and user-friendly AI learning tools can greatly reduce technical

difficulties, allowing students to use new digital technology more comfortably (Strzelecki, 2023).

Once these fundamental digital conditions are completely established, students won't have to invest additional time in repairing standard technical problems. Instead, they can focus on using AI tools in more practical and useful ways. There is a huge difference between working with and using a digital tool casually. When students cooperate with AI, they are able to discuss ideas, solve academic problems and create new learning content together, instead of only using AI to get easy answers (Tlili et al., 2023).

There has been support for this view in previous research. The continued upgrade of digital systems in schools and the provision of clear rules for the proper use of AI for students will lead learners to use artificial intelligence in more critical and responsible ways, rather than seeing it as a lazy shortcut (An et al., 2025). At the same time, reasonable digital planning and management by universities can also guide students to use AI in a wise way during their study (Chan, 2023). A seamless and comprehensive digital campus environment makes students perceive AI as a useful study companion, which significantly improves their overall academic performance and assignment quality (Kuhail et al., 2022). In conclusion, campus digital upgrades not only provide students with more tech tools but also enhance their ability to cooperate with AI technology. Therefore, we suggest that:

H3. University digital transformation positively affects students' collaboration quality with AI.

Work Engagement & AI Collaboration

The JD-R model presents that when individuals have obtained sufficient resources, they will be more likely to experience work engagement. They will reach a positive and satisfied state that will improve their performance. In the academic setting, this engagement is reflected in three interconnected qualities: the energy students present when completing their tasks (vigor), their sense of purpose and commitment in the learning process (dedication) and their ability to stay focused and absorbed (absorption). When students are truly engaged in learning, they complete their studies out of interest rather than obligation (Long et al., 2026).

This engaged state will directly affect the ways of interaction between students and AI. Rather than simply using AI as a tool to complete tasks faster, equipped with higher engagement students are more likely to treat it as a thinking partner and interact with it in a more careful and critical way (Long et al., 2026). They are willing to refine their prompts and question the outputs they receive from AI generation. After that, they will deeply analyze the results and deepen their understanding (Vieriu & Petrea, 2025).

This mode of interaction enables the relationship between humans and AI beyond not only in completing simple and basic task automation, but also closer to genuine knowledge construction (Lin et al., 2025). Besides, the energy and concentration that come with high engagement also enable students equipped with greater mental stamina that are able to handle the challenges posed by AI tools without easily losing motivation (Wang et al., 2026). In conclusion, students with high engagement are able to build productive, rational and high-collaborative relationships with AI. Accordingly, we propose that:

H4. Students' work engagement positively affects their collaboration quality with AI.

Self-Efficacy & AI Collaboration

Within the JD-R framework, personal resources such as self-efficacy are seen as internal buffers that are able to help individuals manage demanding tasks and handle uncertainty. In digital education contexts, technological self-efficacy functions as one such resource that affects how students perceive and use advanced tools like generation AI (Paredes-Aguirre et al., 2026).

For students with strong confidence in their digital abilities, they are more likely to use AI platforms confidently rather than avoid using them or using them in superficial ways only (Fang & Feng, 2026). This internal confidence changes the interaction ways between human and AI to shift students from passive consumers of AI output to active participants who shape and process the interaction process (Ouyang & Jiao, 2021).

When students trust their own technical abilities, challenges such as prompt refinement or handling unexpected AI responses are seen as problems to work through rather than reasons to give up (Zhou et al., 2026). Instead of simply accepting the first output they receive, they take time to refine their inputs, evaluate what the AI produces and integrate useful insight and self-thinking. This more deliberate and thoughtful approach tends to produce richer, more attractive, more academically sound results. At the same time, it also helps to reduce the risk of uncritical over-reliance on AI. This is because generative tools become more accessible, this concern is increasingly relevant (Alghamdi, 2025). Ultimately, students with strong technological self-efficacy are better able to build productive working relationships with AI. Thus, we pose that:

> *H5. Students' technological self-efficacy positively affects their collaboration quality with AI.*

Conceptual Framework

Composed of the hypotheses developed above, our theoretical framework is illustrated in Figure 1.

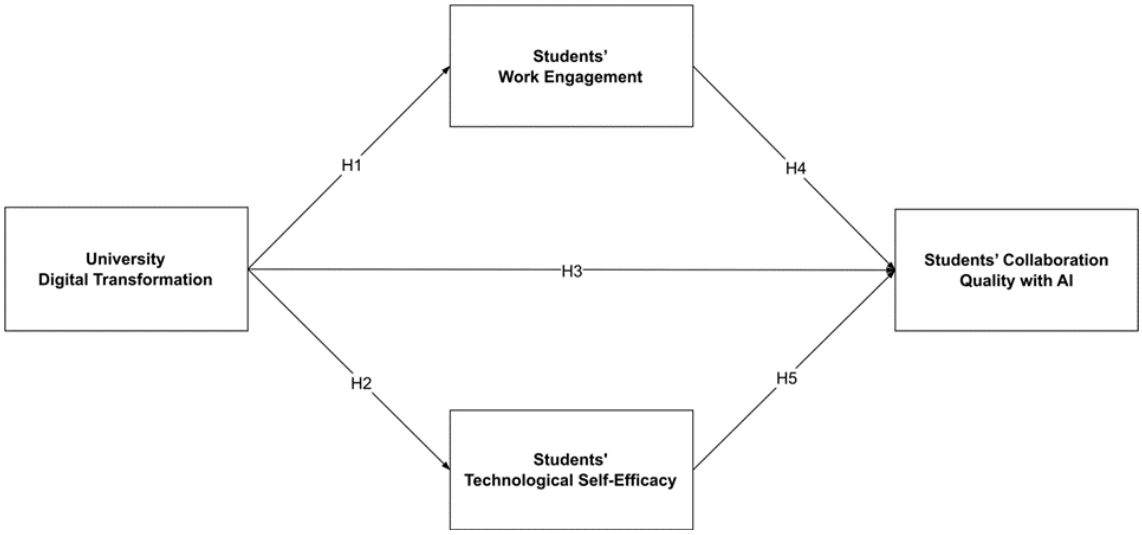

Figure 1. Theoretical Framework

RESEARCH METHOD

Participants and Procedure

This study employs a quantitative research design using a survey method to examine the factors influencing students' collaboration quality with artificial intelligence (AI) among Malaysian university students. The questionnaire was developed based on research objectives and distributed online via Google Forms. To facilitate participation, the survey link was shared through commonly used communication platforms such as WhatsApp and Telegram. Participation was voluntary, and all responses were kept confidential and used solely for academic purposes.

To enhance the appropriateness and robustness of the data collection procedure, screening questions were included at the beginning of the questionnaire. These screening questions were used to confirm that respondents were currently studying at a university in Malaysia and had been enrolled in their current university for at least six months. The six-month tenure criterion was applied to ensure that respondents had sufficient exposure to their university's learning environment, digital infrastructure, and AI-related learning practices before answering the questionnaire (Tan et al., 2017). Only respondents who met these eligibility criteria were allowed to proceed with the full survey.

A total of 150 responses were collected from Malaysian university students. After screening based on predefined criteria, 15 responses were excluded. These included respondents who were not current university students (n = 3) and questionnaires with incomplete or missing key demographic information such as gender, age, and ethnicity (n = 12). Only responses that met the study criteria were included in the analysis. A final sample of 135 valid responses was retained for subsequent analysis.

In terms of demographic characteristics, the sample shows several consistent patterns. Gender distribution indicates that 62.2% (n = 84) of respondents are male and 37.8% (n = 51) are female, reflecting a slightly male-dominated sample. The age profile is concentrated in the early twenties, with respondents aged 21, 22, and 23 forming the majority. Among them, 21-year-old respondents account for 28.9% (n = 39), while those aged 22 and 23 each account for 20.7% (n = 28).

With regard to race, Chinese respondents form the largest group at 48.9% (n = 66), followed by Malays at 34.8% (n = 47) and Indians at 15.6% (n = 21), with a small proportion from other ethnic backgrounds (0.7%, n = 1). In terms of academic level, undergraduate students account for 84.4% (n = 114), followed by master's students at 12.6% (n = 17) and doctoral students at 3.0% (n = 4). In terms of family monthly income, respondents were classified into B40, M40 and T20 groups based on the household income classification outlined by StashAway (2026). Most respondents fall within the M40 category at 54.1% (n = 73), followed by B40 at 24.4% (n = 33) and T20 at 21.5% (n = 29). These characteristics demonstrate that the sample captures a diverse range of backgrounds and is well aligned with the objectives of the study.

Table 1. Summary of Respondents' Demographic Information *(N = 135)*

Response	Frequency	Percentage (%)
Gender		
Female	51	37.8
Male	84	62.2
Age		
18 – 20	19	14.1
21 – 24	109	80.7
≥ 25	7	5.2
Race		
Malay	47	34.8
Chinese	66	48.9
Indian	21	15.6
Others	1	0.7
Current Academic Program		
Undergraduate Program	114	84.4
Master's Program	17	12.6
Doctorate Program	4	3.0
Family Monthly Income Level		
B40 (≤ RM5,859)	33	24.4
M40 (RM5,860 - RM12,679)	73	54.1
T20 (≥ RM12,680)	29	21.5

Measurement

This study measured all constructs using established scales adapted from prior studies. All items were assessed using a five-point Likert scale, ranging from 1 = strongly disagree to 5 = strongly agree. The questionnaire consisted of four main variables: university digital transformation, organizational justice, students' technological self-efficacy, and student–AI collaboration quality.

University digital transformation was measured using three (3) items adapted from Nasiri et al. (2020). This construct was used to assess the extent to which universities adopt and implement digital technologies in their learning and institutional environment. The scale demonstrated acceptable internal consistency, with a Cronbach's alpha value of 0.81.

Students' work engagement was measured using nine (9) items adopted from Schaufeli et al. (2006). This variable was included to assess students' perceptions of fairness within the university context. The scale showed strong reliability, with Cronbach's alpha values ranging from 0.90 to 0.92.

Students' technological self-efficacy was measured using nine (9) items adapted from Huffman et al. (2013). This construct assessed students' confidence in using technology-related tools and systems in their learning activities. The scale demonstrated good internal consistency, with a Cronbach's alpha value of 0.86.

Student–AI collaboration quality was measured using five (5) items adapted from Hesse et al. (2015). This construct assessed the quality of students' interaction and collaboration with AI tools in supporting their learning and problem-solving processes. The scale showed strong reliability, with a Cronbach's alpha value of 0.91.

RESULTS

The result in Table 2 indicates the descriptive statistic, Cronbach's coefficient alpha, and zero-order correlations for all study variables. All constructs show good reliability with strong internal consistency ranging from 0.753 to 0.902.

Table 2. Descriptive Statistic, Cronbach's Coefficients Alpha, and Zero-order Correlations for All Study Variables

Variables	1	2	3	4
1. UDT	**0.753**			
2. SWE	0.760***	**0.874**		
3. STSE	0.478***	0.405***	**0.902**	
4. SACQ	0.750***	0.289***	0.699***	**0.840**
Number of items	3	9	9	5
Mean	4.333	4.260	4.309	4.313
SD	0.701	0.631	0.658	0.713

Note: N = 135; *p < .05, **p < .01, ***p < .001. The diagonal entries represent Cronbach's coefficient alpha. Abbreviation: university digital transformation (UDT); Students' Work Engagement (SWE); Students' Technological Self-Efficacy (STSE); Student-AI Collaboration Quality (SACQ).

Table 3 demonstrates the regression analysis. University digital transformation (UDT) was found to have a positive influence on students' work engagement (beta = 0.760, p < .001), supporting H1. Similarly, UDT was found to have a positive influence on technological self-efficacy (beta = 0.809, p < .001), supporting H2. However, the influence of UDT on AI collaboration quality was not proved (beta = 0.144, p > .05), rejecting H3. The relationship between students' work engagement and AI collaboration quality was also not found (beta = 0.128, p > .05), rejecting H4. Technological self-efficacy was found to have a positive influence on AI collaboration quality (beta = 0.609, p < .001), supporting H5.

Table 3. Regression Analysis

	SWE	STSE	SACQ
UDT	0.760***	0.809***	0.144
SWE	-	-	0.128
STSE	-	-	0.609***
R^2	0.577	0.654	0.706
Adjusted R^2	0.574	0.651	0.699
F-statistic	181.558***	251.391***	104.697***

Note: N = 135; Standardised estimates were reported. Standard errors were in parentheses. *p < .05, **p < .01, ***p < .001.

DISCUSSION

The main purpose of this study was to evaluate the influence of institutional technology elements on the quality of student-AI collaboration in the Malaysian higher education context. The study provides substantial evidence to the structural paths from University Digital Transformation to Students' Work Engagement, Students' Technological Self-Efficacy, and Student-AI Collaboration Quality, based on the Job Demands-Resources (JD-R) model. The interaction framework was developed from the empirical study of 135 respondents. The analysis revealed three hypotheses (H1, H2, and H5) were highly supported and two hypotheses (H3 and H4) with non-significant results.

The Influence of University Digital Transformation on Students' Work Engagement and Students' Technological Self-Efficacy

The regression results clearly support H1 and H2 by showing a significant positive effect of University Digital Transformation on Student Work Engagement (β = 0.760, p < .001) and Students' Technological Self-Efficacy (β = 0.809, p < .001). These findings are in line with the core logic of JD-R theory that organisational resources have a meaningful role in developing individuals' psychological and motivational capacities (Zhang et al., 2026). Campus technologies and digital infrastructures are well established in higher education settings and are more than operational tools. Not only that, but they are also institutional resources that improve students' digital practices and enhance their confidence to engage with contemporary learning tools (Mathur et al., 2026). Therefore, a well-integrated digital learning environment can provide meaningful support to students' academic motivation and sense of capability.

The Influence of University Digital Transformation and Students' Work Engagement on Students' Collaboration Quality with AI

H3 and H4 are rejected because University Digital Transformation (β = 0.144, p = 0.088) and Student Work Engagement (β = 0.128, p = 0.145) do not have a significant direct effect on Student-AI Collaboration Quality as expected. This is because students can access digital structure does not mean they can effectively use applications of AI. Malaysia is experiencing a rapid overall digital transformation (Lim et al., 2025), but it needs specific cognition skills to effectively use generative AI such as fast creation and critical evaluation of AI-generated content, which are not simply acquired through hardware upgrades. In this sense the campus digital environment remains a background resource; unless it can also enhance student's ability and confidence, or else it cannot shape interaction quality. Furthermore, the reason to reject the H4 is that students who are heavily involved in traditional academic methods could value critical thinking significantly. This would explain why overall academic involvement does not directly correlate with higher quality AI collaboration, because frequent reliance on AI technologies might feel at odds with intellectual rigour for these students.

The Influence of Students' Technological Self-Efficacy on Students' Collaboration Quality with AI

However, regarding the hypotheses of the structural model, H5 received robust evidence supporting it, where Students' Technological Self-Efficacy was identified as having a highly significant positive impact on Student-AI Collaboration Quality (β = 0.609, p < .001). The current research is in agreement with results from past psychological studies, which have highlighted self-efficacy as a crucial factor in technology-rich settings (Alqurni, 2026). When individuals feel capable within the technological environment, they will interact more effectively with the technologies they use – such as AI technologies in this case – improving upon their processes, scrutinizing the results of the AI, and retaining control as opposed to passively accepting the results.

Managerial Implications

The conclusions drawn from this research have great significance in terms of practice for higher education management. In view of the fast-moving process of digital transformation impacting Malaysia's socioeconomic structure (Lim et al., 2025), educational institutions must stop limiting themselves by merely developing their technological infrastructure. In light of the fact that organizational digital transformation on its own cannot contribute to an enhancement in collaboration quality without ensuring personal efficacy in this respect, funds must be allocated to specific projects, like those aimed at developing artificial intelligence literacy and instant engineering abilities. It is vital to prepare workers to be able to work in the modern technology-oriented world (Gan et al., 2025).

Limitations and Directions for Future Research

There are various limitations associated with this research that have to be pointed out. First, the study includes a relatively small number of participants which is 135 students. It means that there might be limitations in the generalisation of the results of the research among the population of Malaysia. Another issue is associated with the cross-sectional nature of the survey. It means that there is no opportunity for following the change in the behavior of students in terms of collaborating with AI. Finally, future studies could benefit from qualitative instruments such as interviews.

CONCLUSION

Overall, this study highlights the important role of university digital transformation in shaping students' learning experiences and influencing their interactions with AI technologies among Malaysian university students. As higher education institutions continue to integrate digital systems and AI-related technologies into academic environments, understanding the factors that contribute to effective AI collaboration has become increasingly important. The findings of this study suggest that both institutional and individual factors contribute to students' experiences with AI technologies, emphasizing the need to create learning environments that support technological development and engagement.

From a theoretical perspective, the findings contribute to a better understanding of how university digital transformation influences students' learning experiences within increasingly technology-driven environments. The results indicate that digital transformation should not only focus on technological infrastructure but also consider students' motivation, confidence, and readiness to interact with technological systems. Kee et al. (2023) suggested that acquiring digital skills and supportive educational conditions can positively influence individuals' perceived capabilities and future readiness. This indicates that universities should provide students with sufficient opportunities to develop technological competencies that can improve their confidence in adapting to digital learning environments.

In addition, students' perceptions and preparedness toward technology also play an important role in shaping their future interactions with AI systems. Gan et al. (2025) highlighted that perceptions of AI adoption and skill preparedness may influence individuals' readiness to adapt to future technological environments. This suggests that students who possess stronger confidence and technological preparedness may be more willing to explore AI tools and integrate them effectively into their learning experiences. As AI technologies become increasingly common within educational and workplace settings, strengthening students' technological confidence and readiness may contribute to more effective learning outcomes.

Furthermore, creating supportive environments remains an important factor in improving students' learning experiences. Gan and Kee (2024) emphasized that favorable conditions and sufficient resources can strengthen engagement and participation. Similarly, universities should create learning environments that reduce technological barriers and encourage students to participate actively in technology-based learning activities. Providing digital workshops, AI-related training programs, and practical learning opportunities may help students develop stronger engagement and more effective interactions with AI technologies.

Despite the contributions of this study, several limitations should be acknowledged. The findings were obtained from a limited sample of Malaysian university students and therefore may not fully represent broader populations. In addition, there may be other psychological, social, or environmental factors that influence students' AI collaboration

experiences but were not included in the current study. Future research is encouraged to involve larger and more diverse populations and examine additional factors that may influence students' interaction and collaboration with AI technologies.

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