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Determinants of Digital Adaptation among Libyan Students in Malaysian Public Universities during the COVID-19 Pandemic

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Abstract

The rapid shift of higher education to online learning during the COVID-19 crisis transformed higher education and compelled students to quickly adapt to new virtual worlds. For foreign students, this transition brought further hurdles on technology readiness for engagement and unfamiliar training systems. Drawing on the input-process-output conceptual model, the study also investigates digital adaptation among Libyan students in Malaysian public universities with a focus on technological infrastructure and academic engagement as intervening variables. The data in this quantitative research were gathered through a survey as a tool to measure students' perceptions about their digital learning experience from 110 respondents. Findings: Descriptive findings revealed that students had moderate level of technological access, high academic engagement and positive adaptation to the digital learning. Analysis of correlation showed a strong positive link among three variables that students in favorable technological condition and high participant are prone to cope better with online learning. Regression results also indicated that technological infrastructures and academic engagement were significant predictors of digital adaptation, in which academic involvement exerted stronger predictive power. These findings highlight that dependable technology creates the infrastructure for online learning; students' motivation, participation and cognitive engagement are even more pivotal to their flexibility. The study has shown the significance of building an enabling digital ecosystem that merges robust ICT infrastructure with instructional practices conducive to interaction and sustained engagement. Such understanding can also support universities in creating effective digital strategies for international learners and for advancing readiness over time for technology-enhanced learning.

Keywords: *technological infrastructure, academic engagement, digital adaptation*.

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1. Introduction

The sudden and widespread move to virtual education in response to the COVID-19 pandemic caused a transformation of higher education systems worldwide, driving digital platforms in academic sectors much faster. This abrupt change forced students and colleges to adjust on the fly to new technological platforms, pedagogical approaches and expectations for distance learning. For international students, these difficulties were compounded by cultural, linguistic and academic adjustment processes that, with the pivot to digital learning forced by a pandemic

situation meant that digital adaptation was a key component of successful learning in online university settings. Digital adaptation varies as it includes learners' success with digital learning ecosystems, their interaction with electronic content and ability to overcome technological and instructional loads (Sysoieva, 2022; Shulga et al., 2021). Even with leapfrogging digitalization, the technological preparedness and ICT infrastructure of many higher education institutions were confronted by critical challenges in particular in developing and middle-income countries. Research has consistently shown that poor internet connection, digital divide and lack of institutional support have profound negative effect on online learning (Habiba & Ahmed, 2020; Ndibalema, 2022). For international students, these challenges are magnified by unfamiliar online platforms and different norms of academic engagement. More than ever, researchers underscore that robust and sustainable digital ecosystems are critical to ensure equitable access and continuation of e-learning (Alammary, 2024; Subramaniam et al., 2024). Poor digital infrastructure disrupts not only participation but also diminishes the opportunity for meaningful academic engagement, a crucial aspect of efficacy in online learning (Kaushik & Agrawal, 2021).

Academic engagement including behavioral, emotional and cognitive engagement is referred as one of the key factors for determining students' success in digital learning settings. Recent research shows that engaged students are more highly motivated, persevering and adaptable particularly when academe have been facing crisis-oriented shifts to online learning (Dubey et al., 2023; Prakasha et al., 2023). Yet, engagement also strongly correlates with the digital learning platforms' design and its quality, good instructional strategies, as well as adequate learning resources (Pratiwi & Priyana, 2022; Chiu, 2021). Systematic reviews show drops in participation during emergency remote implementation among participants facing technological, psychological, and social difficulties (Salas-Pilco et al., 2022; Maini et al., 2021). These results highlight the importance of technology infrastructure and academic engagement in influencing students' use of digital learning. International students often encounter further obstacles in online learning environments such as demands for cultural adaptation, diminished social support, and differential expectations of academic communication and digital engagement (Wong & Jeganathan, 2020; Ebrahimi, 2024). Recent research within Malaysian and international higher education institutions indicates that many international students experience isolation, limited acquaintances, as well as challenges of dealing with digital systems different to those in their home countries (Selvanathan et al., 2023; Shonfeld et al., 2021). For some researchers, guaranteeing high quality of digital learning for all learners demands that the institutions modify course design, learning resources and technical tools to different cultures and diverse academic needs (Konstantinidou & Nisiforou, 2022; Alenezi et al., 2023).

While there is an emerging literature on the factors that influence students' e-learning experiences and online learning satisfaction (Alsoud & Harasis, 2021; Muhammad & Srinivasan, 2021; Younas et al., 2022), little attention has been paid to how international student groups digitally adjust in response to e Libyan international students in Malaysian public universities are unique subsector of the learners going through challenging technological, cultural and academic adjustments when immersed in digital learning environments. Understanding particular variables that affect their adaptation is essential; if support mechanisms are to be improved and if equitable e-learning experiences are to be guaranteed. Hence, it is aimed to examine the relationship between technological infrastructure, and

academic involvement towards digital adaptation on Libyan students in Malaysian public universities. Through the analysis of these predictors, the research opens up to discussion about how universities should enhance their support for international students and foster better digital quality in learning environments, as well as shaping more sustainable approaches regarding digital education in future-post-pandemic periods.

2. Literature Review

2.1 Theoretical Discussion

Theoretical perspective To better understand the adaptation of students in digital learning environments, we need a theoretical framework that incorporates technology, behavior as well as context. In relation to online learning and COVID-19 pandemic, there are numerous theoretical threads, which shed light on the role played by technological infrastructure and academic engagement in digital adaptation of university students, particularly in international and culturally diverse higher education contexts. One of the main theoretical foundation behind this study is the Technology Readiness and Acceptance framework where users' ability to interact with digital systems rests on user's confidence, access to technology and support (Kaushik & Agrawal, 2021). Universities with stronger ICT ecosystems, consisting of stable internet connection, user-friendly platforms and relevant digital resources make seamless switch over to online learning. Evidence in higher education emphasizes that the technological infrastructure is fundamental to students' digital experiences, accessibility, continuity and successful participation (Habiba & Ahmed, 2020; Ndibalema, 2022). COVID-19 accelerated the digitization process and strongly reaffirmed the importance of resilient and sustainable technology systems to provide equitable learning opportunities (Alammary, 2024; Subramaniam et al., 2024). Technology infrastructure, therefore, is not just the equivalent of a support system but an integral part in defining students' digital readiness and continuing adjustment.

In addition to this technological perspective, a theoretical model of engagement offers behavioral and pedagogical insights about the interaction of students with digital learning environments. Academic engagement consists of the feelings, cognitive and behavioral aspects that affect motivation, academic persistence and achievement. Online engagement is primarily influenced by how courses were designed, and interactive learning activities, as well as, digital support mechanisms that are made available through the implementers/instructors or from institutions (Chiu, 2021; Pratiwi & Priyana, 2022). The engagement theory posits that the most effective learning is one in which learners are participating in knowledge building and social interaction reasons why digital technology are extensively used to facilitate these tasks in online education. Recent studies have stressed on the fact that engagement is a critical factor of online learning success, serving as a mediator between technological aspects and student achievement (Dubey et al., 2023; Prakasha et al., 2023). Systematic reviews during the pandemic have also reported changes in engagement levels as a result of abrupt digital transformation, uneven access to technologies and varied degrees of digital empowerment (Salas-Pilco et al., 2022; Maini et al., 2021).

To frame these perspectives in the larger context of global disruptive education, digital adaptation theory provides a comprehensive perspective about how learners acclimate themselves within technologically mediated environments. Digital adaptation is understood as

the students' ability to use new platforms, master digital learning competences, control online communication and maintain academic performance in the changing digital ecosystems (Sysoieva, 2022; Shulga et al., 2021). Studies indicate that digital adaptation is not only technically but also psychologically, sociocultural, and institutionally constructed. Students coming from abroad, however, need to go through complicated adjustment processes that include dealing with unknown digital infrastructures, a relative lack of social support and different types of expectations regarding communication and academic conduct (Wong & Jeganathan, 2020; Ebrahimi, 2024). As the COVID-19 pandemic was deepening, several schools and institutions were unable to offer multicultural digital resources, which added further stress for culturally diverse student bodies (Selvanathan et al., 2023; Shonfeld et al., 2021).

Educators insist that high-quality digital teaching should systematically be guided by the principles of adapting content and instructional design, using technology tools, and providing support systems according to learners' various needs (Konstantinidou & Nisiforou, 2022; Alenezi et al., 2023). The fusing of this theoretical rationale implies that technology infrastructure underpins the conditions of academic engagement, which, in turn, engenders students' aptitude to adjust themselves to digital learning settings. The digital reflex is not solely spurred by technological change, but a composite organism of institutional preparedness, pedagogical design and learner motivation. This theoretical base undergirds the model of the study that characterizes technological infrastructure as a critical predictor of academic engagement and digital readiness, while academic engagement serves as a behavioral pathway between technology and online learning adjustment among students.

2.2 Hypotheses Development

There has been a lot of focus on how students can adjust and make it online. Based on theoretical approaches presented above, in these section hypotheses about the relationship between technology infrastructures, academic engagement and digital adaptations among Libyan students in public universities have been developed.

Technological Infrastructure and Academic Engagement

The technological infrastructure is the basilar condition for a successful online learning; it has been largely acknowledged as the first condition of students' involvement in digital learning environment. Students who have consistent access to the internet, functional hardware, and well-designed digital platforms are better able to be active participants in their online courses by interacting with learning materials and engaging in virtual discussions. Evidence-based research shows that inadequate technological support consequently interferes with the students' capacity to maintain their involvement, resulting in low levels of motivation, interaction and learning engagement (Habiba & Ahmed,2011; Ndibalema, 2022). The pandemic also reinforced how critical infrastructure is to nurturing students' engagement. Research conducted in a higher education context has also shown that well-designed digital environments enhance students' capacity to navigate and use online systems, as well as access course related materials and engage continually with teaching staff and other students (Alammary, 2024; Subramaniam et al., 2024). On the other hand, lack of stability in ICT supported environment reduces the ability of students to engage in behavior and cognition by blocking participation, comprehension and task accomplishment (Kaushik & Agrawal, 2021). Furthermore, engagement literature reveals that technology-based systems such as learning

management system tools, communication tools and interactive applications improve student's emotional and cognitive involvement by facilitating enriched learning experiences (Chiu, 2021; Pratiwi & Priyana, 2022). When digital tools work well and instructors integrate technology-supported pedagogy, students are more likely to actively engage.

H1: Technological infrastructure has a significant positive effect on academic engagement.

Technological Infrastructure and Digital Adaptation

Adaptation to the digital refers to students' adaption to digital learning worlds by developing habits on how best to move around, integrate, communicate and manage tasks. The Streptomyces life cycle has been shown to be strongly technology-driven. When students enjoy constant access to digital tools and spaces, they are more likely to be able to develop the skills needed for participation in online learning conditions (Sysoieva, 2022; Shulga et al., 2021). The sudden transition to online education in the context of COVID-19 demonstrated that students who have reliable ICT support infrastructure from their institutions and robust digital systems felt more comfortable, satisfied and adaptable in digital environment (Alsoud & Harasis, 2021; Muhammad & Srinivasan, 2021). In other words, insufficient infrastructures intensified edu-exclusion and learning disruption, exacerbated the difficulty of digital adaptation. In addition, the technical infrastructure was related to students' perception of usefulness and ease of use in relation to digital system factors, which in turn influence digital readiness and adaptability among students (Kaushik & Agrawal, 2021). It has also been documented that institutions with better digital systems make it easier for international students, who already tend to have more adjustment issues because of their unfamiliarity with technology and academic culture norms (Wong & Jeganathan, 2020; Ebrahimi, 2024).

H2: Technological infrastructure has a significant positive effect on digital adaptation.

Academic Engagement and Digital Adaptation

Engagement of students based on academics is well known as a strong indicator of their success in an online setting. Behavioral, emotional and cognitive engagement contribute to students' course navigation, social interaction with instructor and peers, and control over learning tasks in the online setting. Numerous research have suggested that active students are more likely to comes up with adaptive strategies, sustain motivation and handle problems related to the online learning (Dubey et al., 2023; Prakasha et al., 2023). Systematic research works underscore that students who are more involved tend also to persevere more, engage in a deeper processing of the content and are frequent users of digital learning tools, all these leading to enhanced DA (Salas-Pilco et al., 2022; Maini et al., 2021). Further, engagement facilitates the acquisition of digital competencies by stimulating active involvement in learning activities, cooperative communication, and virtual interaction (Chiu, 2021; Pratiwi & Priyana, 2022). Further, because adaptation to digital is not so much technological development as it is a behavioral and mental adjustment, engagement is pivotal in informing students' experiences. Engaged international students are more likely to adapt quickly to new academic expectations, technologies and communication practices that will help them better adjust Shonfeld et al., 2021).

H3: Academic engagement has a significant positive effect on digital adaptation.

Academic Engagement as a Mediator

The interplay among technology infrastructure and digital adaptation is now considered a more complicated series of stages characterized by behaviorand mind-based processes. Academic engagement is an important mediator of this relationship, as the mere existence of technical infrastructures does not ensure successful adaptation it is rather active learners' participation with digital platforms and learning resources that enables the development of the competences necessary for adaptation. Research has suggested that technological infrastructure can increase engagement by allowing access to interactive learning systems and digital resources (Habiba & Ahmed, 2020; Alammary, 2024). In addition, increased engagement promotes the development of digital competences, raises digital systems understanding and enhances their ability to face new educational scenarios (Dubey et al., 2023; Prakasha et al., 2023). Engagement thus acts as the intermediary behavior through which technology impacts adaptation. However, evidence exists to suggest that engagement mediates the relationship between organisational technology readiness and student adjustment outcomes such as academic achievement, satisfaction and comfort in digital environments (Salas-Pilco et al., 2022; Maini et al., 2021). Studies on international students also indicate that in the presence of strong digital support, students tend to become more engaged and this eventually informs their settling into academic and cultural expectations (Ebrahimi et al., 2024; Wong & Jeganathan, 2020).

H4: Academic engagement significantly mediates the relationship between technological infrastructure and digital adaptation.

3. Methodology

This research paper was undertaken to investigate the effect of technology infrastructure and academic involvement in adaptation to digitalization by Libyan students in public universities at Malaysia. Quantitative approaches are common in online and digital learning research: they enable researchers to systematically assess perceptions, behaviors and adaptation patterns while enabling them to draw statistically reliable inferences about relationships among variables (Alsoud & Harasis, 2021; Younas et al., 2022). It is important to pay attention to Libyans students as international education learners face the specific technological, cultural and academic challenges in digital transitions, which make them a relevant cohort for understanding factors that influence the transformation to digital education in higher education (Wong & Jeganathan, 2020; Ebrahimi, 2024). A sample size of 110 students took part in the research through completion of a structured online questionnaire, which is similar with related empirical studies on student engagement and digital learning during the pandemic and post-pandemic era (Dubey et al., 2023; Prakasha et al., 2023).

Information was collected via an online questionnaire circulated through digital ecosystems, in order to reach students who remained studying both off campus and remotely. Online questionnaires are seen as effective and feasible method to investigate digital learning experiences, since students can respond at their convenience with reduced logistical constraints related to distance or time (Selvanathan et al., 2023; Muhammad & Srinivasan, 2021). The questions were anonymous, which facilitated honest answers and minimized bias for social desirability. The instrument included items for the measurement of technological infrastructure, academic engagement and digital adaptation. Technology infrastructure items were derived

from a previous study on students' access to ICT services, stability of digital systems and institution backing for online learning (Habiba & Ahmed, 2020; Ndibalema, 2022). Academic engagement was assessed with established measures of the behavioral, emotional and cognitive domains of academic engagement in an online learning context that have previously been adopted for research on digital pedagogy and student´s engagement (Pratiwi & Priyana, 2022; Chiu, 2021). Digital adaptation was measured using items measuring ability of students to navigate technological systems, communicate online as well as adapt to new realities and digital learning expectations, in accordance with the latest conceptualizations of adaptation at higher education (Sysoieva, 2022; Shulga et al., 2021). They were all rated on a five-point Likert scale from strongly disagree to strongly agree, consistent with scales adopted in recent researches related to online learning (Maini et al., 2021; Salas-Pilco et al., 2022).

Analysis Percentages, means and standard deviations were used to describe student characteristics and examine the general patterns regarding technological infrastructures, engagement and adaptations. The first method was correlation which shows the strengths and directions of relationships between variables, a method which has consistently been employed in studies involving determination of digital readiness and online learning determinants (Younas et al., 2022; Alsoud & Harasis, 2021). Multiple regression analysis was subsequently executed as a technique to verify the direct relationships posited in the hypotheses of the study, whereas mediation analysis checked if academic engagement acted as mediator between technological infrastructure and digital adaptation. These statistical methods are similar to the recent studies which have examined the ways that digital ecosystems, engagement, and conditions of online learning influence student outcomes in higher education (Dubey et al., 2023; Prakasha et al., 2023; Alenezi et al., 2023). Ethical aspect was seen in the whole period of study and IC was signed by all students involved with our recent research (they had an option not to give answers or leave any time themselves) through voluntary, maximum paying attention on conservation student privacy and confidentiality.

4. Findings

This section provides an overview of the main results obtained from the study, starting with descriptive statistics on its relevant variables, through correlation analysis to describe their relationships, to regression analysis used for determining what aspects can predict students' digital adaption. The results of such findings might help present a general picture about how school technical infrastructure and academic engagement are associated with the adjustment of students to online learning.

The descriptive analysis in Table 1 indicates that students experienced a moderate to high level of all three variables, and academic engagement the highest mean score (M = 3.780, SD = 0.680), which implies most students would remain active in their online learning. Technology infrastructure also garnered a high score (M = 3.620, SD = 0.710) indicating that students had sufficient access to the digital equipment and online resources essential for remote study, with a slightly higher SD implying some degree of variability in quality of access times. Digital Adaptation also presented a similar mean (M = 3.550, SD = 0.740), meaning that the ability to adapt to digital learning was reached by many students generally while differences can be observed regarding those who were able to adjust more easily or not. Descriptively, all items

indicate students perceived moderate-to-positive levels of engagement, support around technology and adaptability to online learning during the transition.

Table 1. Descriptive Statistics

Variable	Mean (M)	Standard Deviation (SD)
Technological Infrastructure	3.620	0.710
Academic Engagement	3.780	0.680
Digital Adaptation	3.550	0.740

Note. *All variables were measured using a 5-point Likert scale (1 = Strongly Disagree, 5 = Strongly Agree).*

The correlation findings displayed in Table 2. suggest that there are strong positive associations between all the three variables, which means that progress in one variable is likely to be accompanied by a similar improvement on the other two. Academic Engagement And Technological Infrastructure Data Analysis Technological Infrastructure had a moderate positive significant relationship with Academic Engagement (r = 0.551), which implies that when there is improvement in the accessibility of digital resources and stability of online systems, students are able to engage more in their online learning activities. A slightly stronger correlation is observed in the second pair of constructs Technological Infrastructure–Digital Adaptation (r = 0.602), indicating that participants who were better supported technologically were also more likely to easily adapt to digital learning environments. Academic Engagement displayed the most statistically significant correlation to Digital Adaptation (r = 0.631), which means those students who are more engaged, motivated or attentive in their Internet classwork than others adapt more successfully to digital learning. Taken together, the relationships illustrate how infrastructure, engagement and adaptation are mutually reinforcing in determining students' digital learning.

Table 2. Correlation Matrix

Variable	TI	AE	DA
TI	1.000		
AE	0.551	1.000	
DA	0.602	0.631	1.000

TI: Technological Infrastructure; **AE**: Academic Engagement; **DA**: Digital Adaptation.
Note. *All correlations are significant at* ***p < 0.01*** *(two-tailed).*

The findings of the regression analysis in Table 3 indicate that Technological Infrastructure and Academic Engagement are two significant predictors for Digital Adaptation amongst students. Academic Engagement was the stronger predictor (β = 0.372, t = 4.233, p <. 001), suggesting that the students who are active and engaged in online learning are more capable of adjusting to digital environments. Technology Infrastructure was also a strong contributor to the model (β = 0.334, t = 3.938, p <. 001), indicating that reliable digital and connectivity is important to supporting adaptation. The tolerance and VIF statistics do not provide any reasons to suspect multicollinearity since both predictors make a unique contribution to the outcome. These results suggest that technological readiness combined with active engagement is a plausible model in terms of explaining well how students overcome challenges associated with the online learning environment.

Table 3. Regression Analysis

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	0.352	0.177		1.987	0.050		
	TI	0.318	0.081	0.334	3.938	0.000	0.612	1.635
	DA	0.402	0.095	0.372	4.233	0.000	0.612	1.635
a. Dependent Variable: Digital Adaptation								

TI: Technological Infrastructure; **AE**: Academic Engagement; **DA**: Digital Adaptation.

5. Discussion

The results of this research contribute meaningful understanding in regard to the variables responsible for influence of digital adoption among Libyan students in Malaysian public universities, particularly with regards to the sudden transition toward online learning. Taken together, the findings suggest that Technological Infrastructure and Academic Engagement have a direct impact on students' readiness for digital learning environments. This in a way complements the finding of research which demonstrated that quality of digital systems and extent of student engagement are vital components for online learning outcomes (Habiba & Ahmed, 2020; Kaushik & Agrawal, 2021). The descriptive statistics reported moderate high mean scores across all items that can be interpreted as students held positive perceptions about online learning conditions due to the pandemic. These findings reflect reports at an international level, where students have stated having a good understanding of digital use but are experiencing mixed abilities to maintain motivation and engagement (Maini et al., 2021; Prakasha et al., 2023). That Technological Infrastructure is closely related to Digital Adaptation highlights the importance of a reliable ICT for online learning. Students who described having good access to a stable internet connection, working devices and user-friendly platforms were more likely to adapt successfully to online spaces. This supports research, instructing that infrastructure is the edifice on which all-digital learning interactions rest (Habiba & Ahmed, 2020; Ndibalema, 2022).

In the absence of infrastructure, students often encounter system delays, poor connectivity and experience challenges in terms of accessing course content preventing learning continuity and lowering confidence on technology platforms. Conversely, institutions that had already spending in digital structure such as the cloud-based solution and flexible entrances to online system were ready for and supportive of a students' success (Alammary, 2024; Subramaniam et al., 2024). This lack of presence of the material world obviously concerns for a virtual environment such as an online learning system where Academic Engagement importantly determines Digital Adaptation: better embedded, active and affectively bonded students in their study work more effectively on-line. Engagement has been identified by a number of studies as one of the factors that affect persistence, satisfaction, and learning outcomes in digital environments (Dubey et al., 2023; Pratiwi & Priyana, 2022). Online learning is a process of involving actively, motivating The Relationship between Online Learning Activities and Learner Engagement in Universities academic staff are expected to create opportunities for increased participation in scholar-researcher productive educational interactions". This effect is also linked to student who are well supported, connected and able to interact with lecturers

and peers in being able to a positive response better digital learning challenge. This is corroborated by studies evidencing that design engagement driven pedagogical scenarios like collaborative activities, interactive materials and clear communication can contribute to alleviate the isolation and fatigue of remote learning (Chiu, 2021; Salas-Pilco et al., 2002).
For overseas students, such the Libyan learners at Malaysian universities, becoming digital takes on an extra complexity. The cultural adaptation, ambiguous expectations of learning and digital literacy may all influence the way in which students accommodate to online learning requirements. Research on international students during the pandemic focus on challenges to isolation, linguistic challenge, and lack of social support's which impact learning engagement alongwith adaptation (Wong & Jeganathan, 2020; Ebrahimi, 2024). Studies also suggest that a reason could be international students' difficulty in navigating platforms, policies related to digital era and difference in communication styles among instructors (Shonfeld et al., 2021; Selvanathan et al., 2023). Such challenges highlight the necessity of universities to activate culturally aware and inclusive online learning initiatives that consider the needs of international learners.
The findings also resonate with work that underscores the significance of institutional responsiveness in periods of crisis. Digital conversion is effective when the learning institutions are not only functionally equipped, but supported pedagogically (Cheung, Wang & Kwok, 2023). It is concluded in the literature that students are more successful to adapt when courses and learning activities have been trained, technical support is available during the delivery of instructions and learners are guided purposely to gain confidence for digital tools good practices (Konstantinidou & Nisiforou, 2022). In the absence of these factors, learners become disengaged and experience academic stress, which may lead to confusion about what, is expected frustration as was experienced by many learners during COVID-19 (Alsoud & Harasis, 2021; Muhammad & Srinivasan, 2021).

The findings of the present study generally support these trends. Due to the high predictive value of Academic Engagement and Technological infrastructure, it is clear that both the structural context as well as the behavior or user must be taken into account. If the country strengthens infrastructure but does not improve engagement approaches, then adaptation results may not be dramatic and vice-versa. An integral digital teaching and learning environment needs modern ICT networks, intuitive learning management systems, and pedagogical concepts that actively promote participation, motivation and real interactivity.
Lastly, the study adds to conversations about post-pandemic online learning. As digital and hybrid modes of delivery increasingly become part of the normal offer at universities, consideration of how students adjust to learning in these environments is required. There is emerging evidence that digital readiness is not merely a short-term response to the pandemic; rather, it is an essential competency for all 21st-century learners (Sato et al., in press; Mospan, 2023). The findings stress the need for institutions to develop digital environments that are sustainable and can support local as well as global learners, with a focus on equitable access, culturally responsive pedagogies and sustained connections.

6. Conclusion

This research investigates the predictors of digital adaptation among Libyan students at Malaysian public universities, namely those of technological infrastructure and academic engagement. Key findings Students generally responded with positive perceptions of their digital learning environment and moderate-to-high levels of access to technology, engagement in classwork, and perceived capability for online learning. Technological infrastructure and academic engagement both emerged as significant predictors of digital adaptation with student engagement the more robust predictor. This shows us that reliable digital tools and systems are important for facilitating access and engagement, but students' motivation to be engaged and invest in participating in learning activities is more important in influencing how successfully they transition to fully online modes of study. The findings also add to the growing focus on the need for enabling and engaging digital learning ecosystems, especially among international students whose navigation occurs across cultural -academic- technological domains simultaneously. Acceleration of digital adoption calls for collective work to improve technology readiness and at the same time enhance interactive, gamified, well-designed online learning experiences. As higher ed continues to incorporate online and blended learning beyond the pandemic, it's increasingly important to know how students adjust to digital classrooms. This study provides university leaders with evidence to inform more successful digital strategies in aid of varied types of learners and sustained success in technology-enhanced education.

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