

Latha Subramaniam, Ching Seng Yap*, Farah Waheeda Jalaludin and Kai Wah Hen

Digital Divide and University Students' Online Learning amidst Covid-19 Pandemic in Malaysia

<https://doi.org/10.1515/libri-2023-0115>

Received November 1, 2023; accepted March 29, 2024;

published online June 6, 2024

Abstract: The advent of digitalization has been hailed as a remedy to mitigate the impact of the Covid-19 pandemic. However, it has also brought to light the existence of a digital divide, exacerbating the hardships faced by those who are digitally excluded. Amidst the turmoil of the crisis, there has been limited attention given to addressing the digital divide in developing countries including Malaysia. In response, Malaysian universities swiftly transitioned to online learning to curb the spread of the contagion. Nonetheless, this rapid shift has inadvertently marginalized underprivileged students, hindering their access to the benefits of online education. Employing the three-level digital divide framework, this study aims to probe into the extent of the digital divide among Malaysian university students and evaluate its progression. Through mean score and frequency analyses, we assessed the magnitude of the digital divide among these students. Furthermore, we employed partial least squares structural equation modeling to gauge the flow of the digital divide from the initial level to the third level. Subsequently, we examined the mediating roles of material access, digital skills, and digital usage. The findings revealed that the digital divide persists across all three levels among university students in Malaysia. The path analysis lends support to all proposed hypotheses, with the exception of digital usage as a predictor of student satisfaction and as a mediator.

Keywords: digital divide; material access; digital skills; digital usage; online learning; Malaysia

1 Introduction

Information and communication technologies (ICTs) have played pivotal roles in numerous facets of our daily life, spanning politics, economics, social, culture, and education, with this significance becoming even more pronounced during the Covid-19 pandemic. While these advancements undeniably bring about convenience, heightened efficiency, and increased productivity (Wang, Zhou, and Wang 2021), they also give rise to a concerning phenomenon known as the digital divide, which can lead to social exclusion and segregation (Cheshmehzangi et al. 2023; Katz, Jordan, and Ognyanova 2021).

Early studies depicted the digital divide as a simple discrepancy between those who had access to computers and the Internet (“haves”) and those who did not (“have-nots”) (Howland 1998). However, a more comprehensive examination has brought to light that this issue extends far beyond mere accessibility to physical technologies such as devices and the Internet. The digital divide is also characterized by differences in motivation and attitudes towards technology, disparities in the acquisition of digital skills, levels of engagement in online activities, and, ultimately, inequalities in the outcomes achieved by individuals (Helsper, Van Deursen, and Eynon 2015; Van Dijk 2017).

The digital divide has had detrimental effects across multiple sectors during the Covid-19 pandemic. Specifically, its impact on the education sector has been severe, as it limits students' access to crucial digital resources and facilities. Reports from The Star (2020a; 2020b) and UNESCO (2020) have highlighted that due to the digital divide, online learning has become a privilege that is out of reach for many underprivileged students, particularly those hailing from lower-income households. Recent empirical studies examining the impact of the digital divide on online learning among minority students lend support to this notion. For example, Hass, Hass, and Joseph (2023) conducted research in the USA, while Mathrani, Sarvesh, and Umer (2022) explored the issue in five South Asian countries. Similarly, students from disadvantaged socio-economic backgrounds did not derive as much benefit from online learning as their counterparts from more affluent backgrounds (e.g., Guo and Wan 2022).

In Malaysia, the story of a university student resorting to climbing a tree for internet access (BBC 2020), and another whose father constructed a study area on a hilltop

*Corresponding author: Ching Seng Yap, Curtin University Malaysia, CDT 250, 98009, Miri, Sarawak, Malaysia, E-mail: yapchingseng@curtin.edu.my, <https://orcid.org/0000-0002-4181-6589>

Latha Subramaniam and Farah Waheeda Jalaludin, Universiti Tunku Abdul Rahman, Sungai Long Campus, Jalan Sungai Long, Bandar Sungai Long, Cheras 43000, Kajang, Selangor, Malaysia, E-mail: latha.s2996@tutar.my (L. Subramaniam), farah@utar.edu.my (F.W. Jalaludin)

Kai Wah Hen, Tunghai University, 1727, Sec. 4, Taiwan Boulevard, Xitun District, Taichung City, 407224, Taiwan, ROC, E-mail: henkw@thu.edu.tw

(Bernama 2020), vividly underscores the harsh reality of the digital divide among university students. This divide has had disastrous implications for online learning during the Covid-19 pandemic. At the peak of the pandemic, urgent measures were prioritized to curb the infection rates and lower the number of Covid-19 cases. With a crumbling healthcare system, other issues such as those social, economic, and education during the pandemic were not given the same weighting (Azman 2021; Baharin and Hamid 2021).

The Malaysian Communication and Multimedia Commission's Internet Users Survey 2020 reported that in the year of the Covid-19 pandemic, when digitalization was rampant, Malaysia experienced the lowest growth of Internet usage since 2012 (MCMC 2020). The resulting absence of official data and resources addressing the digital divide among university students thus jeopardized the prospects of successful online learning. In addition, existing solutions to the digital divide generally focused on material access and ignored other elements of the digital divide. Abrupt and overnight transition to online learning together with the digital divide have had devastating impacts on disadvantaged individuals' life, which includes students' learning processes, particularly during the Covid-19 pandemic (Ajrun 2023; Saha, Dutta, and Sifat 2021; Soh et al. 2012). Disadvantaged students encounter challenges not only in acquiring material access but also in developing the necessary digital skills for appropriate digital usage and effective online learning. In summary, a more comprehensive understanding of the digital divide among university students is imperative for gaining insights into the mechanisms and necessary support required to enhance the effectiveness of online learning. Additionally, it is essential to devise effective strategies and policies to address the issue of the digital divide more comprehensively.

Therefore, the objectives of this study are twofold: (1) to determine the existence of the three levels of the digital divide and (2) to assess the impact of the digital divide on online learning outcomes among Malaysian university students during the Covid-19 pandemic. This investigation will test the relationship between motivational access and online learning outcomes, with material access, digital skills, and digital usage serving as mediators. By adopting this multifaceted perspective, the study provides empirical evidence on the presence of the digital divide among Malaysian university students within the realm of online learning.

2 Literature Review

2.1 Three Levels of the Digital Divide

Up until the late 1990s, studies on the digital divide predominantly focused on access to technologies such as computers

and the Internet (Huffman 2018). However, contemporary literature has revealed that the digital divide is a complex issue intertwined with existing socioeconomic and sociodemographic disparities (Lythreath, Singh, and El-Kassar 2022). Van Dijk (2006, 2012, 2017) has dissected this issue into distinct components such as motivational access, material access, digital skills, digital usage, and the resultant outcomes of digital usage, with these components subsequently classified into the first, second, and third levels of the digital divide, respectively.

The first level of the digital divide encompasses the foundational process of technology appropriation, specifically focusing on motivational access and material access (Van Dijk 2017). Motivational access pertains to one's desire and willingness to engage with the Internet and technologies, encompassing one's attitude, intention, and acceptance of information and communication technologies. Factors such as aversion to the medium, technophobia, and computer anxiety can impede an individual's ability to access digital platforms. Following that is material access, which refers to the physical availability of various digital tools and facilities. In developing countries, including Malaysia, where there is a high number of Internet users, the quantity and types of connections become a potential source of the digital divide, with prior studies emphasizing the crucial importance of having diverse forms of Internet connectivity (Prieger 2015; Quaglione et al. 2020). To keep pace with the rapid advancement of the digital age, individuals should have access to a wide range of Internet connections, devices, and peripherals (Van Deursen and Van Dijk 2019).

The second level of the digital divide focuses on the disparities in digital skills and utilization. Digital skills refer to an individual's level of proficiency and literacy in effectively operating and navigating ICTs and technologies in general. Prior research consistently demonstrates that a lack of fundamental Internet, computer, or ICT skills can significantly impede an individual's capacity to proficiently navigate the digital era (Hargittai 2005; Helsper and Eynon 2013). Usage represents the ultimate stage in Van Dijk's (2017) model of technology appropriation, and it is the most pivotal stage that stems from motivational access. The actual utilization of digital technologies or media by an individual can be assessed through diverse metrics such as the duration or frequency of usage, the specific purpose for which it is employed, and the extent of engagement in online activities.

The third level of the digital divide is centered on the outcomes resulting from digital usage. Individuals who undergo the entire process of technology appropriation and engage in online activities ultimately aim to attain positive offline outcomes or benefits. Van Deursen and Helsper's (2015) findings revealed that even among users who have equal access, skills, and usage of digital technologies, there can still

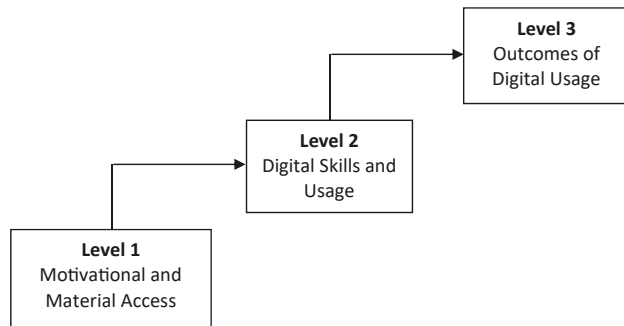


Figure 1: The three levels of the digital divide.

be disparities in terms of outcomes, which underscores the potential of digital technology to empower individuals, while also prompting consideration of whether all users are reaping comparable benefits (Aissaoui 2022; Helsper, Van Deursen, and Eynon 2015; Ragnedda and Ruiu 2017).

Online learning was lauded as a new frontier for higher education institutions, but this digital revolution has starkly revealed the reality for underdeveloped and developing countries, where the digital age remains a distant prospect (Hill and Lawton 2018; Laurillard and Kennedy 2017). Consequently, the digital divide is perceived as a significant hurdle that impedes the effective implementation of online teaching and learning during the Covid-19 pandemic (Kummitha et al. 2021; The World Bank 2020; UNESCO 2020); Figure 1 provides a visual representation of its three levels.

2.2 Online Learning Outcomes

Motivational factors, encompassing acceptance, attitude, and perceptions towards ICTs, have a significant influence on students' engagement in the digital realm and subsequently affect their learning outcomes (Chen and Chen 2007; Ghobadi and Ghobadi 2015; Novita and Widuri 2019). Access to technology is the initial step in bridging the digital divide; students without or with limited access to physical technologies would be deprived of valuable learning opportunities (Apuke and Iyendo 2018; Hussein et al. 2020; Zhai et al. 2019). The development of digital competencies among students not only promotes their success in online learning but also empowers them with the skills necessary to navigate the digital environment effectively (Adhikari et al. 2017; Alqurashi 2019; Fidalgo et al. 2020). Active participation in digital activities furnishes students with the necessary support and resources to navigate online learning processes. A lack of exposure to online tools and practices can thus impede students from fully benefitting from their online learning experiences (Hanif, Jamal, and Imran 2018; Henderson, Selwyn, and Aston 2017).

Building upon previous studies that examined the digital divide and its impact on learning outcomes, this study incorporates two key concepts from educational and pedagogical research to assess "offline outcomes" in the context of online learning, with these concepts aligning with the definition of "offline outcomes" of digital use as outlined by Helsper, Van Deursen, and Eynon (2015). They defined "offline outcomes" in relation to the level of satisfaction achieved and the accomplishments individuals gain from their online engagements. In this study, students' satisfaction was adopted to gauge their level of fulfillment with online learning, while students' perceived learning was used to assess their perception of the knowledge and skills acquired through online learning (Alqurashi 2019; Arbaugh 2000; Eom, Wen, and Ashill 2016; Hiltz 1994; McCroskey et al. 1996; Sher 2009; Strong et al. 2012).

3 Hypotheses Development

A deficiency in motivational access can impede the effective acquisition of digital tools and equipment. Maintaining a positive attitude and motivation towards technology is crucial in bridging the gap in material access, and thus an individual with a negative attitude towards technology may be less inclined to embrace technological tools in their daily life (Van Deursen and Van Dijk 2015; Van Deursen and Van Dijk 2019). Lack of motivation acts as a barrier to material access, as it can lead individuals to resist obtaining the necessary physical tools and equipment (Ghobadi and Ghobadi 2015; Gonzales 2016; Van Dijk 2006; Van Dijk 2017). Therefore, we posit the following hypothesis:

H1: Motivational access has a positive relationship with material access.

Access to digital equipment fosters the development of digital skills and competencies (Van Deursen and Van Dijk 2015; Van Deursen and Van Dijk 2019), while access to a diverse range of digital tools is crucial for learning and development of such digital skills (Mossberger, Tolbert, and Hamilton 2012). Cabello et al. (2021) discovered that access to cell phone and various other devices among Chilean children and adolescents is a significant predictor of their digital skills, and thus lower ownership of devices, such as smartphones, among lower-income adults has resulted in a lower level of development of digital skills for this demographic (Hargittai, Piper, and Morris 2019). Van Dijk (2017) expressed that physical ownership of technologies is crucial for individuals to attain digital skills and, thus, lack of material access will naturally impede individuals' acquirement of digital skills. Therefore, we posit the following hypothesis:

H2: Material access has a positive relationship with digital skills.

Possessing sufficient digital skills is a driver of digital usages (Mossberger, Tolbert, and Hamilton 2012; Van Deursen and Van Dijk 2013; Van Deursen and Van Dijk 2015; Van Dijk 2006; Van Dijk 2017). Helsper and Eynon (2013) discovered that different types of digital skills starting from basic button knowledge to more advanced skillsets are important for engagement in online activities, emphasizing that technological competencies promote engagement in online activities. Digitally skilled individuals participate in social media in an articulate and deliberate manner, as these varied skills equip them with the ability to handle a wide range of online activities strategically (Correa 2016). In the Malaysian context, Ojo et al. (2019) found that proficiency in digital skills is the most significant determinant of Internet usage. Therefore, we posit the following hypothesis:

H3: Digital skills have a positive relationship with digital usage.

Participating in a variety of digital activities fosters students' online learning outcomes, with their active engagement in online activities crucial for academic improvement. Involvement in diverse online activities empowers students to enhance their learning by providing them with resources and materials that cater to their academic needs (Britt, Goon, and Timmerman 2015; Sun and Metros 2011; Tien and Fu 2008).

Students' ICT activities affect their learning output, with a lower level of engagement deteriorating their online learning (Dray et al. 2011), while engagement in diverse online activities supplies individuals with beneficial outcomes (Van Deursen and Van Dijk 2013; Van Deursen and Van Dijk 2015). Differences in online activities engagement among individuals are attributed to unequal outcome achievements (Dimaggio and Bonikowski 2008; Kuhn and Mansour 2014) and, therefore, we posit the following hypothesis:

H4: Digital usage has a positive relationship with (a) students' satisfaction and (b) students' perceived learning in online learning during the Covid-19 pandemic.

Material access, digital skills, and digital usage play the role of mediator to facilitate the relationships between the digital divide indicators, which render a successive flow of digital divide across all three levels from motivational access, material access, digital skills, and digital usage to online learning outcomes. These relationships are explained through Van Dijk's technology appropriation process, with motivational access the starting point of the process and outcome the final point (Van Deursen and Helsper 2015; Van Deursen and Van

Dijk 2015; Van Deursen et al. 2017; Van Dijk 2006; Van Dijk 2012; Van Dijk 2017). Heponiemi et al. (2023) stated that the successive flow of handling the digital divide in terms of attitude, access to technology, digital skills, and usage is important for attainment of beneficial offline outcomes in the context of online health and social welfare services.

Enhanced accessibility to technology, coupled with proficiency and active utilization, serves as a catalyst for academic improvement among students (Judson 2010). However, Calderón-Gómez (2019) emphasized that while having privileged and flexible access to a range of digital tools is important, it does not automatically ensure effective Internet use; it is imperative to possess sufficient proficiency in digital skills in order to effectively harness the potential of ICT utilization. Additionally, Cabello-Hutt, Cabello, and Claro (2018) discovered that possessing digital skills plays a mediating role in gaining access to home Internet and actively participating in digital activities. This suggests that even with access to digital devices and the Internet, individuals may not effectively engage in digital usage if they lack the necessary digital skills (Hodge et al. 2017).

Moreover, Hurwitz and Schmitt (2020) discovered that exposure to Internet activities leads to the acquisition of digital skills, ultimately resulting in positive academic outcomes for children. Vandoninck, d'Haenens, and Roe (2013) further demonstrated that European children with a strong grasp of digital skills are better equipped to navigate challenges associated with online engagements, consequently leading to more positive outcomes from Internet use. On the contrary, children with lower levels of digital skills tend to have limited Internet use, restricting their access to the beneficial opportunities that come with digital inclusion (Holloway, Green, and Livingstone 2013; Livingstone and Helsper 2007; Livingstone, Mascheroni, and Staksrud 2015). These studies underscore the critical importance of possessing sufficient digital skills and actively engaging in digital activities for achieving meaningful outcomes in online learning.

Prior studies have established a firm ground to assess the mediating role of material access, digital skills, and digital usage through the successive flow of the digital divide from motivational access to online learning outcomes as shown in Figure 2. Thus, this study investigates the successive flow of the digital divide from the first to the third levels and argues that motivational access would not directly lead to students' satisfaction and their perceived learning but through the indirect effect of material access, digital skills, and digital usage. Therefore, we posit the following hypotheses:

H5: Material access has a mediating effect on the relationship between motivational access and digital skills.

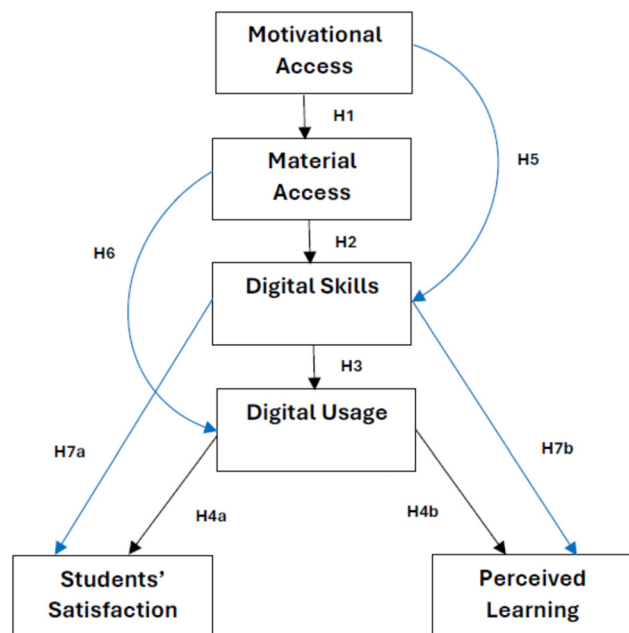


Figure 2: Research model.

H6: Digital skills have a mediating effect on the relationship between material access and digital usage.

H7: Digital usage has a mediating effect on the relationship between digital skills and (a) students' satisfaction and (b) students' perceived learning in online learning during the Covid-19 pandemic.

4 Method

This study employed a quantitative research design, utilizing cross-sectional questionnaire surveys to gather data from samples of students. The surveys were conducted online via Google Forms to facilitate the collection of responses. The survey instrument was adopted or adapted from prior related studies which demonstrated high reliability and validity, including Helsper, Smirnova, and Robinson (2017), Van Deursen, Helsper, and Eynon (2014), Van Deursen and Van Dijk (2013), Strong et al. (2012), Sher (2009), and Hiltz (1994).

4.1 Sample and Sampling Procedures

A total of 363 respondents were collected from ten universities which cover diverse geographical regions across Malaysia, chosen through quota sampling to ensure balanced representation between public and private institutions.

Snowball sampling was used to recruit a student sample, whereby the primary samples from each university were approached through social media and the first author's personal networks. The surveys were then distributed from one eligible student to another, through their social network, university peers, and student organizations. Filtering questions were used in the survey to sieve through eligible respondents to fulfil the scope of the study. The participation eligibility criteria include student respondents having to be of Malaysian nationality, being actively enrolled in full-time studies from the ten selected public and private universities in the present study, and necessitated by their universities to undertake online learning during the Covid-19 pandemic.

Slightly over two-thirds of the students (68.9 %) did not have any prior experience enrolling in online learning or classes before the Covid-19 pandemic. More than two-thirds of the respondents (71.9 %) were female students, with the remaining students being male (28.1 %). This study has representations from various ethnic groups in Malaysia including Indians (39.4 %), Chinese (24.2 %), Malays (18.7 %), and others (17.6 %), that is inclusive of Indigenous groups of East Malaysia and racially ambiguous individuals. Furthermore, 68.3 % of the respondents reported a monthly household income of RM5,000 and below, aligning with the bottom 40 % income group (B40) as categorized by the Department of Statistics Malaysia (DOSM 2021), with RM4,850 as the threshold as of 2019. In the realm of academic disciplines, the primary fields of study encompassed the following percentages: 22.6 % of respondents were enrolled in engineering, 21.8 % in accountancy, management, and business-related programs, 13.5 % in health sciences, 11.8 % in the sciences, and the remaining 30.1 % in other disciplines. Most of the respondents (88.7 %) accessed online learning from their homes during the Covid-19 pandemic.

4.2 Variables and Measurement

This study incorporates an independent variable (motivational access), three mediators (material access, digital skills, and digital usage), and two dependent variables (students' satisfaction and perceived learning). Motivational access, as delineated in this study, encompasses individuals' motivation, attitudes toward technology, and their intention to embrace it. This concept was assessed using the motivation and attitude scale developed by Helsper, Smirnova, and Robinson (2017), comprising four items rated on a five-point Likert scale ranging from 1 ("strongly disagree") to 5 ("strongly agree"). Material access, in this context, pertains to the accessibility of Internet and digital infrastructure, gauged by considering the ownership of devices and peripherals and utilization of Internet services. The latter was tailored to the Malaysian

context, aligning with services offered by telecommunication providers in Malaysia, including fixed broadband, mobile data plans, and wireless broadband. Material access was measured through dichotomous questions requiring a “yes” or “no” response.

Digital skills, in this context, encompass an individual’s competence in utilizing digital technologies effectively and computer literacy, with these skills assessed based on Van Deursen, Helsper, and Eynon’s (2014) five dimensions: operational (10 items), information navigation (8 items), social (6 items), creative (8 items), and mobile skills (3 items). Respondents’ self-reported digital skills were measured on a five-point Likert scale, ranging from “not at all true of me” to “very true of me,” with an additional option of “I do know what this means” in line with Van Deursen, Helsper, and Eynon’s (2014) study.

Digital usage, as defined in this study, refers to the tangible utilization of digital technologies for diverse activities. This was determined by assessing the duration of Internet use and the frequency of engagement in various online activities, as proposed by Van Deursen and Van Dijk (2013). Online activity categories included personal development (4 items), leisure (3 items), commercial transactions (3 items), social interaction (3 items), information (2 items), news (2 items), and gaming (1 item). The duration of Internet use was quantified by daily hours, while frequency was measured on a five-point scale from never to always.

Students’ satisfaction, in the context of this study, is characterized as the degree of contentment with the online courses they attended during the COVID-19 pandemic. This satisfaction was assessed using seven items adapted from Strong et al. (2012) and measured on a five-point Likert scale, ranging from “strongly disagree” to “strongly agree.” Perceived learning in this study pertains to students’ perception of the educational effectiveness of a course during the COVID-19 pandemic, with this concept assessed using six items adapted from Sher (2009) and Hiltz (1994), employing a five-point Likert scale that ranged from “strongly disagree” to “strongly agree.”

4.3 Data Analysis Techniques

This study utilized descriptive analysis to ascertain the presence of three levels of the digital divide among Malaysian university students. Subsequently, hypothesis testing for 1, 2, 3, 4a, and 4b was conducted using partial least squares structural equation modeling (i.e., SmartPLS 3.3.3), followed by mediation analyses for hypotheses 5, 6, 7a, and 7b. For the constructs of digital skills and digital usage which have multiple dimensions, a hierarchical component model (HCM) was used to establish the constructs as formative

higher order constructs (HOCs) and their dimensions as reflective lower order constructs (LOCs). An embedded two-stage approach was used to evaluate the HCM, followed by assessment of the measurement model being conducted to establish construct reliability and validity for LOCs and HOCs (Hair et al. 2017b; Sarstedt et al. 2019) and then assessment of the structural model to test the hypothesized direct relationships of this study. Finally, mediation analyses were conducted to test the indirect effects of the three mediators: material access, digital skills, and digital usage (Hair et al. 2017a; Memon et al. 2018). A mediation analysis may produce three possible results – full mediation, partial mediation, and no mediation (Hair et al. 2017a). Full mediation occurs when the mediated effect is significant but not the direct effect, and is also called indirect-only mediation; hence, the mediator fully explains the relationship between an independent and a dependent variable. Partial mediation occurs when a mediator partially explains the relationship between an independent and a dependent variable. No mediation occurs when there is either a sole direct effect or no discernible effect at all between an independent and a dependent variable.

5 Results

5.1 Descriptive Analyses

Variables with a mean score value of 4 and above indicate that respondents do not perceive a divide, whereas mean score values below 4 suggest the opposite. The student sample demonstrates a digital divide in the second and third levels concerning digital skills, digital usage, and perceived learning outcomes, with the exception of motivational access at the first level. Regarding material access, more than 90 % of respondents possess essential tools for online learning, including a mobile data plan, laptop/notebook, and smartphone. However, due to a technological diffusion rate below 90 %, a noticeable disparity exists among students in accessing various Internet services, devices, and peripherals. This underscores the presence of a digital divide in terms of material access at the first level (Tables 1 and 2).

5.2 Assessment of the Measurement Model

The assessment of the measurement model revealed robust construct reliability and convergent validity across all LOCs, which was evidenced by the outer loadings and construct reliabilities of reflective indicators exceeding 0.7, affirming the reliability of Motivational Access (0.93), Digital Skills

Table 1: Descriptive analysis.

Variable	<i>M</i>	<i>SD</i>
Motivational access	4.15	0.92
Material access ^a	6.44	1.85
Internet services (subscribed)	1.78	0.59
Devices and peripherals (owned)	4.67	1.56
Digital skills	4.05	0.71
Operational	4.51	1.05
Information navigation	3.49	1.14
Social	4.46	0.86
Creative	3.31	1.06
Mobile skills	4.53	0.90
Digital usage	3.76	0.54
Personal development	3.97	0.76
Leisure	3.86	0.87
Commercial transactions	3.45	1.03
Social interactions	4.24	0.80
Information	4.39	0.72
News	3.53	1.04
Gaming	2.96	1.20
Students' satisfaction	2.84	1.01
Perceived learning	3.28	0.90

^aMaterial access was assessed by aggregating the subscribed Internet services (with a maximum of 3) and the devices and peripherals owned (with a maximum of 11).

Table 2: Correlation matrix.

Variable	1.	2.	3.	4.	5.
1. Motivational access	–				
2. Material access	0.124*				
3. Digital skills	0.017	0.192**			
4. Digital usage	0.259**	0.289**	0.329**		
5. Students' satisfaction	0.135**	0.011	–0.159*	–0.004	
6. Perceived learning	0.191**	0.000	–0.047	0.118*	0.672**

* $p < 0.05$; ** $p < 0.01$.

(0.90–0.98), Digital Usage (0.75–0.93), Students' Satisfaction (0.92), and Perceived learning (0.95). Furthermore, the average variance extracted (AVE) exceeded 0.5, indicating substantial convergent validity for Motivational Access (0.78), Digital Skills (0.54–0.82), Digital Usage (0.47–0.87), Students' Satisfaction (0.65), and Perceived learning (0.78).

Additionally, variance inflation factor (VIF) values below 5 for the formative indicators of HOCs confirmed their distinctiveness and non-interchangeability: Digital Skills (1.195–2.637) and Digital Usage (1.126–1.565). The significant outer weights of all formative indicators of HOCs underscore the relative importance of each indicator to its corresponding constructs: Digital Skills (0.177–0.326) and Digital Usage (0.219–0.265) (Hair et al. 2017a). Moreover, the heterotrait-monotrait ratio of correlations (HTMT) below 0.85 provided further support for discriminant validity across all constructs (HTMT = 0.011 to

0.672) in the measurement model, which affirms that the distinctive attributes of each construct are reliably differentiated from one another.

5.3 Assessment of the Structural Model

The statistical significance of the proposed hypotheses was primarily assessed using bootstrapping analysis in the structural model (with 5000 resamples). The findings revealed that all hypotheses, with the exception of H4(a) and H7(a), were supported by the data. As anticipated, the direct relationships posited in H1, H2, H3, and H4(b) were all found to be statistically significant. Figure 3 presents the detailed results obtained from the structural model assessment.

In line with the discussions on mediation analysis by Hair et al. (2017a) and Memon et al. (2018), it was established that material access serves as a full mediator in the relationship between motivational access and digital skills, thereby affirming the support for H5. Furthermore, the sixth hypothesis (H6) was also corroborated, indicating that digital skills act as a partial mediator. Additionally, H7(b) found support, indicating that digital usage serves as a full mediator in the relationship between digital skills and students' perceived learning. However, no mediating effect of digital usage was observed in the relationship between digital skills and students' satisfaction (H7a). Table 3 presents the detailed results of the mediation analysis.

6 Limitations and Recommendations for Future Research

The utilization of nonprobability sampling technique, allowing data collection during the prevailing pandemic in Malaysia, has led to an imbalanced sample that does not accurately reflect the demographic composition, including gender, ethnic group, and household income level, in proportion to the overall population; hence, the findings possess restricted generalizability to a broader context, and future studies could adopt probability sampling techniques to ensure a more precise representation of the population's demographic characteristics. The successive and consequential investigation of the digital divide from motivational access to online learning outcomes has overlooked the possible intervention related to pedagogical and educational variables such as digital distraction and students' disengagement. In addition, it has not explored the potential influence of students' adaptability, equipment quality, and network quality on

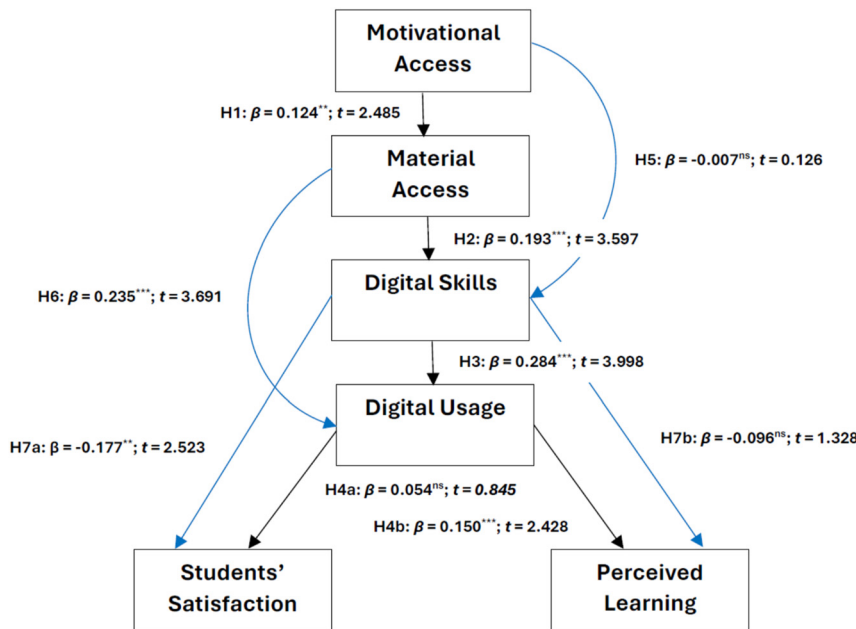


Figure 3: Structural model. Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, ns = not significant.

Table 3: Results of mediation analysis.

Hypothesis	Descriptions	Beta coefficient	Standard error	t-Value	Decision
H5	Motivational access → digital skills	−0.007	0.052	0.126 ^{ns}	Full mediation
	Motivational access → material access → digital skills	0.024	0.012	2.009*	
H6	Material access → digital usage	0.235	0.064	3.691***	Partial mediation
	Material access → digital skills → digital usage	0.055	0.019	2.830**	
H7(a)	Digital skills → students' satisfaction	−0.177	0.070	2.523**	No mediation
	Digital skills → digital usage → students' satisfaction	0.015	0.019	0.794 ^{ns}	
H7(b)	Digital skills → perceived learning	−0.096	0.072	1.328 ^{ns}	Full mediation
	Digital skills → digital usage → perceived learning	0.043	0.022	1.924*	

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, ns = not significant.

digital usage. The potential interference of these variables suggests that investigating the digital divide in an educational context should also encompass elements of learning behavior and the quality of digital infrastructure, pedagogies, curriculum, and policies surrounding digital transformation in education. Future studies should delve into an in-depth analysis of how these factors come into play throughout the entire process, particularly in the context of online learning and any technologically mediated learning environments.

7 Discussion

The descriptive analysis unveiled a digital divide across all three levels among Malaysian university students, although there was a narrowing gap in motivational access, which aligns with Vogels et al.'s (2020) assertion that the Covid-19 pandemic has underscored the significance of digitalization,

leading to generally positive perceptions and attitudes towards the Internet and its applications.

The enduring disparities in material access at the first level, digital skills and usage at the second level, and online learning outcomes at the third level underscore the presence of a digital divide among Malaysian university students. It is noteworthy that a majority of the sampled students hail from lower-income groups, with a higher representation of females and racial minorities (Van Deursen and Van Dijk 2019; Van Dijk 2017).

The noteworthy findings regarding the direct relationships between motivational access, material access, digital skills, digital usage, and one of the online learning outcomes, students' perceived learning, confirm that possessing motivational access promotes the acquisition of material resources; conversely, negative motivation or perception hinders students from gaining access to physical technologies (Ghobadi and Ghobadi 2015; Gonzales 2016; Van Deursen

and Van Dijk 2015; Van Deursen and Van Dijk 2019; Van Dijk 2006; Van Dijk 2017). Furthermore, access to digital tools is a catalyst for the development of digital skills. When students have access to a range of Internet services, devices, and peripherals, they are presented with greater opportunities to enhance their digital competencies (Cabello et al. 2021; Hargittai, Piper, and Morris 2019; Van Deursen and Van Dijk 2015; Van Deursen and Van Dijk 2019). Following this, having digital capabilities increases engagement in online activities, with a proficient grasp of digital skills encouraging students to participate in a wide range of digital uses (Correa 2016; Helsper and Eynon 2013; Ojo et al. 2019; Van Deursen and Van Dijk 2013; Van Deursen and Van Dijk 2015).

Digital usage is a significant predictor of students' acquisition of knowledge from online learning, particularly in terms of perceived learning, though not necessarily satisfaction, which underscores the notion that active engagement in digital activities positively influences students' learning outcomes (Britt, Goon, and Timmerman 2015; Dimaggio and Bonikowski 2008; Dray et al. 2011; Kuhn and Mansour 2014; Sun and Metros 2011; Tien and Fu 2008; Van Deursen and Van Dijk 2013; Van Deursen and Van Dijk 2015). The positive impact of digital usage on one's learning outcomes, while not observed in other aspects, may potentially be attributed to the presence of digital distraction. Engaging in online activities, as noted by Hanif, Jamal, and Imran (2018) and Henderson, Selwyn, and Aston (2017), provides students with valuable resources and materials for knowledge acquisition in online learning. However, it also introduces distraction, diverting students from their learning pursuits and leading to a less significant association with their overall online learning satisfaction, as suggested by Flanigan and Babchuk (2022), and Taneja, Fiore, and Fischer (2015).

In the findings of the mediation analysis, we discovered that material access serves as a full mediator in the relationship between motivational access and digital skills. This outcome emphasizes that motivational access alone, without adequate physical access to digital tools and infrastructure, including Internet connections, devices, or peripherals, would not facilitate the development of digital skills (Van Deursen and Van Dijk 2015; Van Deursen et al. 2017). Digital skills, meanwhile, only act as a partial mediator in facilitating the relationship between material access and digital usage. This finding suggests that having access to material resources, coupled with the adequate development of digital competencies, motivates students to engage in various online activities (Cabello-Hutt, Cabello, and Claro 2018; Calderón-Gómez 2019; Hodge et al. 2017; Judson 2010).

On the contrary, the involvement of digital usage as a mediator did not show a significant relationship between digital skills and students' satisfaction. However, digital usage

did fully mediate the relationship between digital skills and students' perceived learning. These results present a contrasting conclusion to studies that previously inferred that engaging in digital activities is crucial in enhancing the relationship between digital skills and learning outcomes (Holloway, Green, and Livingstone 2013; Hurwitz and Schmitt 2020; Livingstone and Helsper 2007; Livingstone, Mascheroni, and Staksrud 2015; Vandoninck, d'Haenens, and Roe 2013).

The mediation analysis reinforces the significance of material access and digital skills as significant mediators in the observed relationships. While digital usage was confirmed as a mediator for the relationship between digital skills and students' perceived learning, it did not hold true for students' satisfaction, with this discrepancy potentially attributable to student disengagement, a concept articulated by Chiu (2021) as a form of emotional detachment and estrangement from online learning. Additionally, Bergdahl, Nouri, and Fors (2020) emphasized that students, regardless of their level of digital competencies, can become disengaged in a technologically enhanced learning environment. Compared to face-to-face learning, online learning may lack the same level of expressiveness and warmth, potentially hindering students from fully immersing themselves in the learning experience.

8 Implications

8.1 Theoretical Implications

Theoretically, this study adopted the three-level digital divide framework established by multiple digital divide studies such as Hargittai (2005), Helsper and Eynon (2013), Helsper, Van Deursen, and Eynon (2015), Ragnedda and Ruiu (2017), Van Deursen and Helsper (2015, 2018), and Van Dijk (2017) to explore the process of the digital divide from motivational access to online learning outcomes. The results affirm that the framework is indeed a useful tool for evaluating the sequential progression from the first to the third levels of the digital divide. Furthermore, this study addressed the scarcity of digital divide research in Malaysia, which is a step forward to address the issue in the context of a developing country. Simultaneously, the implementation of the three levels of the digital divide in an online learning context has also established grounds to investigate this issue from different aspects of outcomes. This study not only contributed to addressing the digital divide but also paved the way for a multidisciplinary approach, prominently utilizing variables related to online learning outcomes and drawing from both pedagogical and educational research to evaluate the learning outcomes (Helsper, Van Deursen, and Eynon 2015).

8.2 Practical Implications

From the practical perspective, there is no denying that a collaborative effort among various stakeholders is essential to narrow the digital divide among Malaysian university students, thereby enhancing their online learning experience both during and post Covid-19 pandemic.

First, prior studies did establish that existing forms of inequalities hinder digital inclusiveness (Guo and Wan 2022; Van Dijk 2012; Van Dijk 2017). Therefore, students, their family, and their communities have limited power to tackle the issue of digital divide among themselves, especially with chains of socioeconomic and sociodemographic inequalities that tie them. Considering that, minor steps students could take are to be tenacious and persistent in learning ever-evolving digital skills, have active, creative, and strategic involvement in digital activities, and tackle the psychological factors that lead to their online learning disengagements and distractions (Bergdahl, Nouri, and Fors 2020).

Students' families should provide unequivocal emotional support and encouragement for them to face the adversity brought forward by the digital divide and the mental challenges of undertaking online learning specifically during the pandemic (e.g., Huang and Zhang 2022). Societal support either emotionally or financially, from peers or community through fundraising to lighten the cost digitalization for students, donations of digital equipment, or peer encouragement through online peer learning would greatly assist digitally secluded students and their online learning.

Educators and university administrations indeed bear the responsibility of acknowledging and providing support for students facing challenges due to the digital divide in online learning. Thoughtful planning and implementation of technology in virtual classrooms are critical for fostering students' interaction and engagement, ensuring meaningful online learning experiences (e.g., Salta et al. 2022). Furthermore, universities should increase investments in digital education, which should encompass ongoing training for educators, as well as providing incentives, competitive salaries, and recognition to motivate and appreciate their contributions. Simultaneously, institutions should continually offer students digital training and workshops as well as adapt curricula to align with the evolving digital landscape. This comprehensive approach is crucial in creating an inclusive and effective educational environment for all students.

Non-governmental organizations, particularly those dedicated to promoting education equity, digital inclusion, and social equality, play a crucial role in addressing this digital divide issue; their initiatives can provide essential support to students who may have been overlooked by government assistance programs. These organizations can

also take the lead in organizing workshops and training sessions to help disadvantaged individuals develop vital digital skills. This proactive approach is vital in ensuring that no student is left behind in the digital age.

Finally, bridging the digital divide among university students requires a concerted effort from both private corporations, particularly those in the technology and telecommunications industry, and public institutions, including government bodies, political organizations, and policymakers. Given that the digital divide is closely intertwined with social and economic disparities, substantial support and intervention from both the public and private sectors are imperative.

The Ministry of Higher Education in Malaysia has taken commendable steps by providing assistance such as free mobile data plans in collaboration with major telecommunication companies, distributing free laptops to students from lower income backgrounds, and offering special discounts in partnership with technology firms (The Star 2020b; The Star 2022). While these measures are crucial in addressing the gap in material access, a detailed frequency analysis indicates that the issue extends beyond mere physical access. As elucidated through the three levels of the digital divide framework, disparities in digital skills, digital usage, and online learning outcomes must also be addressed. Therefore, it is imperative to recognize that while these aids are a positive step, they are not sufficient on their own, and a comprehensive approach is needed to ensure equitable access and outcomes for all university students.

9 Conclusion

This study concludes on a grim note that the digital divide is a major obstacle for developing countries including Malaysia and poses daunting challenges for university students. In response to the first research objective, this study has validated the existence of the digital divide at all three levels among Malaysian university students, excluding motivational access in the first level. In response to the second research objective, the digital divide indeed has a detrimental impact on educational outcomes. The results confirmed the successive flow of the digital divide that starts from motivational access to online learning outcomes except for the relationship between digital usage and students' satisfaction. The reason for the contradictory relationship between digital usage and students' satisfaction highlights the possible case of digital distraction among students, with it found that digital usage does not mediate the relationship between digital skills and students' satisfaction; prior studies have shown digital disengagement

could also be the cause of disruption (e.g., Bergdahl, Nouri, and Fors 2020).

This study makes noteworthy contributions on the reality of the digital divide among Malaysian university students and how online learning was affected during the Covid-19 pandemic. Despite the waning influence of the COVID-19 pandemic, the significance of the findings persists, offering valuable insights for future crises and emergencies such as flooding, which is prevalent in Malaysia. The lessons derived from the digital divide during the COVID-19 pandemic can serve as valuable insights for improving the transition to online learning and shaping adaptive e-learning strategies in flood-affected regions. Additionally, these findings have the potential to offer valuable insights for addressing digital divide issues in other developing countries grappling with similar challenges.

Acknowledgments: This research received support from the Fundamental Research Grant Scheme of the Ministry of Higher Education, Malaysia [FRGS/1/2018/SS03/UTAR/03/01], and the Topup Scheme of Universiti Tunku Abdul Rahman [Vote No. 6235/F03].

References

- Adhikari, J., C. Scogings, A. Mathrani, and I. Sofat. 2017. "Evolving Digital Divides in Information Literacy and Learning Outcomes." *International Journal of Information and Learning Technology* 34: 290–306. <https://doi.org/10.1108/IJILT-04-2017-0022>.
- Aissaoui, N. 2022. "The Digital Divide: A Literature Review and Some Directions for Future Research in Light of COVID-19." *Global Knowledge, Memory and Communication* 71 (8/9): 686–708. <https://doi.org/10.1108/GKMC-06-2020-0075>.
- Ajrun, N. 2023. "Bridging the Digital Divide Affecting Persons with Disabilities in Malaysia." *International Journal of Disability, Development and Education* 70 (4): 562–74. <https://doi.org/10.1080/1034912X.2021.1901860>.
- Alqurashi, E. 2019. "Predicting Student Satisfaction and Perceived Learning within Online Learning Environments." *Distance Education* 40 (1): 133–48. <https://doi.org/10.1080/01587919.2018.1553562>.
- Apuke, O.-D., and T.-O. Iyendo. 2018. "University Students' Usage of the Internet Resources for Research and Learning: Forms of Access and Perceptions of Utility." *Heliyon* 4 (12): e01052. <https://doi.org/10.1016/j.heliyon.2018.e01052>.
- Arbaugh, J. B. 2000. "Virtual Classroom Characteristics and Student Satisfaction with Internet-Based MBA Courses." *Journal of Management Education* 24 (1): 32–54. <https://doi.org/10.1177/105256290002400104>.
- Azman, N. H. 2021. *Better Policies Needed for Digital Inclusion*. <https://themalaysianreserve.com/2021/06/22/better-policies-needed-for-digital-inclusion/> (accessed January 10, 2024).
- Baharin, B. S., and M. A. Hamid. 2021. "Letter: Budget 2022 – An Opportunity for Reset to Prepare for the Future." *Malaysia*. <https://www.malaysiakini.com/letters/599759> (accessed January 9, 2024).
- BBC. 2020. "Malaysian Student Sits Exams in a Tree to Ensure Good Wifi." <https://www.bbc.com/news/blogs-news-from-elsewhere-53079907> (accessed February 7, 2024).
- Bergdahl, N., J. Nouri, and U. Fors. 2020. "Disengagement, Engagement and Digital Skills in Technology-Enhanced Learning." *Education and Information Technologies* 25 (2): 957–83. <https://doi.org/10.1007/s10639-019-09998-w>.
- Bernama. 2020. "Father Sets Up Daughter's 'Classroom' in Tent Atop Hill." <https://www.bernama.com/en/news.php?id=1906801> (accessed February 3, 2024).
- Britt, M., D. Goon, and M. Timmerman. 2015. "How to Better Engage Online Students with Online Strategies." *College Student Journal* 49 (3): 399–404. <https://www.ingentaconnect.com/content/prin/csj/2015/00000049/00000003/art00008> (accessed May 10, 2024).
- Cabello, P., M. Claro, R. Rojas, and D. Trucco. 2021. "Children's and Adolescents' Digital Access in Chile: The Role of Digital Access Modalities in Digital Uses and Skills." *Journal of Children and Media* 15 (2): 183–201. <https://doi.org/10.1080/17482798.2020.1744176>.
- Cabello-Hutt, T., P. Cabello, and M. Claro. 2018. "Online Opportunities and Risks for Children and Adolescents: The Role of Digital Skills, Age, Gender and Parental Mediation in Brazil." *New Media & Society* 20 (7): 2411–31. <https://doi.org/10.1177/1461444817724168>.
- Calderón-Gómez, D. 2019. "Technological Capital and Digital Divide Among Young People: An Intersectional Approach." *Journal of Youth Studies* 22 (7): 941–58. <https://doi.org/10.1080/13676261.2018.1559283>.
- Chen, Y. J., and P. C. Chen. 2007. "Effects of Online Interaction on Adult Students' Satisfaction and Learning." *The Journal of Human Resource and Adult Learning* 3: 78–89.
- Cheshmehzangi, A., T. Zou, Z. Su, and T. Tang. 2023. "The Growing Digital Divide in Education among Primary and Secondary Children during the COVID-19 Pandemic: An Overview of Social Exclusion and Education Equality Issues." *Journal of Human Behavior in the Social Environment* 33 (3): 434–49. <https://doi.org/10.1080/10911359.2022.2062515>.
- Chiu, T. K. F. 2021. "Student Engagement in K-12 Online Learning amid COVID-19: A Qualitative Approach from a Self-Determination Theory Perspective." *Interactive Learning Environments* 31 (6): 3326–39. <https://doi.org/10.1080/10494820.2021.1926289>.
- Correa, T. 2016. "Digital Skills and Social Media Use: How Internet Skills Are Related to Different Types of Facebook Use Among 'Digital Natives.'" *Information, Communication & Society* 19 (8): 1095–107. <https://doi.org/10.1080/1369118X.2015.1084023>.
- DiMaggio, P., and B. Bonikowski. 2008. "Make Money Surfing the Web? The Impact of Internet Use on the Earnings of U.S. Workers." *American Sociological Review* 73 (2): 227–50. <https://doi.org/10.1177/000312240807300203>.
- DOSM. 2021. "Household Income & Basic Amenities Survey Report 2019." *Department of Statistics Malaysia*. https://v1.dosm.gov.my/v1/index.php?r=column/cthemeByCat&cat=120&bul_id=TU00TmRhQ1N5TUxHVWN0T2YjbXlYZz09&menu_id=amVoWU54UTl0a21NWmdhMjFMMWcyZz09 (accessed December 2, 2023).
- Dray, B. J., P. R. Lowenthal, M. J. Miszkiewicz, M. A. Ruiz-Primo, and K. Marczynski. 2011. "Developing an Instrument to Assess Student Readiness for Online Learning: A Validation Study." *Distance Education* 32 (1): 29–47. <https://doi.org/10.1080/01587919.2011.565496>.
- Eom, S. B., H. J. Wen, and N. Ashill. 2016. "The Determinants of Students' Perceived Learning Outcomes and Satisfaction in University Online Education: An Update." *Decision Sciences Journal of Innovative Education* 14 (2): 185–215. <https://doi.org/10.1111/j.1540-4609.2006.00114.x>.

- Fidalgo, P., J. Thormann, O. Kulyk, and J.A. Lencastre. 2020. "Students' Perceptions on Distance Education: A Multinational Study." *International Journal of Educational Technology in Higher Education* 17: 18. <https://doi.org/10.1186/s41239-020-00194-2>.
- Flanigan, A. E., and W. A. Babchuk. 2022. "Digital Distraction in the Classroom: Exploring Instructor Perceptions and Reactions." *Teaching in Higher Education* 27 (3): 352–70. <https://doi.org/10.1080/13562517.2020.1724937>.
- Ghobadi, S., and Z. Ghobadi. 2015. "How Access Gaps Interact and Shape Digital Divide: A Cognitive Investigation." *Behaviour & Information Technology* 34 (4): 330–40. <https://doi.org/10.1080/0144929X.2013.833650>.
- Gonzales, A. 2016. "The Contemporary US Digital Divide: From Initial Access to Technology Maintenance." *Information, Communication & Society* 19 (2): 234–48. <https://doi.org/10.1080/1369118X.2015.1050438>.
- Guo, C., and B. Wan. 2022. "The Digital Divide in Online Learning in China during the COVID-19 Pandemic." *Technology in Society* 71: 102122. <https://doi.org/10.1016/j.techsoc.2022.102122>.
- Hair, Jr. J. F., G. T. M. Hult, C. M. Ringle, and M. Sarstedt. 2017a. *A Primer on Partial Least Squares Structural Equation Modelling (PLS-SEM)*, 2nd ed. London: Sage Publications.
- Hair, Jr. J. F., M. Sarstedt, C. M. Ringle, and S. P. Gudergan. 2017b. *Advanced Issues in Partial Least Squares Structural Equation Modelling*. London: Sage Publications.
- Hanif, A., F. Q. Jamal, and M. Imran. 2018. "Extending the Technology Acceptance Model for Use of E-Learning Systems by Digital Learners." *IEEE Access* 6: 73395–404. <https://doi.org/10.1109/ACCESS.2018.2881384>.
- Hargittai, E. 2005. "Survey Measures of Web-Oriented Digital Literacy." *Social Science Computer Review* 3 (3): 371–9. <https://doi.org/10.1177/0894439305275911>.
- Hargittai, E., A. M. Piper, and M. R. Morris. 2019. "From Internet Access to Internet Skills: Digital Inequality among Older Adults." *Universal Access in the Information Society* 18 (4): 881–90. <https://doi.org/10.1007/s10209-018-0617-5>.
- Hass, D., A. Hass, and M. Joseph. 2023. "Emergency Online Learning & the Digital Divide: An Exploratory Study of the Effects of Covid-19 on Minority Students." *Marketing Education Review* 33 (1): 22–37. <https://doi.org/10.1080/10528008.2022.2136498>.
- Helsper, E. J., and R. Eynon. 2013. "Distinct Skill Pathways to Digital Engagement." *European Journal of Communication* 28 (6): 696–713. <https://doi.org/10.1177/0267323113499113>.
- Helsper, E. J., A. J. Van Deursen, and R. Eynon. 2015. "Tangible Outcomes of Internet Use: From Digital Skills to Tangible Outcomes Project Report." <http://www.oii.ox.ac.uk/research/projects/?id=112> (accessed November 20, 2023).
- Helsper, E. J., S. Smirnova, and D. Robinson. 2017. "Digital Reach Survey." <http://www.lse.ac.uk/media-and-communications/research/research-projects/disto/disto-youth> (accessed September 8, 2023).
- Henderson, M., N. Selwyn, and R. Aston. 2017. "What Works and Why? Student Perceptions of 'Useful' Digital Technology in University Teaching and Learning." *Studies in Higher Education* 42 (8): 1567–79. <https://doi.org/10.1080/03075079.2015.1007946>.
- Heponiemi, T., K. Gluschkoff, L. Leemann, K. Manderbacka, A. M. Aalto, and H. Hyppönen. 2023. "Digital Inequality in Finland: Access, Skills and Attitudes as Social Impact Mediators." *New Media & Society* 25 (9): 2475–91. <https://doi.org/10.1177/14614448211023007>.
- Hill, C., and W. Lawton. 2018. "Universities, the Digital Divide and Global Inequality." *Journal of Higher Education Policy and Management* 40 (6): 598–610. <https://doi.org/10.1080/1360080X.2018.1531211>.
- Hiltz, S. R. 1994. *The Virtual Classroom: Learning without Limits via Computer Networks*. Norwood: Ablex Publishing Corporation.
- Hodge, H., D. Carson, D. Carson, L. Newman, and J. Garrett. 2017. "Using Internet Technologies in Rural Communities to Access Services: The Views of Older People and Service Providers." *Journal of Rural Studies* 54: 469–78. <https://doi.org/10.1016/j.jrurstud.2016.06.016>.
- Holloway, D., L. Green, and S. Livingstone. 2013. "Zero to Eight: Young Children and Their Internet Use." *EU Kids Online*. <https://ro.ecu.edu.au/ecuworks2013/929> (accessed December 14, 2023).
- Howland, J. S. 1998. "The 'Digital Divide': Are We Becoming a World of Technological 'Haves' and 'Have-Nots'?" *The Electronic Library* 16 (5): 287–9. <https://doi.org/10.1108/eb045651>.
- Huang, L., and T. Zhang. 2022. "Perceived Social Support, Psychological Capital, and Subjective Well-Being among College Students in the Context of Online Learning during the COVID-19 Pandemic." *The Asia-Pacific Education Researcher* 31 (5): 563–74. <https://doi.org/10.1007/s40299-021-00608-3>.
- Huffman, S. 2018. "The Digital Divide Revisited: What Is Next?" *Education* 138 (3): 239–46. <https://www.ingentaconnect.com/contentone/prin/ed/2018/00000138/00000003/art00004> (accessed May 10, 2024).
- Hurwitz, L. B., and K. L. Schmitt. 2020. "Can Children Benefit from Early Internet Exposure? Short-and Long-Term Links between Internet Use, Digital Skill, and Academic Performance." *Computers & Education* 146: 103750. <https://doi.org/10.1016/j.compedu.2019.103750>.
- Hussein, E., S. Daoud, H. Alrabaiah, and R. Badawi. 2020. "Exploring Undergraduate Students' Attitudes towards Emergency Online Learning during COVID-19: A Case from the UAE." *Children and Youth Services Review* 119: 105699. <https://doi.org/10.1016/j.childyouth.2020.105699>.
- Judson, E. 2010. "Improving Technology Literacy: Does it Open Doors to Traditional Content?" *Educational Technology Research & Development* 58 (3): 271–84. <https://doi.org/10.1007/s11423-009-9135-8>.
- Katz, V. S., A. B. Jordan, and K. Ognyanova. 2021. "Digital Inequality, Faculty Communication, and Remote Learning Experiences during the COVID-19 Pandemic: A Survey of U.S. Undergraduates." *PLoS One* 16 (2): 1–16. <https://doi.org/10.1371/journal.pone.0246641>.
- Kuhn, P., and H. Mansour. 2014. "Is Internet Job Search Still Ineffective?" *The Economic Journal* 124 (581): 121–33. <https://doi.org/10.1111/eoj.12119>.
- Kummitha, H. R., N. Kolloju, P. Chittoor, and V. Madepalli. 2021. "Coronavirus Disease and Its Effect on Teaching and Learning Process in the Higher Educational Institutions." *Higher Education for the Future* 8 (1): 90–107. <https://doi.org/10.1177/2347631120983650>.
- Laurillard, D., and E. Kennedy. 2017. "The Potential of MOOCs for Learning at Scale in the Global South." *Center for Global Higher Education Working Paper Series* 31: 1–37. <https://www.researchcghe.org/perch/resources/publications/wp31.pdf> (accessed May 10, 2024).
- Livingstone, S., and E. Helsper. 2007. "Gradations in Digital Inclusion: Children, Young People and the Digital Divide." *New Media & Society* 9 (4): 671–96. <https://doi.org/10.1177/1461444807080335>.
- Livingstone, S., G. Mascheroni, and E. Staksrud. 2015. *Developing a Framework for Researching Children's Online Risks and Opportunities in Europe*. London: EU Kids Online.
- Lythreathis, S., S. K. Singh, and A. N. El-Kassar. 2022. "The Digital Divide: A Review and Future Research Agenda." *Technological Forecasting and Social Change* 175: 121359. <https://doi.org/10.1016/j.techfore.2021.121359>.
- Mathrani, A., T. Sarvesh, and R. Umer. 2022. "Digital Divide Framework: Online Learning in Developing Countries during the COVID-19 Lockdown." *Globalisation, Societies and Education* 20 (5): 625–40. <https://doi.org/10.1080/14767724.2021.1981253>.

- McCroskey, J. C., J. M. Fayer, V. P. Richmond, A. Sallinen, and R. A. Barraclough. 1996. "A Multi-cultural Examination of the Relationship between Nonverbal Immediacy and Affective Learning." *Communication Quarterly* 44 (3): 297–307. <https://doi.org/10.1080/01463379609370019>.
- MCMC. 2020. "Internet Users Survey 2020." *Malaysian Communications and Multimedia Commission*. <https://www.mcmc.gov.my/skmmgovmy/media/General/pdf/IUS-2020-Report.pdf> (accessed December 4, 2023).
- Memon, M. A., J. H. Cheah, T. Ramayah, H. Ting, and F. Chuah. 2018. "Mediation Analysis Issues and Recommendations." *Journal of Applied Structural Equation Modeling* 2 (1): 1–9. [https://doi.org/10.47263/jasem.2\(1\)01](https://doi.org/10.47263/jasem.2(1)01). https://jasemjournal.com/wp-content/uploads/2019/10/JASEM_12Editorial-Memon-et-al.-2018.pdf (accessed May 10, 2024).
- Mossberger, K. C. J. Tolbert, and A. Hamilton. 2012. "Measuring Digital Citizenship: Mobile Access and Broadband." *International Journal of Communication* 6: 2492–528. <https://ijoc.org/index.php/ijoc/article/view/1777/808> (accessed May 10, 2024).
- Novita, R., and R. Widuri. 2019. "Student Satisfaction and Perceived Learning Outcomes in Computerized Audit Course." In *Proceedings of the Sixth International Conference on Research and Innovation in Information Systems (ICRIIS)*, 1–6. Johor Bahru, Malaysia: IEEE. <https://doi.org/10.1109/ICRIIS48246.2019.9073674>.
- Ojo, A. O., C. N. Arasanmi, M. Raman, and C. N. L. Tan. 2019. "Ability, Motivation, Opportunity and Sociodemographic Determinants of Internet Usage in Malaysia." *Information Development* 35 (5): 819–30. <https://doi.org/10.1177/0266666918804859>.
- Prieger, J. E. 2015. "The Broadband Digital Divide and the Benefits of Mobile Broadband for Minorities." *The Journal of Economic Inequality* 13 (3): 373–400. <https://doi.org/10.1007/s10888-015-9296-0>.
- Quaglione, D., N. Matteucci, D. Furia, A. Marra, and C. Pozzi. 2020. "Are Mobile and Fixed Broadband Substitutes or Complements? New Empirical Evidence from Italy and Implications for the Digital Divide Policies." *Socio-Economic Planning Sciences* 71: 100823. <https://doi.org/10.1016/j.seps.2020.100823>.
- Ragnedda, M., and M. Ruiu. 2017. "Social Capital and the Three Levels of Digital Divide." In *Theorizing Digital Divides*. Routledge Advances in Sociology, edited by M. Ragnedda, and G. W. Muschert, 21–34. Abingdon: Taylor & Francis.
- Saha, A., A. Dutta, and R. I. Sifat. 2021. "The Mental Impact of Digital Divide Due to COVID-19 Pandemic Induced Emergency Online Learning at Undergraduate Level: Evidence from Undergraduate Students from Dhaka City." *Journal of Affective Disorders* 294: 170–9. <https://doi.org/10.1016/j.jad.2021.07.045>.
- Salta, K., K. Paschalidou, M. Tsetseri, and D. Koulougliotis. 2022. "Shift from a Traditional to a Distance Learning Environment during the COVID-19 Pandemic: University Students' Engagement and Interactions." *Science & Education* 31 (1): 93–122. <https://doi.org/10.1007/s11191-021-00234-x>.
- Sarstedt, M., J. F. Hair Jr., J. H. Cheah, J. M. Becker, and C. M. Ringle. 2019. "How to Specify, Estimate, and Validate Higher-Order Constructs in PLS-SEM." *Australasian Marketing Journal* 27 (3): 197–211. <https://doi.org/10.1016/j.ausmj.2019.05.003>.
- Sher, A. 2009. "Assessing the Relationship of Student-Instructor and Student-Student Interaction to Student Learning and Satisfaction in Web-Based Online Learning Environment." *The Journal of Interactive Online Learning* 8 (2): 102–20. <https://www.ncolr.org/jiol/issues/pdf/8.2.1.pdf>.
- Soh, P. C., Y. L. Yan, T. S. Ong, and B. H. Teh. 2012. "Digital Divide amongst Urban Youths in Malaysia-Myth or Reality?" *Asian Social Science* 8 (15): 75–85. <https://doi.org/10.5539/ass.v8n15p75>.
- Strong, R., T. L. Irby, J. T. Wynn, and M. M. McClure. 2012. "Investigating Students' Satisfaction with eLearning Courses: The Effect of Learning Environment and Social Presence." *Journal of Agricultural Education* 53 (3): 98–110. <https://doi.org/10.5032/jae.2012.03098>.
- Sun, J. C. Y., and S. E. Metros. 2011. "The Digital Divide and its Impact on Academic Performance." *US-China Education Review A*: 153–61. <https://eric.ed.gov/?id=ED524846> (accessed May 10, 2024).
- Taneja, A., V. Fiore, and B. Fischer. 2015. "Cyber-Slacking in the Classroom: Potential for Digital Distraction in the New Age." *Computers & Education* 82: 141–51. <https://doi.org/10.1016/j.compedu.2014.11.009>.
- The Star. 2020a. "MCO: Impact of Digital Divide Deepens with E-Learning." *The Star*. <https://www.thestar.com.my/news/nation/2020/04/17/mco-impact-of-digital-divide-deepens-with-e-learning> (accessed November 18, 2023).
- The Star. 2020b. "Online Studies: Data and Device Assistance for Higher Education Students." *The Star*. <https://www.thestar.com.my/news/nation/2020/10/30/online-studies-data-and-device-assistance-for-higher-education-studentsn> (accessed November 18, 2023).
- The Star. 2022. "Noraini: 10,000 B40 Students Given Laptops under PerantiSiswa Package." *The Star*. <https://www.thestar.com.my/news/nation/2022/04/14/noraini-10000-b40-students-given-laptops-under-perantisiswa-package> (accessed November 19, 2023).
- The World Bank. 2020. "Covid-19 Coronavirus Response: East Asia and Pacific – Tertiary Education." <https://pubdocs.worldbank.org/en/506241590701178057/EAP-TE-and-COVID-19-FINAL-26May20.pdf> (accessed November 19, 2023).
- Tien, F. F., and T. T. Fu. 2008. "The Correlates of the Digital Divide and Their Impact on College Student Learning." *Computers & Education* 50 (1): 421–36. <https://doi.org/10.1016/j.compedu.2006.07.005>.
- UNESCO. 2020. "COVID-19 and Higher Education: Today and Tomorrow." *UNESCO International Institute for Education in Latin America and the Caribbean*. <https://unesdoc.unesco.org/ark:/48223/pf0000375693?posInSet=1&queryId=af319f22-c0b9-416d-82c9-c9c38e0cd24d> (accessed May 10, 2024).
- Van Deursen, A. J. A. M., E. Helsper, R. Eynon, and J. A. G. M. Van Dijk. 2017. "The Compoundness and Sequentiality of Digital Inequality." *International Journal of Communication* 11: 452–73. <https://ijoc.org/index.php/ijoc/article/view/5739/1911> (accessed May 10, 2024).
- Van Deursen, A. J. A. M., and E. Helsper. 2015. "The Third-Level Digital Divide: Who Benefits Most from Being Online?" In *Communication and Information Technologies Annual: Digital Distinctions and Inequalities*. Studies in Media and Communications, Vol. 10, 29–52. Leeds: Emerald Group Publishing Limited.
- Van Deursen, A. J. A. M., and E. Helsper. 2018. "Collateral Benefits of Internet Use: Explaining the Diverse Outcomes of Engaging with the Internet." *New Media & Society* 20 (7): 2333–51. <https://doi.org/10.1177/146144481771>.
- Van Deursen, A. J. A. M., E. J. Helsper, and R. Eynon. 2014. Measuring Digital Skills: From Digital Skills to Tangible Outcomes. https://research.utwente.nl/files/5139522/Measuring_Digital_Skills.pdf (accessed November 25, 2023).
- Van Deursen, A. J. A. M., and J. A. G. M. Van Dijk. 2013. "The Digital Divide Shifts to Differences in Usage." *New Media & Society* 16 (3): 507–26. <https://doi.org/10.1177/146144481348>.
- Van Deursen, A. J. A. M., and J. A. G. M. Van Dijk. 2015. "Toward a Multifaceted Model of Internet Access for Understanding Digital Divides: An Empirical Investigation." *The Information Society* 31 (5): 379–91. <https://doi.org/10.1080/01972243.2015.1069770>.
- Van Deursen, A. J. A. M., and J. A. G. M. Van Dijk. 2019. "The First-Level Digital Divide Shifts from Inequalities in Physical Access to Inequalities in Material Access." *New Media & Society* 21 (2): 354–75. <https://doi.org/10.1177/1461444818797082>.

- Van Dijk, J. A. G. M. 2006. "Digital Divide Research, Achievements and Shortcomings." *Poetics* 34 (4–5): 221–35. <https://doi.org/10.1016/j.poetic.2006.05.004>.
- Van Dijk, J. A. G. M. 2012. "The Evolution of the Digital Divide: The Digital Divide Turns to Inequality of Skills and Usage." In *Digital Enlightenment Yearbook 2012*, 57–75. Amsterdam: IOS Press. <https://ebooks.iospress.nl/doi/10.3233/978-1-61499-057-4-57>.
- Van Dijk, J. A. G. M. 2017. "Digital Divide: Impact of Access." *The International Encyclopedia of Media Effects*: 1–11. <https://doi.org/10.1002/9781118783764.wbieme0043>.
- Vandoninck, S., L. d'Haenens, and K. Roe. 2013. "Online Risks: Coping Strategies of Less Resilient Children and Teenagers across Europe." *Journal of Children and Media* 7 (1): 60–78. <https://doi.org/10.1080/17482798.2012.739780>.
- Vogels, E., A. Perrin, L. Rainie, and M. Anderson. 2020. "53% of Americans Say the Internet Has Been Essential during the COVID-19 Outbreak: Americans with Lower Incomes are Particularly Likely to Have Concerns Related to the Digital Divide and the Digital Homework Gap." *Pew Research Center*. <https://www.pewresearch.org/internet/2020/04/30/53/> (accessed December 20, 2023).
- Wang, D., T. Zhou, and M. Wang. 2021. "Information and Communication Technology (ICT), Digital Divide and Urbanization: Evidence from Chinese Cities." *Technology in Society* 64: 101516. <https://doi.org/10.1016/j.techsoc.2020.101516>.
- Zhai, X., M. Zhang, M. Li, and X. Zhang. 2019. "Understanding the Relationship between Levels of Mobile Technology Use in High School Physics Classrooms and the Learning Outcome." *British Journal of Educational Technology* 50 (2): 750–66. <https://doi.org/10.1111/bjet.12700>.

Footnotes

- This manuscript is derived from the dissertation authored by the primary contributor, who is also the first author of this manuscript, and a separate publication has already been released based on the content of the dissertation. The respective works are as follows.
- Subramaniam, L. 2023. "Digital Divide among Malaysian Tertiary Students and Its Impact on Online Learning during the Covid-19 Pandemic." MPhil diss., Universiti Tunku Abdul Rahman. <http://eprints.utar.edu.my/5910/> (accessed May 10, 2024).
- Subramaniam, L., F. W. Jalaludin, K. W. Hen, and C. S. Yap. 2023. "The Second and Third Levels of Digital Divide among Malaysian University Students during the Covid-19 Pandemic." *TELKOMNIKA Telecommunication Computing Electronics and Control* 21 (6): 1326–33. <https://doi.org/10.12928/telkomnika.v21i6.25258>.