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The Sequential Levels of the Digital Divide in the Educational Domain Among Indonesian University Students

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Abstract

This research examines the sequential relationships between digital access, digital literacy, digital usage, and educational outcomes in the context of the digital divide in higher education in Indonesia. The study utilizes data from 457 undergraduate students across six urban and rural universities, employing a quantitative survey methodology and applying Partial Least Squares Structural Equation Modeling (PLS-SEM) to analyze the causal pathways. Findings indicate that access, as assessed by device type and duration, significantly improves digital literacy, which subsequently influences educational technology usage patterns and learning outcomes. Communication and content creation skills significantly impact academic performance and satisfaction. The results substantiate a multilevel framework of digital inequality and emphasize the significance of equitable digital engagement beyond simple access. This study provides insights for digital literacy initiatives and educational technology interventions designed to mitigate outcome-based disparities across various geographic and institutional contexts.

Keywords: *Digital access, Digital divide, Digital literacy, Educational outcomes, Higher education*

Introduction

The progression of digital technology has significantly altered almost every aspect of human existence, with education being one of the

most impacted domains (Dogruer et al., 2011). In the contemporary knowledge-driven culture, fair access to digital resources has become a fundamental requirement for effective teaching and learning processes (Nascimbeni & Vosloo, 2019). This transformation has concurrently exacerbated existing inequalities, leading to what scholars term the digital divide, a multifaceted phenomenon that includes disparities in access to digital technology, digital skills, and the ability to achieve significant outcomes from its utilization (Scheerder et al., 2017;Van Dijk, 2017).

Researchers have categorized the digital divide into three progressive tiers: material access (first level), digital skills and usage (second level), and digital outcomes (third level) (van Deursen & van Dijk, 2019). Between 2005 and 2015, studies in digital communication increasingly emphasized how literacy and varied usage habits impede the advantages of mere access(Van Laar et al., 2019). Simply offering internet access or gadgets does not ensure effective utilization, nor does usage inherently lead to personal or academic progress (Scheerder et al., 2017). These levels are intricately linked, creating a continuum in which each step influences the subsequent one, particularly in education, where sophisticated cognitive and creative skills are necessary to convert digital inputs into significant learning results (Halim et al., 2024).

The significance of this three-tiered paradigm became particularly evident during the COVID-19 pandemic, which revealed both infrastructural and competency-related deficiencies in global digital learning (Nash, 2020). In Turkey, students with elevated digital literacy necessitated low support for online education (Karagul et al., 2021). In contrast, students from lower socioeconomic backgrounds or rural areas, as evidenced by research from Poland, South Korea, and India, often faced challenges related to access and digital competency (Juszczyk & Kim, 2022). Comparable phenomena are probably widespread in Indonesia, however they remain inadequately examined in higher education contexts (Hidayat, 2025).

Comprehending the interrelationship among the three tiers of the digital divide is especially vital within the framework of Indonesian higher education (Ika Sari et al., 2024). Despite the significant rise in internet penetration, reaching 79.5% in early 2024 according to APJII (2024), and the launch of extensive digital literacy programs such as the Gerakan Nasional Literasi Digital (GNLD), most interventions still focus on

improving basic access and awareness (Hidayat, 2024). Notwithstanding the continuous improvement of Indonesia's Digital Literacy Index (Ministry of Communications and Informatics, 2022), a substantial implementation gap persists. Modern programs often emphasize superficial digital skills, overlooking the essential abilities of critical analysis, information evaluation, and content creation necessary for achieving educational goals in digital environments (Morissan, 2020).

This discord has significant ramifications. Narrowly focused digital policies on access or basic skills do not equip students to be autonomous, strategic, and critically engaged technology users (van Deursen & Helsper, 2015). This risks perpetuating educational inequality, as only students with pre-existing advantages such as metropolitan location, high socioeconomic status, or institutional support can effectively utilize digital technologies for academic success (Vodă et al., 2022). Consequently, examining the sequential framework of the digital divide in the educational sector is crucial (van de Werfhorst et al., 2022). It offers a detailed perspective to pinpoint the locations of failures and how institutions might intervene comprehensively (UNESCO, 2019).

In light of the scarcity of extensive studies on this matter in Indonesia, the current research aims to solve this empirical and contextual deficiency by employing a three-tiered sequential framework to analyze the digital divide in Indonesian higher education (Helmiatin et al., 2024). This study examines the structural links between access, literacy, digital usage, and educational attainment among university students. This contribution is theoretically sound and practically significant, since it aids in the formulation of inclusive, evidence-based digital education strategies for poor nations.

Research Method

This research seeks to assess the levels of digital literacy, e-learning utilization, and e-learning outcomes among university students in Indonesia, while examining the impact of social disparities on these factors in both urban and rural settings. A quantitative approach utilizing a survey method was employed to gather generalizable data that reflects the wider student population. The survey aimed to provide an overview of the contribution of internet use to academic life across various social and geographical backgrounds.

The target population comprised students from six higher education institutions, selected both purposively and randomly to ensure variation in regional distribution and institutional status. This included two public universities (PTN) and four private universities (PTS) situated in urban (DKI Jakarta) and non-urban (West Java) areas. The selection of these six universities aimed to represent varying levels of digital infrastructure, which are expected to impact the digital divide among students. The research utilized a multistage cluster sampling method based on the principles of probability sampling. Academic programs within each university were categorized as clusters, and students were randomly chosen from active enrollment lists during the even semester of the 2023/2024 academic year. A total of 457 valid responses were collected, with 59.7% from urban students and 40.3% from rural students, ensuring balanced regional representation.

The research instrument comprised a structured questionnaire that included four primary constructs: digital access (5 items), digital literacy (22 items), digital usage (12 items), and educational outcomes (13 items). All constructs were validated using Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA). The findings indicated that all subdimensions attained Cronbach's alpha values exceeding 0.80, signifying a strong level of internal consistency and reliability.

The data's distributional characteristics were evaluated through skewness and kurtosis analyses, revealing a non-normal distribution for multiple variables. Partial Least Squares Structural Equation Modeling (PLS-SEM) was utilized to evaluate the structural model (Edeh et al., 2023). PLS-SEM was selected due to its effectiveness in managing non-normal data, multiple latent constructs, and intricate structural relationships, rendering it especially appropriate for exploratory research with a predictive focus (Hair, Jr. et al., 2022).

The demographic variables encompassed gender, age, residence (urban or rural), parental socioeconomic status, and institutional affiliation. The demographic distribution of the respondents is summarized in Table 1. The findings are organized into two primary sections: the first part provides descriptive statistics that encapsulate participant demographics and digital behavior patterns, while the second part involves inferential analyses employing PLS-SEM to evaluate the proposed model.

Table 1. Distribution of Respondents Demography (n=457)

Variable	Item	Frequency	%
Gender	Male	218	47.7
	Female	239	52.3
Age	< 27 years (Gen-Z)	447	97.8
	>27 years (Gen Y)	10	2.2
Residences	Urban	273	59.7
	Rural	184	40.3
Universities	*Universitas Negeri Jakarta*	52	11.4
	Universitas Pancasila	97	21.2
	Universitas Nasional	65	14.2
	Universitas Siliwangi	87	19
	Universitas Galuh	74	16.2
	Universitas Perjuangan 45	82	17.9
Parents' SES (Rupiah)	*Not fix income*	94	20.6
	< 2 Juta	82	17.9
	2, 01 juta - 4 juta	117	25.6
	4, 01 juta - 6 juta	87	19
	6, 01 juta - 10 juta	46	10.1
	> 10 juta	31	6.8

The demographic characteristics of the 457 student participants in this study are outlined in Table 1. The distribution of gender among respondents shows a fairly even split, with 47.7% identifying as male and 52.3% as female. The generational composition reveals that a significant majority (97.8%) are members of Generation Z (under 27 years), whereas a mere 2.2% are from Generation Y (over 27 years). This suggests that the sample primarily represents the digital-native group actively participating in undergraduate education.

In terms of residential background, 59.7% of students live in urban areas, whereas 40.3% originate from rural regions, enabling the study to encompass viewpoints from a variety of geographic and infrastructural contexts. The urban–rural composition holds significant importance in examining digital access and usage patterns, especially considering the infrastructural disparities commonly observed in these areas of Indonesia.

The distribution across institutions reveals participation from six higher education entities: Universitas Negeri Jakarta (11.4%), Universitas Pancasila (21.2%), Universitas Nasional (14.2%), Universitas Siliwangi

(19.0%), Universitas Galuh (16.2%), and Universitas Perjuangan 45 (17.9%). This distribution guarantees a well-rounded representation of students from both public and private universities, along with those from institutions situated in capital and non-capital areas.

The data indicate significant variation concerning parental socioeconomic status. About 20.6% of students indicated that their parents lack a stable income, whereas 17.9% have parents who earn below 2 million rupiah each month. The highest percentage, at 25.6%, is observed in the range of 2.01 to 4 million rupiah. At the same time, 19.0% indicated that their family incomes ranged from 4.01 to 6 million, 10.1% reported incomes between 6.01 and 10 million, while merely 6.8% of students disclosed parental incomes surpassing 10 million rupiah on a monthly basis. This income distribution highlights the necessity of examining socioeconomic disparities when analyzing digital divide issues, especially concerning material access, device ownership, and the quality of digital engagement.

The demographic profile of respondents in this study offers a solid basis for examining differences in digital access, literacy, and educational outcomes across various socio-demographic factors pertinent to higher education in Indonesia.

Study instrument

This study used Google Forms to administer a structured questionnaire to answer four research topics. Demographics and four digital divide constructs digital access, digital literacy, educational usage, and educational outcomes were assessed in the instrument. Digital access was measured by internet usage length and frequency, normal access times, physical locations, connectivity and maintenance expenses, and the types of digital devices used. The indices included main digital divide material and infrastructural elements.

Twenty-two items from digital skills literature assessed second-level digital literacy. These items were exploratory factor analyzed to identify their hidden structure. The study showed strong construct adequacy, as shown by a KMO value of .951 and a significant Bartlett's Test of Sphericity ($\chi^2 = 9864.756$, $p < .001$). Technical and operational competence, information navigation and processing, communication and interaction fluency, and creative content development were found to be

related. High composite reliability ratings indicated strong internal consistency in each area.

Twelve elements were used to assess educational usage, representing how students use digital resources in academic settings. Communication with peers and lecturers, information-seeking, and deeper interactions like exploratory learning and task-specific digital inquiry were included. Exploratory factor analysis confirmed the construct's multidimensionality (KMO = .896, Bartlett's test = χ^2 = 3734.978, $p < .001$), identifying three coherent subdimensions.

The questionnaire analyzed educational outcomes by measuring achievement, such as perceived academic performance and productivity increases, and satisfaction, specifically with communication quality and informational adequacy. The factor analysis revealed that achievement was a unidimensional construct (KMO = .951; χ^2 = 9864.756, $p < .001$). In contrast, satisfaction showed a two-factor structure, distinguishing communication and information satisfaction (KMO = .921; χ^2 = 3716.016, $p < .001$). Composite reliability levels exceeded criteria for all components.

After factor analysis, SmartPLS software validated measurement model validity and reliability. Partial Least Squares Structural Equation Modeling (PLS-SEM) was chosen for its capacity to handle complex models with numerous latent components, non-normal data, and modest sample sizes. This strategy is ideal for prediction-oriented investigations like the current one, which investigates sequential causal linkages across three digital divide theoretical levels. The model evaluation showed all constructs had sufficient psychometric characteristics. Each latent variable met Hair et al. (2022) standards for Average Variance Extracted (AVE) values above 0.50 and Composite Reliability (CR) scores above 0.70. The results confirm the instrument's reliability and validity, providing a solid empirical foundation for assessing the structural model (table 2).

Table 2. Analysis for model fit based on the value of AVE and CR

Variables	Average Variance Extracted (AVE)	Composite Reliability (CR)
Duration of Access	1.000	1.000
Time for Access	0.684	0.915
Place for Access	1.000	1.000
Cost for Access	1.000	1.000

Device for Access	0.653	0.790
TOS	0.748	0.937
INPS	0.741	0.945
CIS	0.781	0.947
CCPS	0.720	0.939
Usage for Communication	0.759	0.926
Usage for Information Seeking	0.701	0.932
Usage for Information Digging	0.683	0.866
Achievement Outcomes	0.799	0.975
Satisfaction of Communication	0.700	0.942
Satisfaction of Information	0.768	0.908

Research Design and Analytical Procedures

The analysis was conducted in two primary phases to ensure descriptive clarity and strong inferential validity. In the preliminary stage, descriptive statistics were computed using IBM SPSS to assess the distributional characteristics, central tendencies, and variability of each observed variable. This procedure facilitated a fundamental comprehension of respondent profiles, especially concerning digital access, skill development, educational technology usage patterns, and perceived learning outcomes. The initial insights were crucial for contextualizing the latent constructs and guiding the subsequent steps in model estimation.

The second phase of analysis utilized Partial Least Squares Structural Equation Modeling (PLS-SEM), conducted via SmartPLS software, to examine the proposed sequential relationships among the three levels of the digital divide: digital access, digital literacy, and educational outcomes. PLS-SEM was chosen due to its effectiveness in managing multiple interrelated latent variables and its resilience to non-normal data distributions. PLS-SEM is notably effective for modeling complex predictive frameworks in under theorized domains, such as digital inequality in Indonesian higher education, in contrast to covariance-based SEM.

This study employed a multistep methodological sequence to maintain systematic coherence from conceptualization to statistical modeling, integrating both theoretical design and empirical execution. Each stage, including construct development, instrument validation, multistage probability sampling, and structural model analysis, was designed to uphold methodological rigor and ensure data integrity. Figure

1 illustrates the complete research workflow, delineating the logical progression of the study. This encompasses the establishment of objectives, development of constructs based on literature, design of instruments, procedures for sampling, data collection and cleaning, statistical analysis, and final interpretation. The diagram illustrates the progression of research activities and situates the analytical strategy within the broader multilevel digital divide framework, based on Van Dijk's theory, wherein digital access influences skills, usage, and ultimately academic outcomes.

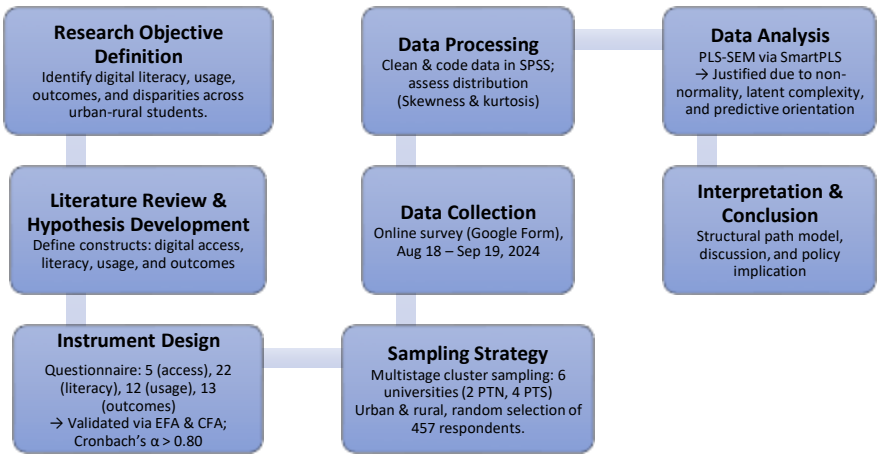

Figure 1. Research Procedure Flowchart

Results and Discussion

Descriptive Analysis of Digital Access

This investigation aimed to empirically explore the sequential connections among the three dimensions of the digital divide specifically, access, digital skills, and digital outcomes within the framework of higher education in Indonesia. Based on established digital inequality frameworks, this study examines whether these levels operate in a progressive, interdependent way, ultimately influencing students' educational engagement and learning outcomes in a digital context.

The initial inquiry concentrated on assessing students' digital access levels, examining factors such as internet affordability, duration of usage, timing of access, locations of access, and the types of devices employed. Table 3 illustrates that a significant percentage of respondents (45.7%) indicated they spend between IDR 51,000 and 100,000 monthly on mobile

data packages, highlighting a considerable dependence on personal funding for internet access instead of institutional support. Furthermore, over half of the participants (55.6%) indicated that they accessed the internet for more than six hours each day, while an additional 26.7% reported using the internet for four to six hours daily. The results indicate a significant degree of digital involvement among students regarding the duration of their online activities.

Nonetheless, the financial implications tied to maintaining constant connectivity particularly the reliance on data packages underscore persistent structural challenges regarding equitable internet access. The dependence on mobile data highlights infrastructural inequalities, especially in situations where reliable broadband or campus-based Wi-Fi is scarce or not fully utilized. The findings indicate that Indonesian university students engage in frequent and prolonged internet usage; however, their access is contingent upon costs and the devices they use, placing them within a nuanced first-level digital divide.

Table 3. Distribution of Cost and Duration for Accees to Internet (n=457)

Variable	Item	Frequency	%
Cost for Access Internet (a month)	Don't Buy	10	2.2
	Less than 50.000 rupiah	79	17.3
	51.000-100.000 rupiah	209	45.7
	101.000-200.000 rupiah	86	18.8
	201.000-300.000 rupiah	43	9.4
	More than 300.000 rupiah	30	6.6
Durarion of use (a day)	Less than 1 hour	3	0.7
	1 to 2 hours	15	3.3
	2 to 4 hours	63	13.8
	4-6 hours	122	26.7
	More than 6 hours	254	55.6

Additional understanding of digital access patterns was achieved through the examination of the temporal, spatial, and technological aspects of students' internet usage, as outlined in Table 4. The results indicate that the main period for internet usage among Indonesian university students occurs between 10:01 AM and 9:00 PM, demonstrating

significant connectivity during both academic and social activities throughout the day. This temporal pattern corresponds with standard university schedules and highlights the importance of internet use in both academic involvement and everyday activities.

The data reveals that most students utilize home Wi-Fi to access the internet, suggesting that home environments are the main venues for digital interaction. The availability of campus Wi-Fi has been noted, yet its usage appears to be only moderate, indicating possible constraints in infrastructure, accessibility, or reliability within the institutional environment. This finding supports the previous observation that students predominantly depend on self-provided connectivity, especially in non-metropolitan regions where university-based digital infrastructure might be inconsistently available or lacking in development.

The data indicate that students predominantly use smartphones and laptops for internet connectivity. Smartphones are widely used for various academic and personal online activities, whereas laptops are crucial for more intricate tasks like preparing assignments, creating content, and accessing learning management systems. The simultaneous dependence on these devices illustrates both practical need and the blended characteristics of modern digital learning settings.

Collectively, these findings provide a detailed insight into the ways Indonesian students engage with digital resources, emphasizing the significance of time flexibility, private infrastructure, and mobile technologies in influencing their digital experiences. This has significant implications for crafting inclusive digital learning policies and establishing institutional support systems to address infrastructure-related disparities in access has been shown in Table 4.

Table 4. Distribution of Device, Place, and Timing for Accees to Internet (n=457)

Variable/ Item	Never (%)	Rarely (%)	Fairly often (%)	Often (%)	Very often (%)	Mean	STD	Level
Timing for Access								
00.01 am to 05 am	22.8	53	14.2	7.4	2.6	2.14	.941	Moderat

Variable/ Item	Never (%)	Rarely (%)	Fairly often (%)	Often (%)	Very often (%)	Mean	STD	Level
05.01 am to 07 am	10.3	55.4	22.5	7.7	4.2	2.40	.922	Moderat
07.01 am to 10 am	1.8	23.6	39.4	24.7	10.5	3.19	.970	Moderat
10.01 am to 12.00 am	0.9	12.3	37.6	34.4	14.9	3.50	.920	High
00.01 pm to 1 pm	1.3	12.9	32.4	35.7	17.7	3.56	.970	High
1.01 pm to 3 pm	1.3	14.2	33.9	34.4	16.2	3.50	.969	High
3.01 pm to 5 pm	1.3	16.4	30	35.2	17.1	3.50	1.00	High
5.01 pm to 7 pm	1.3	15.3	29.1	33.3	21	3.57	1.02	High
7.01 pm to 9 pm	0.7	7.9	27.6	36.5	27.4	3.82	.945	High
9.01 pm to 12.00 pm	3.1	28.9	23	30	15.1	3.25	1.12	Moderat
Place for Access								
Wifi at home	19.7	4.6	5.7	24.9	45.1	3.71	1.54	High
Wifi at coffee	20.1	38.5	26.7	12	2.6	2.39	1.02	Moderat
Wifi at office	56.2	15.1	12.7	9.4	6.6	1.95	1.28	Moderat
Wifi at university	8.1	32.8	13.6	33.7	11.8	3.08	1.20	Moderat
Wifi at “warnet”	54.3	20.1	20.1	3.9	1.5	1.78	.997	Moderat
Wherever (by quota)	2.6	11.6	1.5	35.9	48.4	4.16	1.08	High
Device								
Dekstop	75.5	4.6	8.3	7.4	4.2	1.06	1.50	Low
Laptop	16	5.7	20.4	35.7	22.3	3.34	1.50	High
Smartphone	2	2	4.4	78.1	13.6	3.99	.69	High

Variable/ Item	Never (%)	Rarely (%)	Fairly often (%)	Often (%)	Very often (%)	Mean	STD	Level
Tablet	84.9	2.2	2.2	5	3.7	0.71	1.36	Low
Game Console	85.3	3.7	3.9	3.7	3.3	0.67	1.28	Low

Descriptive Analysis of Digital Literacy

The second stage of the analysis focuses on assessing the digital literacy and educational usage among university students in Indonesia. Descriptive statistics, such as means and standard deviations, were utilized to analyze students' proficiency across four fundamental dimensions of digital literacy, as established through exploratory factor analysis.

Table 5 illustrates that the first dimension, Technical and Operational Skills (TOS) includes five items that evaluate students' fundamental technological competencies, including device operation and interface navigation. The results for this dimension showed a mean score of 4.04 on a 5-point Likert scale, categorizing it clearly within the high proficiency range. The second dimension, Information Navigation and Processing Skills (INPS), assessed through six items, indicates students' capability to locate, evaluate, and synthesize digital information. This dimension achieved a notable mean of 3.73, reflecting a robust level of competency, albeit slightly lower than that of TOS.

The third component, Communication and Interaction Skills (CIS), assesses how well students can participate in online discussions, collaborate via digital platforms, and utilize communication tools effectively. The mean score of 4.13 indicates that this dimension stands out as the highest, highlighting students' proficiency in utilizing digital tools for both interpersonal and academic communication. The final dimension encompasses the skills related to content creation and production, highlighting students' capabilities to generate, modify, and share multimedia or textual content. This dimension attained a notable category rating, with a mean of 3.82, suggesting that students engage not only as consumers of digital information but also as active content creators.

Collectively, these findings confirm that Indonesian university students demonstrate consistently elevated levels of digital literacy across all four dimensions. Although technical and communication skills seem

to be the most prominent strengths, students also exhibit impressive abilities in information processing and content creation. This extensive digital skill set enables individuals to maneuver through intricate online landscapes and interact effectively with educational technologies. The results of this study are crucial for comprehending the impact of digital readiness on the efficacy of technology-mediated learning, as well as for guiding specific interventions aimed at improving skills in higher education environments.

Table 5. Level of Digital Literacy Among Indonesia Student (n=457)

No	Indikator	Mean	SD	Level
Digital Literacy		**3.74**	**.64**	**High**
Technical and operational Skills (TOS)		**4.04**	**.74**	**High**
1	I know about how to customize privacy settings	4.05	.82	High
2	I know how to turn off location settings on my mobile device (smartphone)	4.16	.84	High
3	I know how to protect my device (e.g. PIN, screen pattern, fingerprint, facial recognition)	4.28	.78	High
4	I know how to store photos, documents, contacts or other files in the cloud (e.g. Google Drive, iCloud)	4.25	.82	High
5	I know how to block pop-up messages or unwanted ads	3.89	1	High
Information Navigation and Processing Skills (IVPS)		**3.73**	**.80**	**High**
6	I know how to choose the best keywords for online searches	3.74	.87	High
7	I know how to find websites I've visited before	3.92	.89	High
8	I know how to find information on websites regardless of design	3.62	.99	High
9	I know how to use advanced search functions in search engines	3.70	1.02	High
10	I know how to check if the information I find online is correct	3.72	.91	High
11	I know how to tell if a site is trustworthy	3.68	.92	High

No	Indikator	Mean	SD	Level
Communication and Interactional Skills		**4.13**	**.74**	**High**
12	Depending on the situation, I know which medium/tool to use to communicate with someone (calling, WhatsApp messaging, emailing)	4.18	.82	High
13	I know when to mute my voice or turn off video in online interactions	4.17	.81	High
14	I know which images and information I can share online	4.19	.79	High
15	I know when it is appropriate and inappropriate to use emoticons (e.g. smileys, emojis), text greetings (e.g. LOL, OMG) and capital letters	4.13	.83	High
16	I know how to report negative content related to me or the group I am a part of.	3.99*	.96	High
Content Creation and Production Skills		**3.82**	**.79**	**High**
17	I know how to create something that combines various digital media (photo, music, video, gift)	3.94	.86	High
18	I know how to edit existing digital images, music, and videos	3.93	.86	High
19	I know how to make sure that many people will see what I put online	3.73	.98	High
20	I know how to change the things I upload/post online depending on how others react to them	3.69	1.03	High
21	I know how to differentiate between sponsored and non-sponsored content online (social media posts)	3.91	.905	High
22	I know how to reference and use copyrighted content	3.72	.94	High

The results concerning the use of educational technology are illustrated in Table 6 and are categorized into three specific dimensions: communication, information seeking, and information exploration. Every dimension encapsulates a distinct facet of student interaction with digital tools in relation to their academic pursuits.

The initial dimension, employed for communication, was evaluated through four items that examine students' use of digital platforms for engaging with peers, lecturers, or academic communities. The analysis produced a mean score of 3.56, reflecting a significant degree of engagement. The second dimension, information seeking, included five items aimed at assessing students' initiatives to find academic content, references, and supporting materials online. This dimension received a strong score, with a mean of 3.71, indicating that students demonstrate proficiency in utilizing digital resources to enhance their academic inquiry and research activities.

Conversely, the third dimension, information digging, signifies a more profound and thorough investigation of digital content encompassing the assessment of credibility, triangulation of information, or participation in self-directed learning. It was assessed through three items, yielding mean scores between 2.46 and 3.17, with an overall mean of 2.87. This suggests a moderate level of proficiency, indicating that although students can perform basic information retrieval, their ability for more advanced critical digital engagement is still somewhat restricted. When considered together, these findings indicate that Indonesian university students demonstrate a significant engagement with educational technology, especially in areas concerning communication and information retrieval. Nonetheless, the comparatively moderate scores in the area of information exploration indicate a possible developmental gap in critical digital literacy, an aspect that requires additional educational focus and instructional assistance.

These findings further validate and build upon previous studies regarding digital literacy in Indonesia. The findings of the present study align with the 2022 national survey conducted by the Ministry of Communication and Information of the Republic of Indonesia, which indicated a national digital literacy index score of 3.52 (Bulya & Izzati, 2024). This study not only supports the current national trends but also offers a detailed examination of the ways in which digital literacy and usage are expressed in various educational settings. This highlights the necessity for focused approaches to enhance students' analytical and critical interaction with digital content within the context of wider educational reforms in the digital age.

Table 6. Level of Education Usage Among Indonesia Student (n=457)

No	Indicators	Mean	SD	Level
Education Usage		**3.45**	**.71**	**High**
Use for Communication		**3.56**	**.81**	**High**
1	Discuss assignments with friends	3.68	.92	High
2	Discuss with friends about lecture material	3.53	.96	High
3	Share references about lecture materials with friend	3.57	.93	High
4	Ask friends for lecture material	3.49	.93	High
Use for Information Seeking		**3.71***	**.78**	**High**
5	Search for information to complete tasks	3.92*	.84	High
6	Searching for materials to do coursework	3.95*	.84	High
7	Downloading e-books for lecture materials	3.45	1.07	High
8	Search for references on YouTube for lecture materials	3.55	.99	High
9	Downloading articles for coursework	3.68	.92	High
Use for Information Digging		**2.87**	**.95**	**Moderat**
10	Searching for video tutorials to use Ms. Office	3.17	1.11	Moderat
11	Requesting lecture materials from lecturers	2.99	1.10	Moderat
12	Ask the campus staff for the class schedule	2.46	1.21	Moderat

Educational Outcomes in the Digital Context

The third research question sought to evaluate the educational outcomes of university students resulting from their digital engagement. This construct was defined by two primary dimensions: achievement and satisfaction, which collectively offer a thorough assessment of perceived academic benefits in a digitally mediated learning environment. Table 7 presents the achievement dimension, assessed via ten items, which resulted in a mean score of 4.08 on a 5-point Likert scale. The high score indicates a strong consensus among students regarding academic improvement, increased productivity, enhanced learning efficiency, and improved access to educational resources facilitated by digital technology. The significant level of perceived achievement indicates that students engage with digital tools and derive measurable educational benefits from their use.

The data on achievement alone provide compelling evidence that digital literacy and usage are positively associated with educational performance outcomes, although the satisfaction dimension is not yet detailed here. The findings support the third-level digital divide theory, which highlights the importance of not only access and usage but also the benefits and outcomes derived from digital engagement (Van Deursen & Helsper, 2018). Achievement serves as a functional indicator of the educational value obtained from digital practices.

The consistently high levels of self-reported achievement among students indicate that digital inclusion in higher education should extend beyond infrastructure and skill development to prioritize the enhancement of learning outcomes. This study documents positive perceptions that underscore the potential of digital integration to improve academic quality and student success, particularly when bolstered by appropriate institutional policies and learning strategies. An analysis of the satisfaction dimension will be presented, facilitating a comprehensive interpretation of student evaluations of their digital learning experiences in both cognitive and affective domains.

Table 7. Level of Achievement Outcomes on Education Among Indonesia Student (n=457)

No	Indicators	Mean	Std.	Level
Achievement		**4.08***	**.70**	High
1	The internet makes it easier for me to discuss with friends	4.11*	.79	High
2	The internet helps me to find lecture materials	4.13*	.79	High
3	The internet helps me to explain lecture material to my friends	3.98*	.79	High
4	The Internet helps me to attend lectures anywhere	4.13*	.78	High
5	The internet makes it easier for me to complete my assignments	4.19*	.77	High
6	The internet makes it easy for me to get sources of reading material for lectures	4.18	.75	High
7	The platform available on the internet helps me complete my assignments on time.	4.08	.79	High

No	Indicators	Mean	Std.	Level
8	The resources I get from the internet help me understand course material	4.06	.77	High
9	The internet helps me get clear information from lecturers regarding class schedules, assignments, group assignments, and course materials.	4.11	.77	High
10	The internet makes it easy for me to get the information I need from campus staff.	3.90	.86	High

The evaluation of educational outcomes continued with the assessment of satisfaction as the second dimension, which was analyzed through two sub-components: communication satisfaction and information-seeking satisfaction, as detailed in Table 8. The dimensions represent students' emotional assessments of their digital learning experiences, supplementing the previously discussed cognitive aspect of achievement.

The communication satisfaction sub-dimension, assessed via seven items, produced a mean score of 3.24, categorizing it as moderate. This finding indicates that although students utilize digital communication for educational objectives, their satisfaction with the quality, clarity, or effectiveness of these interactions is limited. Factors contributing to this issue may encompass constraints in platform usability, diminished immediacy in online interactions, or challenges associated with asynchronous communication that reduce perceived satisfaction.

Conversely, information-seeking satisfaction, assessed via three items, exhibited a high level, with a mean score of 3.61. This suggests that students are typically content with their capacity to find, access, and employ academic information in digital contexts. The satisfaction observed may arise from enhanced familiarity with search strategies, broader access to digital repositories, and increased autonomy in navigating educational content.

Collectively, these findings offer a detailed understanding of students' educational outcomes in digitally mediated environments. The third research question can be addressed by concluding that Indonesian university students report high levels of achievement and satisfaction with information-seeking activities, while their satisfaction with digital

academic communication remains moderate. This discrepancy indicates a potential area for improvement in pedagogy and technology, especially in developing more engaging and interactive digital communication channels in higher education (Van Deursen et al., 2014).

The results have significant implications for the third level of the digital divide, which emphasizes internet outcomes the concrete and subjective advantages individuals gain from digital engagement. Students demonstrate significant cognitive gains and enhanced informational empowerment; however, advancements in digital communication design and pedagogy could further enhance their affective experiences and promote comprehensive digital inclusion.

Table 8. Level of Satisfaction Outcomes on Education Among Indonesia Student (n=457)

No	Indicators	Mean	Std.	Level
Satisfaction		**3.35**	**.67**	High
Satisfaction of Communication		**3.24**	**.72**	**Moderat**
1	Your online communication with friends about coursework? (compared to offline communication you might have)	3.31	.83	High
2	Your online discussions with friends for coursework	3.37	.83	High
3	Your online discussions with friends about course materials (compared to offline discussions you might have)	3.25	.85	Moderat
4	Online discussions with lecturers about course materials (compared to offline discussions)	3.14	.85	Moderat
5	Online lectures (compared to offline lectures)	3.04	.92	Moderat
6	Information you get from campus staff online (compared to information you might get offline)	3.29	.87	Moderat
7	Lecture materials from lecturers obtained online versus offline	3.32	.85	Moderat
Satisfaction of Information		**3.61**	**.70**	**High**
8	Assignments you completed from sources or references obtained online	3.67	.78	High

No	Indicators	Mean	Std.	Level
9	Sources of reading obtained online to be used as references	3.72	.78	High
10	Answers you receive from lecturers to questions you ask lecturers online regarding class schedules, assignments, groups or lecture materials.	3.46	.83	High

Structural Model Evaluation

This section analyzes the structural relationships between digital access, digital literacy, and educational outcomes through the application of PLS-SEM. The analysis employed a sequential framework grounded in theoretical models of the digital divide, operationalized via path coefficient estimates, t-statistics, and significance thresholds ($p < .05$). The findings indicate a multi-level progression: access facilitates skill development, which subsequently promotes meaningful digital use, ultimately resulting in educational improvements, as can be shown in table 9.

Table 9. Path Analysis Results of First, Second, and Third Levels of Digital Divide

Descriptions	Beta Coefficient	*t-Value*	*p-Value*	*Decissions*
Cost of Services → TOS	-0.064	1.325	0.186	Non-supported
Cost of Services → INPS	0.014	0.361	0.718	Non-supported
Duration of Access →TOS	0.012	0.224	0.807	Non-supported
Duration of Access → INPS	-0.045	1.196	0.222	Non-supported
Place of Access → TOS	0.049	1.020	0.308	Non-supported
Place of Access → INPS	0.010	0.275	0.783	Non-supported
Time of Access → TOS	0.231	4.489	0.000	Supported
Time of Access → INPS	0.071	1.731	0.084	Non-supported

Descriptions	**Beta Coefficient**	***t-Value***	***p-Value***	***Decissions***
Device (Laptop & Smartphone) → TOS	0.206	3.224	0.001	Supported
Device (Laptop & Smartphone) → INPS	0.090	1.969	0.049	Supported
TOS → INPS	0.602	13.450	0.000	Supported
TOS → CIS	0.494	6.498	0.000	Supported
TOS → CCPS	0.078	1.494	0.108	Non-supported
INPS → CIS	0.303	3.760	0.000	Supported
INPS → CCPS	0.448	9.485	0.000	Supported
CIS → CCPS	0.384	6.921	0.000	Supported
CIS → Use for Communication	0.120	1.811	0.071	Non-supported
CIS → Use for Inform Seeking	0.280	4.550	0.000	Supported
CIS → Use for Inform Digging	-0.035	0.486	0.627	Non-supported
CCPS → Use for Communication	0.245	3.833	0.000	Supported
CCPS → Use for Inform Seeking	0.247	4.147	0.000	Supported
CCPS → Use for Inform Digging	0.279	3.831	0.000	Supported
Use for Communication → Achivement	0.153	2.814	0.005	Supported
Use for Communication → SC	0.043	0.669	0.504	Non-supported
Use for Communication → SI	0.008	0.115	0.909	Non-supported
Use for Inform Seeking → Achivement	0.525	9.265	0.000	Supported
Use for Inform Seeking → SC	0.244	4.411	0.000	Supported
Use for Inform Seeking → SID	0.502	8.837	0.000	Supported
Use for Inform Digging → Achivement	-0.071	1.646	0.100	Non-supported

Descriptions	**Beta Coefficient**	***t-Value***	***p-Value***	***Decissions***
Use for Inform Digging → SC	0.128	2.233	0.026	Supported
Use for Inform Digging → SI	-0.059	1.087	0.277	Non-supported

Digital literacy is predicted by time of access (β = 0.231, p < .001) and device usage (e.g. computers and cellphones) (β = 0.206 for TOS; β = 0.090 for INPS). The data show that access affects productivity, but frequent access and adaptable devices improve key digital skills, particularly TOS and INPS.

At the second level, digital skills are interconnected, forming a progression. TOS significantly predicts INPS (β = 0.602) and CIS (β = 0.494). In addition, INPS improves CIS (β = 0.303) and CCPS (β = 0.448). The findings confirm theoretical hypotheses that essential operational competences enable advanced literacies like digital cooperation and creative output.

Literacy to application is also aided. CIS restricts its function to predicting information seeking (β = 0.280), but CCPS has a wider impact. The study found that content creation skill significantly predicts communication use (β = 0.245), information searching (β = 0.247), and information digging (β = 0.279) in academic digital engagement.

Third-level learning results vary with digital use. While communication is strongly connected with academic achievement (β = 0.153), it does not significantly impact satisfaction. In contrast, information seeking predicts achievement (β = 0.525) and satisfaction outcomes (communication (SC) = 0.244 and information satisfaction (SI) = 0.502). Information digging somewhat improves communication satisfaction (β = 0.128) but does not impact other outcomes. Research shows that deeper, goal-oriented digital activities, especially information search, improve cognitive and affective learning.

The validated model supports the cumulative digital inclusion framework. Time and device affect fundamental abilities that become advanced literacies and instructional technology use. Learning improves greatly with this use. Figure 2 shows statistically confirmed process routes.

These findings demonstrate the sequential nature of the digital divide and help create more fair digital learning environments.

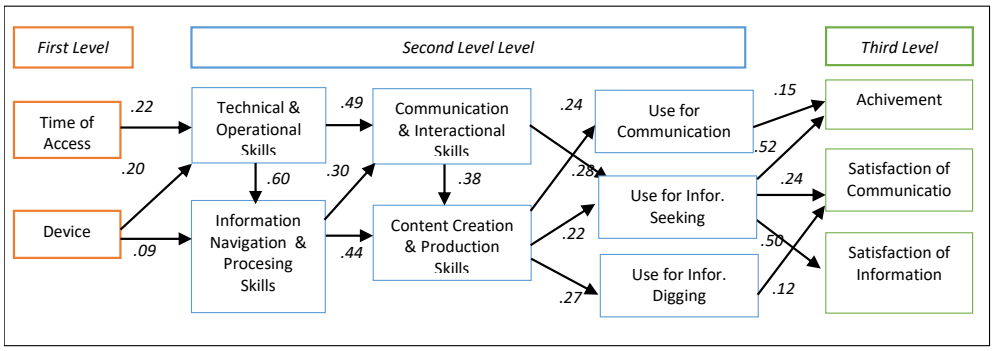

Figure 2: Educational outcomes model

Note. Path are significant at .05; nonsignificant paths are not showen.

Figure 2. Validated Structural Model of the Digital Divide

Discussion of Key Findings

This investigation aimed to examine the potential sequential relationship among the levels of the digital divide, access, digital literacy, and educational outcomes within the framework of higher education in Indonesia (Calderón Gómez, 2021). The empirical findings support this theoretical proposition, showing that digital inclusion operates as a cascading process, with each level having a significant impact on the subsequent one. This study enhances and reinforces the foundational model put forth by Helsper et,al (2020), while also providing fresh perspectives that contextualize and broaden the theory within a Global South framework.

This study makes a significant contribution through its detailed examination of variables related to the second-level digital divide. While earlier studies mainly highlighted creative skills as the key to digital use (Van Deursen & Helsper, 2018), this investigation revealed that communication and interaction skills, in addition to content creation abilities, are crucial in influencing students' engagement with digital tools for educational purposes. The results indicate that within the Indonesian academic environment, marked by cultural collectivism and a rise in digital mobility, the importance of interpersonal digital fluency is on par with individual creativity for effective technology utilization (Tsetsi & Rains, 2017).

The structural analysis elucidated the mechanisms by which these skills impact educational outcomes (Sultanova et al., 2024). Students demonstrating robust communication and content creation abilities tend to engage more actively in digital communication and information-seeking activities, which subsequently aligns with improved academic performance and overall satisfaction. Educational achievement is notably influenced by communication skills and the ability to extract information, with the latter demanding not just creativity but also strong interpersonal and collaborative abilities (Halim et al., 2025). In the meantime, the level of satisfaction regarding communication and the retrieval of information is closely associated with the extent to which students engage in information-seeking activities. This underscores the idea that the third level digital divide extends beyond mere access or capability; it emphasizes the importance of achieving equitable outcomes, ensuring that every student gains both tangible and emotional advantages from engaging with digital resources.

The implications of these findings hold considerable importance. Their findings highlight that the government's efforts in advancing digital literacy are still ongoing and require further attention. This study highlights that, despite the National Digital Literacy Movement's significant advancements in raising awareness and developing basic skills, merely achieving surface-level competencies is inadequate for guaranteeing equitable digital outcomes in higher education. There is a pressing requirement to enhance students' ability to utilize digital tools for significant academic objectives, including self-directed learning, critical inquiry, and collaborative knowledge creation.

Additionally, the findings indicate that a majority of students depend on smartphones and laptops, placing a greater focus on mobile access. Although smartphones offer accessibility and convenience, they might not be the best tools for cultivating the technical and operational skills that are essential for engaging in more advanced digital tasks. Therefore, the study suggests the deliberate incorporation of laptop-based activities into the academic curriculum to enhance the development of comprehensive digital skills (Subramaniam et al., 2023). This aligns with the conclusions drawn by Van Deursen and Helsper (2015), who highlighted the significance of the type of access in addition to access itself.

Ultimately, while this study concentrated on educational outcomes, the framework established here paves the way for further inquiries into the interplay between the digital divide and wider socio-economic, cultural, and psychological factors. A comprehensive understanding of internet outcomes across various life domains will be essential in guaranteeing that digital equity encompasses not only academic achievement but also employment, civic engagement, and overall well-being.

Conclusion

This study supports the sequential digital divide theory in Indonesian higher education. Device ownership and usage time are key to predicting technical, operational, and advanced digital literacies. Effective educational technology use, which affects academic progress and enjoyment, depends on these literacies, notably communication and content creation.

The findings show that solving the digital divide requires more than infrastructure; it requires constant digital skill development (Helsper, 2015). Educational stakeholders must develop basic and advanced digital abilities to ensure fair learning results across institutions and regions. This study theoretically validates models addressing multidimensional digital inequality and discusses digital literacy initiatives, especially in emerging economies.

This study examines the digital divide in Indonesian higher education and the sequential relationships between digital access, literacy, usage, and educational outcomes. Quantitative survey data from 457 undergraduate students at six urban and rural institutions is used to evaluate causal pathways using Partial Least Squares Structural Equation Modeling (PLS-SEM). Access, measured by device kind and duration, improves digital literacy, which affects educational technology use and learning outcomes. Communication and content creation are crucial to academic achievement and enjoyment. These findings support a comprehensive paradigm of digital inequality and underline the importance of fair digital participation beyond access. The study informs digital literacy and educational technology interventions to reduce outcome-based inequities across geographic and institutional contexts.

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