Development and Initial Psychometric Properties of Digital Literacy and Resilience Scale among University Students

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***Abstract*—Technological developments in all dimensions of life demand digital capabilities and resilience, especially for students in universities. This study developed and evaluated a scale to measure digital literacy and resilience among university students. The study comprised 864 participants, including both undergraduate and postgraduate students, with a mean age of 22.13 years. The study included 864 participants, comprising both undergraduate and postgraduate students, with a mean age of 22.13 years. Participants consisted of 34% men and 66% women, with representatives from Indonesia (67.6%), Malaysia (20.5 %), and Timor-Leste. These participants represented several countries in the Association of Southeast Asian Nations (ASEAN). We conducted the Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) procedures to validate the Exploratory Factor analysis and found five factors for digital literacy and four factors for digital resilience. Cronbach's alpha coefficients of 0.91 and 0.88, respectively, show strong internal consistency, correlation values for digital literacy range from 0.533 to 0.765, and correlation values for digital resilience range from 0.324 to 0.586. The confirmatory factor analysis showed that the models for digital resilience and digital literacy needed to lose a few items in order to fit well. This left 27 valid and reliable items across both constructs. The findings contribute to the understanding of digital competence and resilience, providing a valuable tool for educators and policymakers to assess and improve undergraduate students' digital readiness.**

***Keywords*—digital literacy, digital resilience, university students, 21st skill**

I. Introduction

The COVID-19 pandemic has affected various sectors of human life, including the world of education. This condition makes changes in educational activities, one of which is learning activities. The forms of traditional learning cannot be carried out, considering the situation does not allow the gathering, so alternative online learning is carried out [1–4]. Online learning activities are closely related to the integration of digital technology. In the case of students in developing countries like Indonesia, Malaysia, and Timor Leste, as well as a few other Asian countries where universities have not yet fully embraced the digital transformation of educational activities, some students and educators require additional time to adjust [5]. The topic of digital transformation for higher education institutions has recently attracted the attention of researchers, both in terms of its impact on the learning process and institutional operations [6, 7]. The integration of digital technology in online learning is certainly closely related to digital competence for users. Among students in the subject of online learning, digital competence is needed to achieve success in online learning [8, 9]. Digital literacy is one of the most important skills in the digital era [10, 11]. Research conducted by Wang and He [12] shows that the theme of the digital literacy field is closely related to the integration of digital technology. In addition, digital literacy is also closely associated with online risk [13]. Therefore, to successfully implement online learning in universities, digital literacy skills among students need to be addressed as an inseparable part of the digital era.

Academics and policymakers believe that digital literacy is an important part of higher education [13]. These skills will be able to overcome academic barriers that occur in online learning activities in higher education [14]. Students will be able to carry out independent learning outside the campus in a responsible manner [9]. Digital literacy is also an important part of students developing their online identity [15]. In this study, digital literacy as part of digital competence consists of several dimensions, namely 1) information and data literacy, which means a person's literacy ability in browsing, searching, filtering data, evaluating, and managing data, information, and digital content. 2) Communication and collaboration, means a person's literacy ability in interaction, sharing, collaboration, involvement as a citizen through digital technology, netiquette, and managing digital identity. 3) Digital content creation, means one's literacy ability in developing, integrating, and re-elaborating digital content, copyright, licenses, and programming. 4) Safety means a person's literacy ability in protecting devices, personal data, privacy, health, well-being, and environment. 5) Problem solving, means one's literacy ability in overcoming technical problems, identifying technological needs and responses, creatively using digital technology, and identifying digital competence gaps.

In addition to digital literacy, student digital resilience is also an important part of online learning [16]. Digital resilience will help students recognize and manage the risks and threats they face when learning online [17]. Students will also be able to reflect on digital information responsibly [18]. Students who have higher resilience are closely associated

with better mental health [19], reduced stress, greater well-being [20, 21], and achievement of academic success [22].

Digital resilience is a personality dynamic asset that grows from digital activation, i.e. engaging according to online opportunities and challenges, rather than through avoidance and safety behaviors [23]. In this study, digital resilience consists of several dimensions, namely 1) Understand, meaning that someone understands when they are at risk online and can make informed decisions about the digital space, they are in. 2) Learn means that a person learns from their experiences and can adapt to their future choices if possible. 3) Know means that someone knows what to do to seek help from various appropriate sources. 4) Recover means that one can recover when something goes wrong online by receiving the appropriate level of support to help with recovery.

Digital literacy and digital resilience are very important for a student to have in achieving success in online learning. The higher the skill level, the better the participation in online learning. Although until now there is no empirical evidence of research results stating that digital literacy and digital resilience have a positive effect on success in online learning among students, experts believe that digital literacy and digital resilience are important for students in the current digital era.

Although there have been studies that have developed and tested digital literacy and resilience scales [24–26], the development of this scale for students, especially with populations in developing Asian countries, is still limited. For this reason, in this study, the digital literacy and resilience scale among university students for Asia Population was developed by adopting existing theoretical concepts. With a focus on students in Asia, this study uses Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) techniques to create and evaluate a valid and reliable digital literacy and resilience scale. In the context of higher education in Asia, the findings of this study should significantly advance the measurement and comprehension of digital literacy and resilience in the digital age. They should also lay the groundwork for creating successful interventions to improve these skills among students in the region. Given the stark digital gap across the Association of Southeast Asian Nations (ASEAN) nations and the pressing need to equip Asian youth with digital skills to navigate the digital transition, this study is crucial. By concentrating on students, this research may provide important insights into the resilience and digital literacy levels of Asia's future workforce while also highlighting issues that need consideration in the creation of regional curricula and higher education policy.

II. Literature Review

Evaluation of Existing Literature Numerous studies on digital resilience and digital literacy have been conducted in response to the rising tide of digital technologies at universities. The COVID-19 epidemic has accelerated the global trend toward online learning, making these abilities more important than ever for students to thrive in virtual classrooms [27, 28]. In order to build a scale to assess these skills among college students, this literature review will look at research that deal with digital resilience, digital literacy, and its components.

Nowadays, being able to use digital tools effectively is seen as an essential talent for success in the modern world. Literacy in information and data, as well as in communicating and collaborating, creating digital material, staying secure, and solving problems are all part of it [29]. The capacity of a learner to successfully traverse digital settings is dependent on each of these aspects. A number of scholars have stressed the significance of computer literacy in universities. For example, Bennett *et al*. [8] highlighted how children who are proficient in digital literacy are more likely to be able to learn on their own. Digital content creation skills are essential for the responsible production and management of digital resources, including the respect of copyright and licensing requirements [30], and student's ability to communicate and collaborate online allows them to work effectively in online group settings [9]. The correlation between computer proficiency and academic achievement has recently been the subject of several studies. Students who are more proficient with technology are better able to handle the rigors of online courses, adjust to new platforms, and work on their learning, according to research by Reddy *et al*. and Alvermann *et al*. [11, 15]. The necessity for digital resilience is intimately related to digital literacy, however, because digital environments also present risks, such as being exposed to online threats and misinformation [13].

The UK Council for Internet Safety defines "digital resilience" as the capacity to face and overcome digital hazards and obstacles (2019). According to references [16, 17], digitally resilient pupils are better able to handle online hazards, adjust to new digital settings, and ethically evaluate digital content. Researchers have shown that digital resilience is associated with better mental health and higher levels of academic achievement. According to reference [18], students who possess a high level of resilience are better able to handle digital disruptions, keep themselves safe online, and uphold a favorable image when using the internet. Resilient students are better able to handle periods of heavy internet use without experiencing negative mental health effects, according to research by Ang *et al*. [22]. This, in turn, improves their academic performance. Although digital literacy has been the subject of much study, the idea of digital resilience is more recent. Currently, there are a lot of measures that assess digital literacy, but very few that measure resilience. Scholars such as Reddy *et al*. and Lekwa *et al*. [11, 31] have pointed out this fact, arguing that students, despite their technical proficiency, frequently lack the emotional and psychological resilience to deal with the continual digital contact. A complete tool that can evaluate digital literacy and resilience is necessary, as there is a lack of research on university students' digital resilience, particularly in poor nations. By adding a scale that assesses both constructs, this study adds to the expanding body of knowledge on students' digital readiness and well-being, which is useful for both educators and policymakers.

III. Materials and Methods

A. Participant

The study involved 864 mixed among undergraduate and

postgraduate students with a mean age of 22.13 years (SD = 6.552). The sample comprised 34% male and 66% female participants, with representation from Indonesia (67.6%), Malaysia (20.5%), and Timor-Leste (11.9%) (Table 1).

Table 1. Demographic information of participants

Demographic	n = 864	%
Age	22.13 (Mean)	6.552 (SD)
Gender		
Male	294	34
Female	570	66
Nationality		
Indonesia	584	67.6
Malaysia	177	20.5
Timor-Leste	103	11.9

B. Digital Literacy and Resilience Scales

Digital literacy and resilience scales were developed by the researcher according to the digital literacy concept by reference [29] and the digital resilience concept by reference [23]. Digital literacy factors include information and data literacy, communication and collaboration, digital content creation, safety, and problem-solving. Digital resilience factors include knowing, understanding, learning, and recovering. We developed a total of 45 items on digital literacy and 29 items on digital resilience success, using a Likert scale that ranges from "almost needed guidance" to "most advanced and specialist."

C. Procedures

Surveys were conducted with university students at Universitas Pendidikan Ganesha and Universitas Nusa Cendana in Indonesia, Universitas Kebangsaan Malaysia in Malaysia, and Instituto Superior Cristal in Timor-Leste. Data collection was carried out using a standardized online form accessible via a unique link shared with participants.

This study used simple random sampling. Respondents participated voluntarily, regardless of their gender and socio-demographic status [32]. Participants are free to choose the English or Indonesian version. The form received anonymous responses from the participants, each limited to a single one-time response. We closed the form on August 14, 2022. A total of 864 respondents completed this survey.

The instrument was developed in English and Indonesian version. Before applying the survey, the digital literacy and resilience scale was evaluated by three judges, who assessed the understanding of the items. After that, some terms were modified to improve the comprehension of the scale.

The data was screened by Microsoft Excel and the next step doing analysis. The first, demographic analysis such as age, gender, and nationality was done by IBM SPSS Statistic 25. The dataset was randomly split into two independent subsets to ensure methodological rigor. The first subset (n = 432) was used for EFA, while the second subset (n = 432) was employed for CFA. This approach mitigates potential biases and ensures robust validation of the scale. The second, EFA was done by JAS-P 0.16.3.0. Five factors were formed for digital literacy and four factors for digital resilience. According to the theoretical concept used in this study, the total of factors was the same. The third, CFA was done by IBM Amos 22. To get the fit model, the items that are not fit to measure construct were deleted [33]. To determine model fit, the Root Mean Square Error of Approximation (RMSEA) should be less than 0.08, with values below 0.05 indicating excellent fit and values between 0.05 and 0.08 suggesting acceptable fit [34].

IV. Result

A. Measurement of Factor: EFA

The component assessment of digital literacy (45 items) and digital resilience (29 items) revealed distinct factor structures for each construct, aligning with established theoretical frameworks. For digital literacy, a five-factor structure emerged, corresponding to the theoretical constructs of information and data literacy (F1), communication and cooperation (F2), digital content production (F3), safety (F4), and problem-solving (F5), which aligns with the framework used on this study. For digital resilience, a four-factor structure was identified, corresponding to the theoretical constructs of knowing (F1), understanding (F2), learning (F3), and recovering (F4), consistent with recent conceptualizations of digital resilience. The factor structures identified for both constructs demonstrate good alignment with their respective theoretical underpinnings, suggesting that the developed scales possess adequate content and construct validity for assessing digital literacy and resilience among students in the Asian context.

Table 2. Factor correlations on digital literacy

Dimension	Factor 1	Factor 2	Factor 3	Factor 4
Factor 1				
Factor 2	0.689			
Factor 3	0.647	0.670		
Factor 4	0.549	0.717	0.715	
Factor 5	0.765	0.707	0.624	0.533

The correlation factor values on digital literacy range from 0.533–0.765. The high correlation on Factor 5 and Factor 1 with values 0.765 and the lowest on Factor 5 and Factor 4 with values 0.533 (see Table 2). On digital resilience, the correlation factor values range from 0.324–0.586. The high correlation factor values 0.586 on Factor 2 with Factor 1 and the lowest 0.324 on Factor 4 with Factor 3 (see Table 3).

Table 3. Factor correlations on digital resilience

Dimension	Factor 1	Factor 2	Factor 3
Factor 1			
Factor 2	0.586		
Factor 3	0.478	0.395	
Factor 4	0.523	0.478	0.324

The internal consistency of the 29-item scale was evaluated using Cronbach's alpha, which yielded coefficients of 0.91 for digital literacy (comprising five factors) and 0.88 for digital resilience (comprising four factors). Each factor demonstrated acceptable reliability scores ranging from 0.75 to 0.89, indicating strong internal consistency across constructs.

B. Measurement Model: CFA

The results of model testing on 45 items of digital literacy with 5 constructs and 29 items of digital resilience with 4 constructs, the resulting model does not fit. There are some items that are not fit to measure the construct, so that the

several of items is deleted. A total of 29 items on construct digital literacy and 18 items on construct digital resilience were deleted.

The data in Fig. 1 show that, fits a model of digital literacy. The values of CFI, GFI, AGFI, RMSEA, and NFI are adequate. In the model, a construct of problem-solving has many items more than others. There are five items such as PS_1, PS_5, PS_8, PS_10, and PS_11 on construct problem-solving. Digital content creation and information and data literacy are constructed by who has the item at least. There are two items such as DCC_6 and DCC_5 for the construct of digital content creation and IDL_4 and IDL_5 for the construct of information and data literacy. In the construct of communication and collaboration, there are four items such as CC_2, CC_3, CC_5, and CC_6. Finally, on the construct of safety, there are three items such as S_6, S_8, and S_9. The validation values on all of the items can see in Table 4.

Table 4. Standardized regression weights item digital literacy and resilience scale

	Item	Estimate
	Digital Literacy	
IDL_4	Selecting valid/trusted digital information search results	0.801
IDL_5	I can manage and group data links/data links on computers/smartphones/tablets or other digital devices and find them easily whenever I need them	0.806
CC_2	I can start and host online class meetings	0.722
CC_3	I can add or group participants in certain online rooms for online meeting activities	0.732
CC_5	I am able to initiate and organize groups to work on/edit documents online	0.771
CC_6	Create and manage survey instruments and/or online discussion forums to collect data/information from the public	0.873
DCC_5	Avoid violating the simple rules of copyright and license that apply to data, information, digital content, or internet	0.917
DCC_6	Using simple coding to complete simple programming	0.900
S_6	Recognize the privacy policy statement on how personal data is used in digital services	0.837
S_8	Recognize how to use digital technology to keep you engaged in social circles	0.813
S_9	Implement ways to protect your social environment from the impact of digital technology and its use	0.863
PS_1	Understand the occurrence of problems when working with digital devices and systems or programs	0.767
PS_5	Implement simple ways to adapt and consider digital tools and digital programs to my environmental conditions	0.883
PS_8	identify what digital skills and capabilities need improvement	0.729
PS_10	Looking for references use to solve problems in content development, programs, digital that I don't know about	0.764
PS_11	Find a friend or a more advanced expert to discuss obstacles to digital work	0.697
	Digital Resilience	
K_5	I recognize the symptoms of psychological disorders that occur when I access the internet for too long (K5)	0.521
U_5	I Know how to overcome the boredom and stress of working with digital devices and the internet (U5)	0.748
U_8	I get the opportunity to propose a problem-solving idea regarding digital system disturbance at my university (U8)	0.459
L_2	I learned how to file a complaint if I get violent or criminal acts on the internet/digital (cyber-crime) (L2)	0.897
L_3	I always try to find reference sources to overcome mental disorders as a result of digital interactions and work on the internet (L3)	0.826
L_4	I'm looking for information about other forms of ethical and legal violations in sharing content on the internet (L4)	0.816
L_6	I'm learning about how to deal with disruptions in digital access (academic systems, e-learning systems, other systems) (L6)	0.725
K_6	I am able to control myself and my time to work online to avoid psychological pressure (K6)	0.662
U_3	I can control myself to stop surfing internet or using social media (U3)	0.768
R_2	I am able to calm myself down when I am feeling bored or stressed from working digitally or on the internet (R2)	0.675
R_5	I am able to overcome addiction/dependence with social media, online gaming or accessing digital/internet content that I like (R5)	0.603

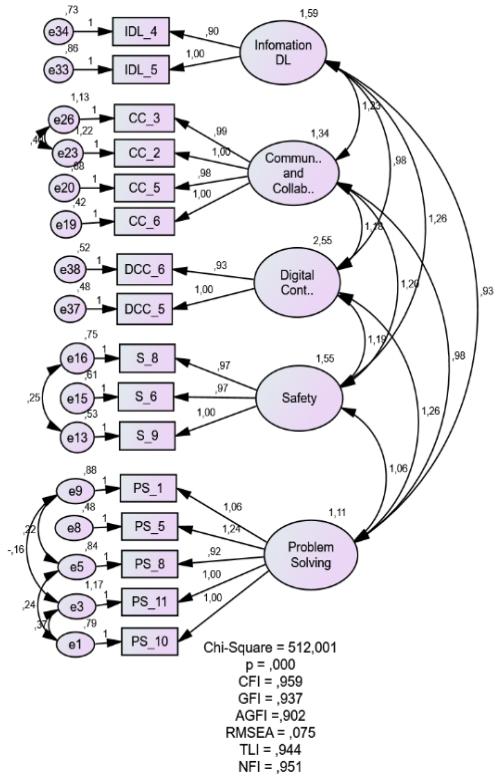

Fig. 1. Fit model of digital literacy.

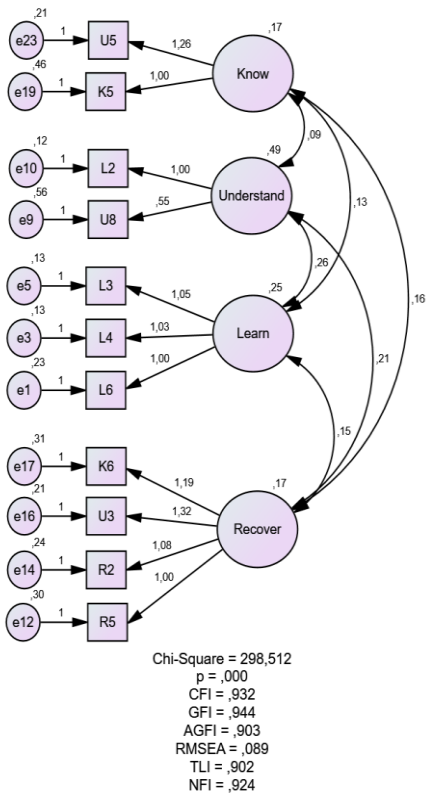

Fig. 2. Fit model of digital resilience.

The data in Fig. 2 show that, fits a model of digital resilience. The values of CFI, GFI, AGFI, RMSEA, and NFI are adequate. In the model, the construct of revision has many items more than others. There are four items such as K_6, U_3, R_2, and R_5 on the new construct. Know and understand is construct who has the item at least. There are two items such as U_5 and K_5 for the construct of know and L_2 and U_8 for the construct of understand. Finally, on the construct of learning, there are three items such as L_3, L_4, and L_6. The validation values on all the items can see in Table 4.

Table 4 shows the valid and reliable constructs. In digital literacy, there are 16 items in total, with an estimated range value of 0.697–0.900. On digital resilience, there are 11 items total, with an estimated range value of 0.459–0.897. So, there are 27 items on the digital literacy and resilience scale among university students.

V. Discussion

This study aims to develop and test the psychometric properties of digital literacy and resilience scale among university students. The initial development refers to the existing theoretical concepts and has succeeded in developing 45 items of digital literacy and 29 items of digital resilience. Items are developed in two versions, namely English and Indonesian. Expert consultation was carried out in the development of the items to ensure that the items had theoretical and practical value. Further refinement of the items was carried out according to input from 3 experts so that the items in the English and Indonesian versions had the same meaning.

EFA test results for a total of 45 items of digital literacy consisting of 5 factors and 29 items of digital resilience consisting of 4 factors. The correlation between the resulting factors is categorized as acceptable, with a range of correlation values of 0.324–0.769. The factors that have been generated are in accordance with the theoretical concepts used. Digital literacy consists of information and data literacy (F1), communication and collaboration (F2), digital content creation (F3), safety (F4), and problem-solving (F5) while digital resilience consists of know (F1), understand (F2), learn (F3), and recover (F4).

The CFA test results for a total of 45 items of digital literacy and 29 items of digital resilience did not meet the model fit requirements. Modifications are made by deleting items that do not fit to the measure construct. For the construct of digital literacy, 29 items have been removed. A total of 16 fit items measure the construct of digital literacy with a range of standardized regression weights values of 0.697–0.900. For the digital resilience construct, 18 items were deleted. A total of 11 items are fit to measure the digital resilience construct with a range of standardized regression weights values of 0.459–0.897. All of the resulting models are categorized as fit models because the Chi-Square, CFI, GFI, AGFI, RMSEA, TLI, NFI values have met the standard criteria.

The scale of digital literacy and resilience among students developed in this study consists of 16 items for digital literacy constructs and 11 items for digital resilience. The test results show that each item validly and reliably measures the construct on the variables of land and digital literacy. Thus, the resulting scale of digital literacy and resilience has been able to be used among students, especially in the Asian region.

Digital literacy and digital resilience are digital skills that are very important for a student to have. Academic activities that integrate digital technology require digital skills support. These skills will support the activity process to run optimally where digital obstacles will be handled properly. As part of academic activities, online learning that integrates digital technology cannot be separated from the support of digital skills. Online learning will take place optimally when the level of digital skills possessed by a student is higher.

The limitation of developing digital literacy and resilience scale among university students lies in the participants. This new instrument was developed in the context of ASEAN student culture involving students from Indonesia, Malaysia, and Timor-Leste. However, the participant area is still insufficient to represent the ASEAN region so that the population needs to be expanded. The coverage area of the participants involved is also limited so that only students who are involved have the opportunity and luck. Therefore, future studies need to carry out testing of psychometric trait scales with different populations.

This study's findings highlight that digital literacy and resilience are essential competencies for students to thrive in online learning settings. This corresponds with prior research that emphasizes digital literacy as an essential skill in higher education, facilitating both autonomous and cooperative learning [8, 10, 35]. Ting [9] observed that digital literacy enhances students' participation in digital learning settings and facilitates the development of their online identity, a crucial element of independent learning.

This study further substantiates that digital resilience acts as a protective factor, empowering students to navigate the digital risks and problems commonly encountered in online learning [16, 27, 36]. Students exhibiting high digital resilience have superior stress management and psychological resilience with extensive technology usage, as evidenced by reference [18]. This research indicates that students exhibiting higher digital resilience were more adept at recovering from digital disruptions and online threats, highlighting the strong correlation between resilience, mental well-being, and academic achievement.

The findings suggest that although students in the digital era are generally adept with technology, a significant number still need improved resilience to manage online threats, including disinformation, psychological stress, and ethical dilemmas in digital material sharing [13]. The findings from the digital literacy and resilience scale indicate that these two elements should be regarded as complementing competencies. Digital literacy empowers students to access, assess, and utilize information proficiently, whereas digital resilience prepares them to navigate the problems that may emerge from digital engagements.

This study offers higher education institutions insights on the significance of developing programs that enhance digital literacy abilities and bolster students' digital resilience. Furthermore, these findings underscore the necessity for an evaluative framework that assesses both competencies—like the scale devised in this study—that can be universally implemented across varied cultural and geographical

contexts, particularly within ASEAN, where digital and cultural dynamics differ. Constraints and Prospective Avenues.

The study's limitation lies in its narrow focus on students from Indonesia, Malaysia, and Timor-Leste, suggesting that future research should include a more diverse sample and conduct pilot tests to validate the digital literacy and resilience scale in various educational contexts.

This research indicates the necessity for longitudinal studies to investigate the evolution of digital literacy and resilience over time, especially in facilitating sustained online learning. In the future, a mixed-methods approach that includes in-depth interviews may yield greater insights into the obstacles students encounter in sustaining digital resilience and literacy across increasingly intricate online contexts.

VI. Conclusion

This research developed and validated a valid and reliable digital literacy and resilience scale for students in the Asian region, specifically Indonesia, Malaysia, and Timor-Leste. The results of the EFA and CFA produced a final scale consisting of 16 items for the digital literacy construct and 11 items for the digital resilience construct. According to the theoretical framework, the resulting digital literacy scale includes five dimensions: information and data literacy, communication and collaboration, digital content creation, security, and problem-solving. Meanwhile, the digital resilience scale consists of four dimensions that align with the latest conceptualization, including knowing, understanding, learning, and recovering. The results of the psychometric test indicate that this scale has excellent validity and reliability. The correlation values between factors in digital literacy range from 0.533 to 0.765, while in digital resilience they range from 0.324 to 0.586. The internal consistency of the scale also proved to be strong with a Cronbach's alpha coefficient of 0.91 for digital literacy and 0.88 for digital resilience. The development of this scale makes an important contribution to the measurement and understanding of digital literacy and resilience among Asian students. Higher education institutions can use this instrument to assess students' digital skills, design appropriate curricula, and develop effective intervention programs to enhance digital literacy and resilience. However, we must acknowledge the limitations of this research, particularly the geographical scope of the sample. Future research should expand the sample to a more diverse population in the Asian region and conduct validation through application in real-world contexts to enhance the relevance and impact of this scale.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

KS and KSu: conceptualization, original draft preparation, writing; IKS: supervision, validation; IMS: investigation, software; IPAA: writing, software; AYAB: investigation, editing, reviewing; all authors had approved the final version.

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