Factor analysis of the relationship of curiosity and device addiction through motivation to digital literacy in the context of smart learning

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ABSTRACT

This study aims to investigate the relationship between curiosity and device addiction factors and motivation towards digital literacy in the context of smart learning. This study used a qualitative approach involving 228 students majoring in Electronics Engineering Education at Universitas Negeri Padang. Data were collected through a Likert-scale questionnaire with a saturated sampling method, ensuring all relevant respondents were involved. To evaluate the measurement model of the research questions, Structural Equation Modeling (SEM) analysis was used. The results revealed that digital literacy is significantly influenced by three main factors: curiosity, gadget addiction and app addiction. Furthermore, the study found that curiosity-driven motivation tends to improve digital literacy, while gadget and app addiction have a negative impact. These findings provide valuable insights for curriculum development, especially in improving digital literacy among electrical engineering education students. In addition, this study highlights the importance of educational interventions that can manage the wise use of technology and promote constructive curiosity. This research contributes to the understanding of how curiosity and excessive use of technology can affect digital literacy skills, which are crucial to face the challenges of the Industrial Revolution 4.0 era. Thus, the results of this study can serve as a basis for more effective educational strategies in preparing students for future digital challenges.

INTRODUCTION

Digital literacy is essential for today's students. In a technology-driven world, digital literacy has become an essential skill for students to succeed academically and professionally. Digital literacy enables students to communicate, collaborate, and interact with others online (Hauck, 2019; Zulkarnain et al., 2020). In addition, digital literacy also affects improving academic performance, which is important for successful study and professional development in the world of work (Abbas et al., 2019; Khan et al., 2022; Pala & Başıbüyük, 2021). Students with good digital literacy can use search engines, social media, and other online tools to find relevant information and resources (Jones

& Hafner, 2021; Yustika & Iswati, 2020). They can also critically evaluate online sources to ensure they are accurate and reliable (Noh, 2017; Silvhiany et al., 2021).

Digital literacy skills are essential for future employment opportunities (Hendriyania et al., 2020). Most jobs today require digital skills, and this trend is expected to continue to increase in the future (Bejaković & Mrnjavac, 2020; Pangrazio, 2016). Therefore, students must strengthen these skills to keep up with the ever-evolving technological advancements and fully participate in the digital era (Purnama et al., 2020).

Digital literacy skills generally cover various aspects, such as the ability to use and even create digital applications (Alexander et al., 2016; Nawaila et al., 2022). Digital literacy also relates to the ability to upload and download files on digital platforms (Hendriyani & Amrizal, 2019). In addition, digital literacy shows students' ability to manage and moderate online communication forums or groups. In addition, digital literacy describes students' knowledge of the rights, obligations, and responsibilities of digital content received and delivered to the public. Some aspects that can improve digital literacy include critical thinking skills, operational skills, visual learning styles, collaborative learning styles, and learning systems that can improve digital literacy (Anggraeni et al., 2022; Anwar et al., 2022; Morgan et al., 2022).

The novelty and contribution of this research is to identify factors that influence students' digital literacy skills in preparing for the challenging world of work along with the fourth industrial revolution (da Silva et al., 2022; Su et al., 2023). While many studies have been conducted on digital literacy, this research has a strong focus on linking digital literacy skills with students' preparation for the increasingly complex world of work in the era of the fourth industrial revolution (Broo et al., 2022; Cetindamar et al., 2024; Kamaludin et al., 2022). This research contributes to a deeper understanding of the factors that influence students' digital literacy skills, including technology accessibility (Hidayat et al., 2021), digital proficiency level, motivation, and the learning approach used (Anwar, 2021).

The main problem identified in this study is the need for an in-depth understanding of how the factors of curiosity and device addiction affect digital literacy motivation in the context of smart learning. This study aims to identify the relationship between the curiosity factor and students' digital literacy and the relationship between device addiction and students' digital literacy. In addition, this study also aims to evaluate the role of motivation in mediating the relationship between curiosity, device addiction, and digital literacy.

This study is not just an academic exercise, but a practical tool for educational institutions and policy makers. By understanding the importance of digital literacy and the factors that influence it, institutions can design more effective curricula to improve students' digital literacy. The research also provides a scientific basis for developing learning programs to prepare students for the challenges of the Industrial Revolution 4.0 era. Thus, this research has a strong practical purpose and can make a real contribution to facing the challenges of the fourth industrial revolution by better understanding the factors that influence students' digital literacy skills.

Based on the literature review and problem formulation, this study hypothesizes that there is a positive relationship between curiosity and students' digital literacy, there is a negative relationship between device addiction and students' digital literacy, and motivation mediates the relationship between curiosity and device addiction with students' digital literacy. With a better understanding of the factors that influence digital literacy, this study contributes significantly to preparing students to face the demands of an increasingly digitalized world of work.

RESEARCH METHOD

This research uses a quantitative approach with a descriptive survey design. The research was conducted at the Department of Electronic Engineering, Faculty of Engineering, Padang State University during the period September 2023 to January 2024. The population in this study consisted of 228 students in the department.

Population and Sample

The population of this study were all students in the Department of Electronic Engineering, Faculty of Engineering, Padang State University, totalling 228 people. The research sample was taken using non-probability sampling techniques with data-based survey methods and remote data collection techniques. The sample selection was non-randomised to ensure adequate representation of the population. The profile of the respondents is presented in Table 1.

Table 1. Respondent Profile

Category	Sub-sategory	Frequency	Percentage
Gender	Male	130	57.02%
	Female	98	42.98%
Ages	17-18 years old	50	21.93%
	19-20 years old	125	54.82%
	21-22 years old	47	20.61%
	23-24 years old	6	2.63
Year of entry	2017	1	0.44%
	2018	11	4.82%
	2019	3	1.32%
	2020	64	28.07%
	2021	24	10.53%
	2022	125	54.82%

Research Instruments

This study used a non-test instrument in the form of a questionnaire to collect primary data from respondents. The questionnaire was prepared based on valid and reliable question items, which were adjusted to the topic of this research. The variables measured are presented in Table 2.

Table 2. Variables Measured

Variables	Number of items	Reference sources
Curiosity	24	Kashdan et al. (2018)
Device Addiction	18	Rozgonjuk et al. (2016)
Motivation	10	Wallace and Leong (2020)
Digital Literacy	9	Nazzal et al. (2022)

Data Collection Technique

Data was collected by distributing Likert scale questionnaires to all respondents. The questionnaire was distributed online through an online survey platform to facilitate data collection in large numbers and in an efficient time.

Data Analysis Technique

Data analysis was carried out using the Confirmatory Factor Analysis (CFA) method to test and confirm each factor forming the research model. CFA is used to test the validity and reliability of the measured constructs. In addition, testing the effectiveness of mediation was carried out using the complementary mediation test procedure, which analyses the direct and indirect effects of the independent variable on the dependent variable through the mediating variable.

Data were analysed using appropriate statistical software, such as AMOS or LISREL, to ensure accurate and reliable results. CFA has been tested repeatedly to test the model formed, as done in the research of Mubai et al. (2023) and Nofriansyah et al. (2020).

The credibility of the data in this study is supported by a high level of confidence in the results, thanks to the selection of appropriate respondents with non-probability sampling, valid and reliable instruments, and the use of credible and consistent methods. Thus, the data collected is expected to produce a consistent and valid model.

FINDINGS AND DISCUSSION

Findings

Measurement Model

The Measurement Model is a statistical model used to measure abstract constructs or variables in research (Henseler & Schuberth, 2020). This model is primarily used in factor analysis and SEM (Structural Equation Modeling) analysis. In factor analysis, the measurement model is used to test the extent to which the measured indicators represent a wider construct or variable (Rhemtulla et al., 2020). This model shows the relationship between the indicators and the measured constructs by calculating factor loadings for each indicator. Factor loadings are coefficients that describe the extent to which the indicator contributes to the measured construct (Benitez et al., 2020).

In SEM analysis, the measurement model is used to test the validity and reliability of constructs measured within a more complex structural model (Purwanto, 2021). This model demonstrates the relationship between latent variables (constructs) and the indicators measured by calculating factor loadings and specific variances (error variances) of each indicator (Kyle et al., 2020). The model also allows for the examination of the interrelationships among indicators by showing the correlations between the error variances of related indicators.

Convergent Validity

Convergent validity is one type of validity in measuring constructs or variables in research (Flake et al., 2022). Convergent validity refers to the extent to which the measured indicators, which should measure the same construct, have strong and positive relationships with each other. The value of convergent validity is the factor loading value of the latent variable with its indicators (Amora, 2021). The expected value should exceed 0.7, although a threshold of 0.6 is commonly used as the minimum value for factor loading (Soltani et al., 2019; Sukardi & Hendriyani, 2021). The results of the convergent validity test are presented in the following Table 3.

Table 3. Convergent Validity Test Results

Variable	Item	Outer Loading > 0,7	Cronbach's Alph	Composite Reliability	AVE > 0.5
Addiction to the Device	ATTD1	0.724	0.873	0.899	0.559
	ATTD2	0.775			
	ATTD3	0.750			
	ATTD4	0.715			
	ATTD5	0.757			
	ATTD6	0.718			
	ATTD7	0.791			
Curiosity	Cu1	0.900	0.857	0.913	0.777
	Cu2	0.894			
	Cu3	0.849			
Digital Literacy	DL1	0.833	0.830	0.887	0.662
	DL2	0.802			
	DL7	0.808			
	DL8	0.809			
Motivation	Mo1	0.804	0.783	0.871	0.692
	Mo2	0.839			
	Mo3	0.853			

Table 3 shows that all items of the statements in the variables addiction to the device, curiosity, digital literacy, and motivation can be considered valid as they have outer loading values >0.7. Furthermore, the Cronbach's Alpha values for addiction to the device = 0.873, curiosity = 0.857, digital literacy = 0.830, and motivation = 0.783; all of them have values > 0.7. Moreover, the composite reliability values for addiction to the device = 0.899, curiosity = 0.913, digital literacy =

0.887, and motivation = 0.871; all of them have values > 0.7. lastly, the ave values for addiction to the device = 0.559, curiosity = 0.777, digital literacy = 0.662, and motivation = 0.692; all of them have values > 0.5.

Discriminant Validity

Discriminant validity is a concept used to assess the extent to which two constructs or measured variables are distinct from each other (Hehman et al., 2019). Discriminant validity serves to measure the accuracy of the reflective model, and the minimum threshold for AVE values of discriminant validity is set at 0.5, with higher values being more desirable (Yusoff et al., 2020). On the other hand, composite reliability is used to assess the stability and internal consistency of the indicators, indicating good reliability (Barati et al., 2019). In this study, the Fornell-Larcker criterion is used to evaluate discriminant validity (Yusoff et al., 2020). The Fornell-Larcker criterion compares the convergent validity and discriminant validity in confirmatory factor analysis (CFA) (de Oliveira Kaizer et al., 2020). Table 4 presents the results of the discriminant validity analysis using the Fornell-Larcker criterion.

Table 4. Discriminant Validity Results

Variable	Addiction to the Device	Curiosity	Digital Literacy	Motivation
Addiction to the Device	0.748			
Curiosity	0.313	0.881		
Digital Literacy	0.222	0.479	0.813	
Motivation	0.190	0.262	0.350	0.832

Based on Table 4, it can be observed that all correlation values in the Fornell-Larcker criterion for each variable meet the requirements for the test of discriminant validity. Some are deemed good and acceptable with values close to 0.9. As for Table 5, it will present the results of the Heterotrait-Monotrait ratio (HTMT) analysis. Based on Table 5, it can be observed that all variables have HTMT values < 0.90, indicating that they have valid (distinct) discriminant validity.

Table 5. HTMT results

Variable	Addiction to the Device	Curiosity	Digital Literacy
Addiction to the Device			
Curiosity	0.335		
Digital Literacy	0.227	0.558	
Motivation	0.206	0.299	0.423

Path Analysis and Research Questions Testing

Path Analysis is a statistical method used to test the causal relationships between variables in a complex model (Barbeau et al., 2019). In Path Analysis, variables are represented by arrows (paths) that depict the direction and strength of the relationships between the variables (Buldur & Güvendi, 2020). These arrows represent the causal paths or influences between variables. Path Analysis allows researchers to test hypotheses about the relationships between variables and assess the extent to which variables influence each other (Parashakti et al., 2020).

On the other hand, research Questions Testing is the process of testing hypotheses or research questions using empirical data (Schweinsberg et al., 2021). At this stage, researchers utilize statistical methods and data analysis to test the proposed research hypotheses or answer the research questions that have been posed (Haven & Van Grootel, 2019). Table 6 presents the results of testing the research questions in the path analysis.

Table 6. Results of the Measurement Model

Variable	Original Sample (O)	T Statistics	P Values	Hypothesis
Addiction to the Device -> Digital Literacy	0.052	0.737	0.462	H1 Rejected
Addiction to the Device -> Motivation	0.119	1.337	0.182	H2 Rejected
Curiosity -> Addiction to the Device	0.313	4.616	0.000	H3 Accepted
Curiosity -> Digital Literacy	0.401	6.371	0.000	H4 Accepted
Curiosity -> Motivation	0.225	2.623	0.009	H5 Accepted
Motivation -> Digital Literacy	0.235	3.269	0.001	H6 Accepted
Addiction to the Device -> Digital Literacy -> Motivation	0.028	1.152	0.250	H7 Rejected
Curiosity -> Addiction to the Device -> Digital Literacy	0.078	2.086	0.037	H8 Accepted

Based on Table 6, it can be observed that several of the proposed hypotheses (H3, H4, H5, H6, and H8) present empirically supported direct relationships between the constructs, with t-values greater than 2.57. Meanwhile, hypotheses H1, H2, and H7 were rejected. It can be concluded that digital literacy cannot be positively influenced by addiction to the device (t = 0.737; p-value = 0.462). Similarly, addiction to the device does not have a positive effect on motivation (t = 1.337; p-value = 0.182), but it is positively influenced by curiosity (t = 2.623; p-value=0.009). Additionally, motivation positively influences digital literacy (t = 3.269; p-value = 0.001). Furthermore, curiosity positively influences addiction to the device (t = 4.616; p-value = 0.000) and digital literacy (t = 6.37; p-value = 0.000).

Ultimately, these findings indicate that addiction to the device does not mediate the relationship between digital literacy and motivation (t = 1.152; p-value = 0.250), while curiosity serves as a mediator between addiction to the device and digital literacy (t = 2.086; p-value = 0.037). Thus, the results of the structural model in this study can be depicted as shown in Figure 1.
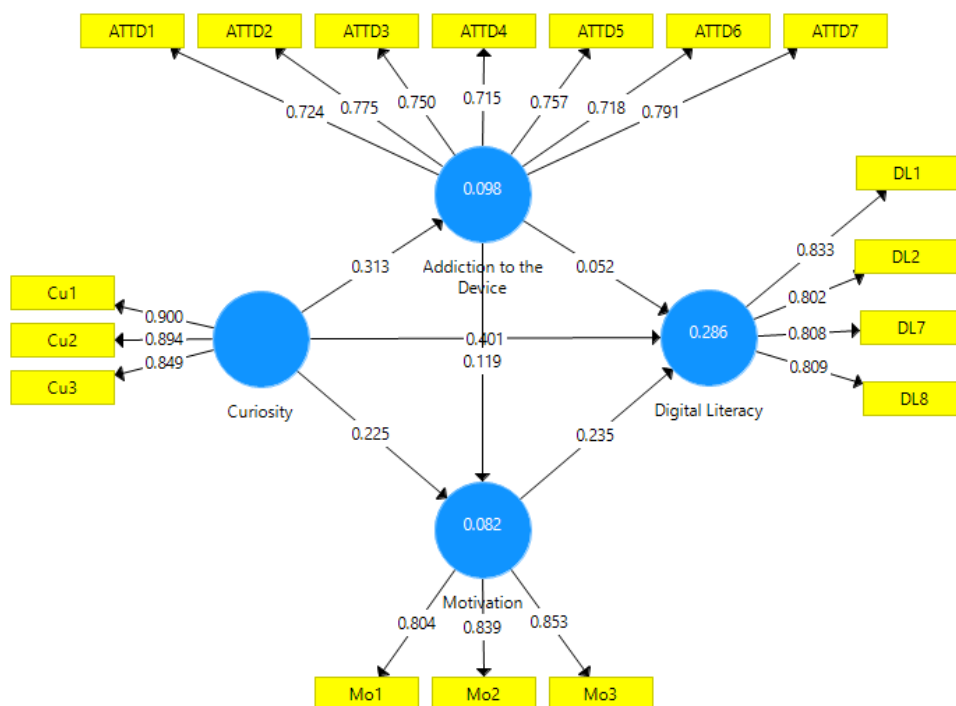

Figure 1. Structural Model Results

The structural model in PLS-SEM tests the path relationships between the four constructs (Dash & Paul, 2021). Figure 1 depicts the results of the structural model. The output from the structural model can be used to assess the significance of the influence of each construct variable, namely addiction to the device, curiosity, digital literacy, and motivation. The structural model testing is designed based on path coefficients, indicated by the original sample values and t-values (Riyadi et al., 2021).

This research focuses on four variables, namely curiosity, addiction to device, motivation, and digital literacy. The study found that addiction to device did not have a significant influence on digital literacy and motivation. This suggests that dependence on electronic devices does not affect one's ability or interest in operating digital technology or driving their motivation towards it (Amini & Bozorgasl, 2023; Sujiarto et al., 2022).

Meanwhile, curiosity was considered significant towards addiction to device, digital literacy, and motivation. This indicates that individuals with a high level of curiosity are more interested in digital technology and have the potential to enhance their digital skills and knowledge. Curiosity also acts as a driving factor for one's motivation in learning digital technology .

In this study, it was found that motivation had a significant influence on digital literacy. This indicates that motivation is crucial in shaping an individual's ability to adapt to digital technology. Although there is no direct influence from the addiction to device variable towards motivation, the research shows that digital literacy is one of the factors that moderates or affects the relationship between these two variables.

The addiction to device variable, considered not significantly affecting motivation, actually has a significant effect on digital literacy through the moderating variable of curiosity. This indicates that interest in digital technology is critical in shaping an individual's ability to operate digital technology (Solberg et al., 2020), although it can become a weakness in dependence on electronic devices.

This research shows that curiosity can play an important role in enhancing digital literacy and motivation in using digital devices. While addiction to digital devices does not have a significant influence on digital literacy and motivation. This demonstrates that having curiosity with the willingness and motivation to learn is more important in acquiring digital literacy skills (Menggo et al., 2021).

In this study, it is evident that motivation plays a crucial role in enhancing digital literacy. This adds evidence that having a high motivation is the key to improving digital literacy skills and abilities. These digital literacy skills are becoming increasingly important in a rapidly digitalizing world with growing challenges. Therefore, motivation can be considered a critical factor to consider in enhancing digital literacy skills (Chiu, 2023).

This research shows that addiction to digital devices has little significant impact on motivation. However, addiction can still affect digital literacy skills. This suggests that there are other factors influencing motivation in the use of digital devices, and addiction is not as detrimental as previously thought. Hence, further research is needed to determine the factors relevant to motivation in using digital devices and digital literacy skills.

Discussion

This study's significant finding that device addiction does not have a substantial impact on digital literacy and motivation, while curiosity does, is a key contribution to the field. This aligns with Bae's (2022) research, which underscores the importance of curiosity in shaping individuals' engagement with digital devices and their digital literacy skills. Abdullah and Husaini (2022) research also emphasizes the significant role of curiosity in device addiction, digital literacy, and motivation, highlighting the importance of this psychological factor in digital learning.

However, Özkan's (2022) research findings, contrary to Güngören et al.'s (2022) research, suggest that device addiction does have a significant effect on motivation through moderating digital literacy. This implies that digital literacy may act as a moderating variable that either strengthens or weakens the relationship between device addiction and motivation. These conflicting results underscore the urgent need for further investigation to comprehend the intricate interactions between

device addiction, digital literacy, and motivation. This study contributes by confirming that context and mediating variables are crucial in the analysis of technology's impact on learning behavior and motivation.

In addition, in line with Liu et al.'s (2023) research, this study's findings observed that motivation significantly influences digital literacy. Both studies emphasize the role of motivation in driving individual engagement and proficiency in digital literacy. The findings indicate that fostering intrinsic and extrinsic motivation can effectively improve students' digital literacy skills. This is important in the context of higher education, where digital literacy skills are becoming increasingly crucial for academic and professional success in the Industrial Revolution 4.0 era.

This study also found that device addiction had no significant effect on motivation when mediated by digital literacy, which is in line with the findings of Güngören et al. (2022) and Chiu et al. (2022). However, Dashtestani and Hojatpanah (2022) study provided contrasting results, showing that device addiction significantly impacts motivation through the moderation of digital literacy. This difference in results highlights the need for more comprehensive research and the use of more robust analytical methods to determine the exact relationship between these variables.

Furthermore, Ali et al. (2015) study revealed that curiosity significantly influences digital variation through the moderation of device addiction. Although Williamson et al.'s (2022) study did not explicitly test this relationship, Boettcher's (2022) findings underscore the importance of curiosity in influencing individuals' diverse and exploratory use of digital technologies. This highlights the potential of curiosity in promoting digital creativity and innovation, which are important aspects of education in the digital age.

The practical implications of this study for curriculum and program development in higher education are significant. By fostering students' curiosity and motivation, their digital literacy can be improved, thereby enhancing their academic performance and readiness for the workforce. Educational institutions can consider integrating strategies that promote curiosity and motivation in learning design and course delivery, making the findings of this study directly applicable to their work.

This study has several limitations that need to be recognized. Firstly, this study used a non-probability sampling method, which may limit the generalization of the findings to a wider population. Secondly, this study was conducted at one university, so the results may need to be more representative of different educational contexts. Thirdly, this study was cross-sectional, so it could not capture the temporal dynamics in the relationship between the variables studied. Further research with a longitudinal design and a more representative sampling method is needed to overcome these limitations and strengthen the validity of the findings.

Overall, this study makes an important contribution to understanding the factors that influence college students' digital literacy and offers insights for developing more effective educational strategies in the digital age.

CONCLUSION

This study concludes that curiosity is important in shaping an individual's ability and interest in understanding digital technology. This finding is consistent with Bae's (2022) and Abdullah and Husaini's (2022) research, which emphasized the importance of curiosity in improving digital literacy and engagement with technology. Based on the results of data analysis, it was found that curiosity significantly influences digital literacy ($p < 0.05$), indicating that more curious individuals tend to have better digital literacy skills. In contrast, device addiction did not have a significant effect on motivation ($p > 0.05$) despite having an impact on digital literacy, in line with the results of Özkan (2022) and Güngören et al. (2022). This finding answers the research question of how curiosity and device addiction affect digital literacy and motivation and confirms that motivational variables play an important role in shaping digital literacy skills ($p < 0.01$).

Furthermore, digital literacy moderates the relationship between device addiction and motivation, strengthening the relationship under high digital literacy conditions. This suggests that while device addiction may negatively affect some aspects of digital skills, good digital literacy may offset such effects. Based on these findings, educational institutions need to consider the factors of

curiosity, device addiction, and motivation in designing learning programs. Investments in technology infrastructure, education, and training to develop digital skills are critical to strengthening students' digital literacy. These recommendations are relevant in the context of preparing students to face the challenges of the Industrial Revolution 4.0 era, where digital literacy skills are becoming increasingly critical. In addition, the results of this study support the policy to integrate digital literacy skills development in higher education curricula as a strategy to improve students' work readiness in an increasingly digitalized world.

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