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Determining The Influence of Digital Literacy on Learning Personal Competence: The Moderating Role of Fear of Missing Out

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Abstract: One of the ways to enhance and improve the quality of learning delivery is through the use of technology, particularly the Internet, which facilitates faster and easier access to information. This research aims to explore the degree to which factors such as digital literacy, metacognitive awareness, meaningful learning, habits of using smartphones, and personal learning competence are related to one another. Both the relationship between metacognitive awareness and personal learning competence, as well as the relationship between smartphone habits and personal learning competence, are moderated by a moderating variable known as the fear of missing out. Fear of missing out is a moderating variable. Structural equation modeling, specifically partial least squares, was employed to analyze data from 597 engineering students. SmartPLS version 4 was the tool used for this analysis. The study found that the moderating variable, fear of missing out, significantly impacts metacognitive awareness, learning personal competence, and smartphone habits, making it a crucial factor to investigate. This result is significant because it is a variable that influences the learning that students go through for their education and because it is an extremely important thing to investigate.

Keywords: *Learning personal competence, fear of missing out (FOMO), metacognitive awareness, digital literacy, meaningful learning.*

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Introduction

The rapid development of digital technology and information entering the educational environment is inevitable, with the rapid and easy dissemination of information being one of the promising factors of digital technology (Karatas & Arpaci, 2021). The changes that occur and the significant impact caused by rapid technological advances and their increasingly widespread use also manifest in the field of education (Akat & Karataş, 2020). From elementary schools to universities, the learning process is transformed from face-to-face to online learning using technological assistance (Mustajab et al., 2020; Samala et al., 2024). Mobile phones are a technological tool that is personal, portable, and increasingly used in the learning process (Khan & Chiang, 2014).

Under conditions that allow students to learn independently, it can provide flexibility for learners to always be learning by using materials that can be obtained independently, thus creating personalized learning where learning is centered on each learner. This methodology is interesting because, in this case, the student is placed at the core of the learning process (Hesson & Shad, 2007), where he/she has a sense of responsibility with the teacher's role centered on guiding the learning process and providing an appropriate environment to facilitate engagement, absorption, and retention (Rayens & Ellis, 2018).

Any engineering curriculum that wants to be successful must include practical classes that can usually only be done face-to-face, must change to activities that can be done independently by each student (Ożadowicz, 2020). Additionally, for them to effectively comprehend their practice, it is necessary to have clarity in the lessons and instructions they receive

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(Voukelatou, 2019). Furthermore, meaningful learning needs cognition that is well-organized, consistent, and unambiguous (Fan et al., 2015).

For engineering students, things that happen outside the classroom are important and can have a significant influence on their learning outcomes (Cervin-Ellqvist et al., 2021). Harmony between engineering education and the industrial world in society is necessary, as the knowledge and skills developed need to be adjusted to the needs of a growing society (Ganefri et al., 2019). Development in an educational environment equipped with the competence of the desire to learn that exists in every student increases awareness of the importance of their innovation (Hidayat, 2017). Such an approach can also guide educational institutions in providing the right learning environment that promotes students' academic success and, consequently, aids student retention (Gonzalez-Nucamendi et al., 2021).

The purpose of this study is to investigate the effects of rapid technological advances in the field of education, which, in the past, was primarily conducted in a face-to-face or offline setting, but has since transitioned to a process carried out online . As a result, human lifestyles are affected by this change, and digital literacy, meaningful learning, metacognitive awareness, smartphone habits, learning personal competence, and fear of missing out as important things to discover. From the explanation above, there are several things that need to be explored, including whether students' rapidly increasing digital knowledge can improve their ability to manage their personal learning? In addition, can meaningful learning have a significant impact on students' personal learning ability, especially students in engineering? And does FOMO influence students as one of the moderating factors on their personal learning ability?

Literature Review

Learning Personal Competence

Learning machine could be used to help learners become more independent by allowing them to complete tasks at their own pace (Blair & Shawler, 2020). Learning personal competence involves enhancing students' ability to learn by integrating diverse content and activities into teaching and teacher-student interactions, can be briefly defined as learning how to learn, where it forces one to figure out one's ability to know their own learning patterns (Drăghicescu et al., 2015). Utilizing technology in this manner to tailor one's educational experience is not a new concept. When an online course considers each student's unique background, interests, skillset, and learning style, we refer to it as providing a personalized learning experience (Klašnja-Milićević & Ivanović, 2021; Saari et al., 2024). Therefore, for engineering students to successfully complete lab experiments, collaborate with one another, and acquire the technical and social skills that are pertinent to their field, they need access to laboratories, equipment, and technical instruments (Anwar et al., 2022). The learning process in higher education, particularly in the field of Engineering Education, should be the main focus of the learning and lecture quality assurance unit, enabling graduates to have the necessary skills to compete in the digital workforce (Rizal et al., 2022).

The ability to use digital technology to customize learning for each student shows great promise, as noted by McLoughlin and Lee (2010). However, the customization process places a significant pedagogical and procedural burden on students to enhance the effectiveness of education. Confident students can utilize diverse data sources to collect information regarding their learning behavior, to enhance their learning results (Hidayat et al., 2019; Su et al., 2017). This efficient learning process can then be used to guide the education of others and provide a solid foundation for personalized offerings in online learning environments (Kim et al., 2014). Matching the technological advancements of students, as suggested by McLoughlin and Lee, is crucial for leveraging digital technology to personalize learning experiences.

Digital Literacy

One example of the increasingly complex and varied applications of digital technology is the proliferation of mobile media, which has been especially prevalent in developing nations. This is just one instance of the use of digital technology. However, despite being an excellent starting point, the complexity of digital messages and actions is increasing at an extremely rapid rate (Pearce, 2013). The proliferation of mobile media, particularly in developing countries (Pearce, 2013), is just one example of the evolution of a wide variety of complex digital behaviors (Hidayati et al., 2022).

The digitization of education has enormous ramifications for daily living (Hidayat et al., 2019). Schools and educators are still grappling with how to integrate technology into the curriculum and prepare students for a digital future given the recent emergence of digital gadgets and instructional software (Pangrazio et al., 2020). To better understand the varying expectations placed on schools and students in today's digital society, the concept of digital literacy has emerged as a focal point (Sánchez-Cruzado et al., 2021). Since the concept of digital literacy was developed from the study of traditional literacy, many of the same tensions and difficulties that have plagued studies of literacy have also affected studies of this emerging field (Tejedor et al., 2020).

H1: There is a correlation between digital literacy and metacognitive awareness.

H2: There is a correlation between digital literacy and meaningful learning.

H3: There is a correlation between digital literacy and smartphone habits.

H4: There is a correlation between Digital Literacy and Learning Personal Competence.

Metacognitive Awareness

Metacognition is a form of higher-order cognition characterized by awareness and control of the mental operations needed for learning (Barnes & Stephens, 2019). It is a crucial strategy for achieving academic success and developing problem-solving skills (Hidayat et al., 2024). Factors such as self-reflection, cognitive methods, mindfulness, and preparation impact students' strategy development through metacognition (Vettori et al., 2018). Students' ability to effectively plan, organize, focus, and adjust their cognitive processes and intellectual abilities has been linked to their success in school and problem-solving (Ibrahim & Khatib, 2017).

Metacognitive regulation shows a learner's actual efforts to improve learning abilities through observation, assessment, and organization (Negovan et al., 2015). Students with a strong desire to learn can benefit from using metacognitive strategies. Additionally, students can enhance the quality of their learning by understanding metacognitive skills (Barenberg & Dutke, 2019). Metacognition is particularly important in the field of engineering, where precise and accurate problem-solving skills are essential (Whistler et al., 2019).

Meaningful Learning

Meaningful learning is a formal teaching technique that involves the non-arbitrary and non-literal connection of new knowledge with relevant prior knowledge (Ausubel, 1963). Through sequential interaction, certain assumptions gradually acquire new, richer, more refined, and clearer meanings, serving as anchors for new meaningful learning (Agra et al., 2019). This instructional method allows for changing the conventional curriculum to better engage students in their education, leading to improved outcomes (Fan et al., 2015; Ganefri et al., 2019).

Meaningful learning occurs when students acquire knowledge and stimulate cognitive processes necessary for effective problem-solving (Amrina et al., 2018; Somyürek, 2015). It is also seen as a learning process that helps students better understand learning objectives (Huang & Chiu, 2015). Meaningful learning could be a potential solution to focus students' attention on their online learning behavior (Tsai & Wilson, 2020).

H5: There is a correlation between Meaningful Learning and Learning Personal Competence.

H6: There is a correlation between Meaningful Learning and Metacognitive Awareness.

Smartphone Habit

Smartphones, as one of the most widely used tools today, have expanded beyond being merely a medium of interaction. They have evolved into instruments that offer virtual surroundings (Augner & Hacker, 2012; Samala & Rawas, 2024). This development has also impacted the mobile phone usage pattern, making the employment of this technology potentially problematic when incorrect usage habits are observed (Gökçearslan et al., 2016).

The majority of people who own smartphones use them for a variety of purposes in addition to making phone calls, such as playing video games, conducting online transactions, exchanging messages, and engaging in many other activities (Jalinus et al., 2022; Kwon et al., 2013). In other words, excessive use of cell phones may lead to addiction, and as a result, the behaviors that users, particularly students, adopt when using their devices are becoming increasingly crucial (Lin et al., 2015).

H7: There is a correlation between smartphone habit and meaningful learning.

H8: There is a correlation between smartphone habit and metacognitive awareness.

H9: There is a correlation between smartphone habit and learning personal competence.

H10: There is a correlation between metacognitive awareness and learning personal competence.

The Moderating of Fear of Missing Out (FOMO)

Fear of missing out (FOMO) is associated with feeling excluded from desired experiences or having a strong desire to stay connected to what others are doing (Przybylski et al., 2013). FOMO is a persistent anxiety that individuals may experience when they notice others enjoying moments or experiences without their presence (Irshad et al., 2022). It is a social construct linked to access to various forms of information such as text and multimedia (images/video) (Hetz et al., 2015). This can impact a person's metacognition, potentially affecting the learning ability of a self-oriented learner by causing excessive anxiety about their surroundings.

Students who suffer from FOMO may experience heightened levels of tension and anxiety, which might impede their ability to engage in metacognitive awareness and reflect on their learning process (Stanton et al., 2021). This is due to the fact that FOMO might encourage students to prioritize their fear of missing out over their educational goals and

strategies. On the other hand, students with a strong level of metacognitive awareness have greater control over their stress and anxiety, enabling them to maintain a positive mindset even in the presence of FOMO fatigue (Ye et al., 2023).

FOMO is connected to the evolving communication norms of younger generations who heavily rely on online platforms for communication (Tomczyk & Selmanagic-Lizde, 2018). It involves negative emotions stemming from the perception of missing out on an event, which is significant in the educational realm and has been discussed in various contexts (Tomczyk & Selmanagic-Lizde, 2018). Students with learning disabilities experience higher levels of anxiety, sadness, and stress symptoms compared to other groups, impacting their learning comprehension (Gallego-Gómez et al., 2020). This heightened anxiety may influence students' smartphone usage habits, which can, in turn, affect their self-oriented learning ability and personal learning style.

FOMO increases the likelihood of students prioritizing the act of following others over their learning objectives, which can negatively impact their competency (Qutishat & Sharour, 2019). This might lead to a deficiency in self-awareness and self-control, which are crucial for one's competence. However, students are more likely to develop personal competence if they can manage their FOMO and cultivate positive smartphone habits. Academic achievement greatly depends on the skills of learning prioritization, goal setting, and adaptability to changing conditions (Tunc-Aksan & Akbay, 2019).

H11: Fear of missing out has an impact on the relationship between metacognitive awareness and learning personal competence.

H12: Fear of missing out has an impact on the relationship between smartphone habits and learning personal competence.

The research model as shown in Figure 1, is to identify the factors that influence Learning Personal Competence.

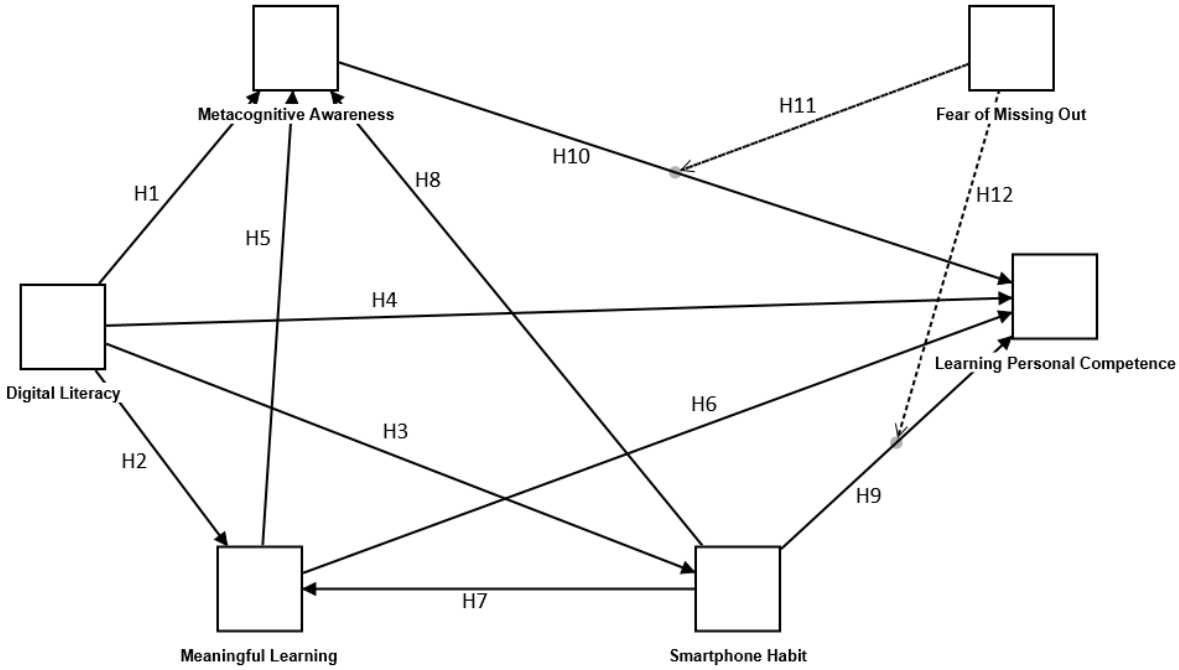

Figure 1. Research Model

Methodology

Participants and Data Collection

A poll sent through Google Forms was used as part of a quantitative research method in this study. This choice was made because the quantitative method makes it possible to look into the links between all the things that are being studied in more depth. Altogether, there are 5,721 students in Universitas Negeri Padang's engineering school. The large size of the population led to the use of the convenience selection method. Panda and Mohapatra (2024) say that choosing the right sample size is one of the most important parts of any study, since a small group might not be typical of the whole community and might not give useful results. Gliner et al. (2009) suggest that a comprehensive research protocol includes defining research settings, components, and population participants, limitations in studying beliefs, and methods for data collection and analysis. In this study, a total of 597 Engineering Education students from Universitas Negeri Padang. These participants were recruited using website tools, and they completed a web-based questionnaire that included statement items representing each variable in the research. All data collected from the respondents who completed the

questionnaire can be utilized, as the distribution process was carefully managed. We distributed the instrument to a total of 597 individuals, and all of them were subsequently returned by the participants. The study utilized convenience sampling, a technique that involves collecting data from individuals in the general community who voluntarily submitted it. By employing this method, any person who is willing to provide the required tool to the researcher can be included as a participant in the study, as long as the respondent is willing to reveal the information. Table 1 presents data regarding the attributes of the participants participating.

Out of the total number of respondents, 214 were male (35.8%) and 383 were female (64.1%). In terms of age groups, there was 1 respondent above 24 years old (0.17%), 10 participants aged 23-24 years (1.68%), 231 participants aged 21-22 years (36.69%), the majority of respondents were in the 19-20 age group (56.11%), and 20 participants were in the 17-18 age group (3.35%).

Table 1. Respondents Demographic

Demographic	Variable	Frequency	Percentage
Gender	Man	214	35.85%
	Woman	383	64.15%
	Total	597	100.00%
Age (years old)	> 24	1	0.17%
	17 - 18	20	3.35%
	19 - 20	335	56.11%
	21 - 22	231	38.69%
	23 - 24	10	1.68%
	Total	597	100.00%
Duration of using the Internet a day (hour(s))	> 10	177	29.65%
	1 - 3	43	7.20%
	4 - 6	199	33.33%
	7 - 9	178	29.82%
	Total	597	100.00%

Instrument

Most of the measurement items in this study refer to previous research, and adjustments were made based on the context of this study. Thus, it was found that the measurement of items in this study used a Likert Scale, where all measurement items were scored using five points ranging from 1 (strongly disagree) to 5 (strongly agree). Within the scope of this study, questionnaires were utilized as research instruments. The majority of the test instruments that were utilized in this investigation were derived from earlier studies, with only minor adjustments made in order to accommodate the requirements of the present investigation. As a research instrument, the questionnaire that individuals fill out serves the purpose of evaluating the variables that are being investigated. This questionnaire is designed to collect precise data on a variety of topics, including digital literacy, metacognitive awareness, meaningful learning, smartphone habit, learning personal competence and fear of missing out.

Digital literacy, in measuring the digital literacy variable, this study used three items from the study Son et al. (2017), these items can identify user skills in employing digital media, including communication tools, internet networks, etc. User competency in digital literacy entails the capacity to locate, work with, assess, use, generate, and apply digital information judiciously, thoughtfully, attentively, and precisely by its intended purpose.

Metacognitive Awareness, to measure this variable, this study refers to previous research conducted by Jaleel and Premachandran (2016), research conducted on school children, in which four items were adopted in this study which could represent the metacognitive awareness variable. These items relate to students who can pay attention to every detail of the learning process they go through such as tasks that are carried out systematically.

Meaningful Learning in this study, meaningful learning was measured by adopting a previous study conducted by Fan et al. (2015), which examined the impact on students who use games as a medium to enhance their learning ability. This study adopted four items from the study to represent meaningful learning in this study.

Smartphone Habit, to measure the Smartphone Habit variable in this study refers to previous research conducted by Van Deursen et al. (2015), in which participants were asked for their views on using the smartphone they own, three statements that could represent the smartphone habit variable have been adapted to this study. The participants were asked to state how smartphones are in their daily lives, and how dependent they are on smartphones.

Learning Personal Competence, in measuring the learning personal competence in this research, researchers adopted previous research conducted by Kwan et al. (2010) which researched the growth of interest in learning regarding their desire to grow in their fields by conducting independent learning. From this research, four items were adopted that could be used as measurements for learning personal competence, where these items represented independent learning.

Fear of Missing Out, in the fear of missing out (FOMO) variable where respondents were asked to give their responses to two statement items that could be a representation of the FOMO variable, these statement items were adopted from previous research conducted by Gallego-Gómez et al. (2020) and became part of a statement of their feelings towards the possibility that they could miss something that might be an interesting part of their lives. Table 2 below explains each item used in this study. Where each item used is on normal loadings where the smallest loadings value is .692. Using the inner Variance Inflation Factor (VIF) as well as the PLS-SEM method, a statistical technique was used to assess common bias in our study (J. F. Hair et al., 2019). VIF values ranged from 1.228 to 2.269 (see Table 2), which is below the threshold of 3.30 suggested by Kock (2015) for considering data to be free of common method bias.

Table 2. Items and Loadings

Items	Loadings	VIF
DL1. Actively respond to discussions through feedback on online discussion forums.	.741	1.228
DL2. Able to write reports or papers to upload to e-Learning.	.814	1.405
DL3. Able to find digital content from various sources.	.751	1.280
FOMO1. It's important to share the details online	.864	1.331
FOMO2. Afraid that other people have more valuable experiences than I do.	.867	1.331
LPC1. Able to predict the demands of lectures well	.791	1.567
LPC2. Know my learning style.	.854	2.269
LPC3. Know my strengths and weaknesses in learning	.838	2.148
LPC4. Able to understand the learning problems I experience	.811	1.810
MA1. I double-check my work to make sure it is completed on time.	.738	1.359
MA2. I pay attention to important information related to a topic.	.712	1.300
MA3. I cover up weaknesses by using good study skills.	.791	1.448
MA4. I think about the benefits of a topic before I start studying it.	.692	1.301
ML1. Can relate the information I learn in one subject to other subjects	.726	1.299
ML2. Learning is a useful activity	.791	2.010
ML3. It is important to understand what I am learning	.794	2.106
ML4. Can be applied to my studies to daily life	.781	1.481
SH1. Using a Smartphone is part of my daily routine.	.875	1.526
SH2. My activities depend on smartphones.	.834	1.958
SH3. Using a smartphone is a habit that I cannot leave.	.817	1.953

Data Analysis

The data was analyzed using the variation-based Structural Equation Modeling (SEM) method called Partial Least Square (PLS) in SmartPLS version 4. When dealing with small data sizes, missing values, atypical data distribution, and multicollinearity, PLS uses the OLS (Ordinary Least Square) technique to overcome regression analysis's restrictions. SmartPLS validates data and structural models. For this investigation, the methodology utilized a two-step data analysis procedure, beginning with an evaluation of the validity and reliability of the measurement model (Ghasemy et al., 2020). The convergent validity of the study was assessed using standard item loading and average variance extracted (AVE), while the discriminant validity was evaluated using the heterotrait-monotrait ratio of correlations (HTMT).

Table 3. Cronbach's Alpha, Composite Reliability, Average Variance Extracted (AVE)

	Cronbach's alpha	Composite reliability	Average variance extracted (AVE)
Digital Literacy	.755	.756	.592
Fear of Missing Out	.766	.766	.749
Learning Personal Competence	.842	.843	.679
Meaningful Learning	.778	.778	.598
Metacognitive Awareness	.715	.722	.539
Smartphone Habit	.805	.869	.710

Findings/Results

Measurement Model

After running the PLS-SEM Algorithm or also called the standard algorithm for calculating components (factors) PLS is nonlinear iterative partial least squares or abbreviated as NIPALS, and bootstrapping is a statistical technique that randomly selects and replaces values with values from a set of observed values. Bootstrapping is a technique used to assess the dependability and precision of sample estimates. This approach is commonly suggested for small samples or samples with unknown or non-normal distributions (Egbert & Plonsky, 2020). To assess measurement quality, standardized item loadings, Average Variance Extracted (AVE), Heterotrait-Monotrait Ratio of Correlations (HTMT), Composite Reliability, and Cronbach's alpha were examined for all constructs.

According to Table 3, all Composite Reliability and Cronbach's alpha values are more than .70 (J. F. Hair et al., 2012). In addition, the data satisfies convergent validity, as shown in Table 2, because all factor loadings for each indicator on the appropriate latent construct surpass the .60 benchmark, and the AVE for each construct exceeds the 0.50 benchmark (J. F. Hair et al., 2012). Furthermore, as indicated in Table 4, the correlation ratio of HTMT is less than .90, satisfying the condition for discriminant validity, the data shows that the lowest correlation is on smartphone habit and the relation of moderating FOMO on metacognitive awareness and learning personal competence with the value of .099. In Table 5, the study provides information on the Fornell-Lecker criterion, which states that the construct value shares a greater amount of its variation with the item that measures it. Therefore, it can be concluded that the Fornell-Lecker criterion used in this study is deemed satisfactory.

Table 4. Heterotrait-Monotrait Ratio of Correlations (HTMT)

	DL	FOMO	LPC	ML	MA	SH	FOMOXMA	FOMOXSH
DL								
FOMO	.195							
LPC	.681	.275						
ML	.730	.205	.749					
MA	.770	.191	.642	.563				
SH	.271	.385	.247	.295	.139			
FOMOXMA	.066	.216	.057	.061	.043	.099		
FOMOXSH	.141	.184	.163	.124	.101	.108	.103	

In Table 5, the study provides information on the Fornell-Lecker criterion, which states that the construct value shares a greater amount of its variation with the item that measures it. Therefore, it can be concluded that the Fornell-Lecker criterion used in this study is deemed satisfactory.

Table 5. Fornell-Larcker Criterion

	DL	FOMO	LPC	MA	ML	SH
DL	.770					
FOMO	.129	.866				
LPC	.508	.208	.824			
MA	.529	.132	.502	.734		
ML	.526	.094	.620	.429	.774	
SH	.212	.270	.208	.111	.260	.843

In the context of structural equation modeling (SEM), the Standardized Root Mean Squared Residual (SRMR) is a metric that quantifies the average discrepancy between the covariance matrix implied in the model and the observed covariance matrix. It is employed to integrate the model with the data. The square root of the average of the sum of the squared differences between the non-redundant cell contents of the model and empirical indicator correlation matrices is used to calculate SRMR. In this study, the SRMR shown in table 6 value is at 0.073, which is the recommended result (Hooper et al., 2008).

Table 6. Model Fit Summary

	Saturated model	Estimated model
SRMR	0.076	0.073
d_ULS	1.221	1.432
d_G	0.361	0.372
Chi-square	1359.114	1388.144
NFI	0.696	0.698

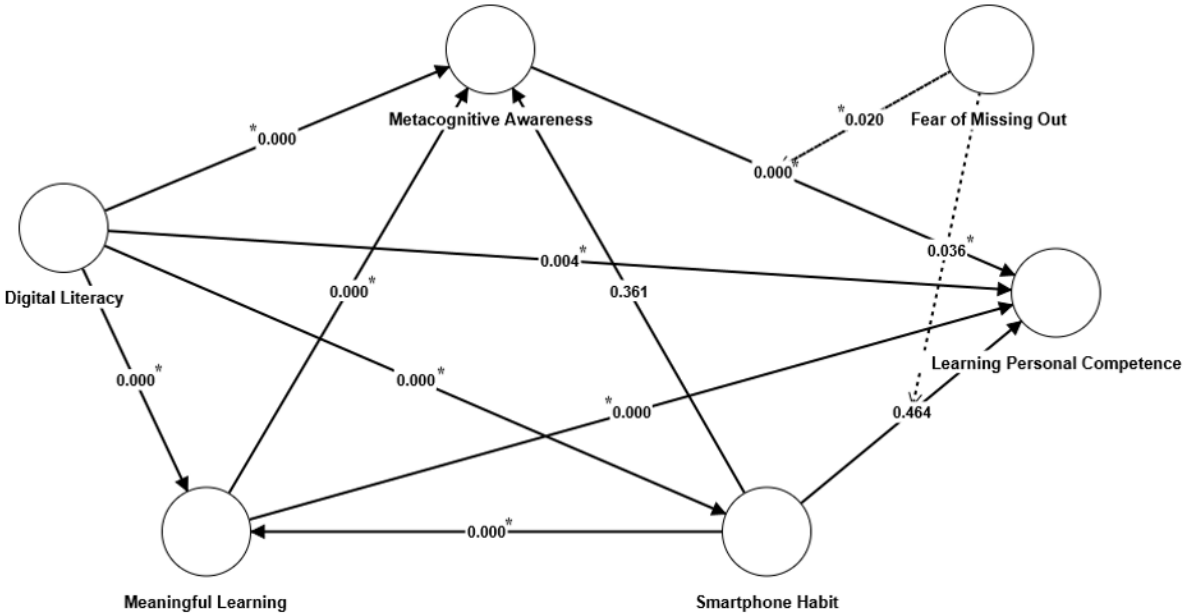

Figure 2. Path Analysis Result

The results of the data collected by the respondents and analyzed using SmartPLS can be seen in Figure 2, which shows the paths of all hypotheses designed in this study, where the results of the analysis test in this study can be seen in Table 7, and Table 8 shows the effect size of each accepted hypothesis, where the results of each effect are calculated by referring J. Hair et al. (2017). From these results, it can be seen in hypothesis 1; namely, the effect of digital literacy on metacognitive awareness is positive and has a significant effect (β = 0.049, *p* = .000) whereby increasing digital literacy, someone will feel good metacognitive awareness, this relationship has a medium effect where the existing influence has a moderate effect, such a relationship is also found in hypothesis 2, namely the effect of digital literacy on meaningful learning (β = 0. 038, *p* = .000), whereby increasing digital literacy, someone will be able to interpret a lesson they are learning well which this relationship has a large effect, in other words, the effect is quite large. Meanwhile, hypothesis 3 is the effect of digital literacy on smartphone habit (β = 0.045, *p* = .000), where with good digital literacy, students will have a habit of using smartphones properly, can regulate their awareness in using smartphones, where the size of this impact has a small effect. Then, hypothesis 4 is the effect of digital literacy on learning personal competence (β = 0.048, *p* = .004), where with good digital literacy, students will have good learning personal competence, where learning personal competence, where the size of this impact has a small effect, it can be said that students can improve digital literacy to be able to manage learning personal competence.

Hypothesis 5 meaningful learning on learning personal competence has a significant effect (β = 0.046, *p* = .000) where this can indicate that the more students can interpret the learning that is being done, the students will be able to carry out the learning process independently, where the effect size of this correlation is medium, with a moderate effect, interpreting learning will have a medium effect on the ability to learn independently, in hypothesis 6 the effect of meaningful learning on metacognitive awareness has a significant relationship (β = 0. 045, *p* = .000) where this means that by giving meaning to the learning that is done, students will be able to reflect on the lesson well, where the effect of this relationship is small. The results of the analysis in hypothesis 7, namely the effect of smartphone habit on meaningful learning, have a positive and significant effect (β = 0.039, *p* = .000), which means that the habit of using a good smartphone will have a positive impact on students in interpreting the learning process they go through, where this relationship has a small effect, in hypothesis 8, the effect of smartphone habit on metacognitive awareness, there is a positive but insignificant effect (β = 0.038, *p* = .361), this can indicate that the habit of using smartphones does not have a direct influence on metacognitive awareness. Furthermore, in hypothesis 9, the effect of smartphone habit on learning personal competence is positive but not significant (β = 0.033, *p* = .464), this could happen because the habit of using smartphones is not always oriented towards the learning process. In hypothesis 10, the effect of metacognitive awareness on learning personal competence is positive and significant (β = 0.039, *p* = .000), where metacognitive awareness can provide awareness of every process that needs to be passed so that it can provide independent learning management, where this relationship has a small effect size, this still needs to be considered to be able to improve students' independent learning abilities.

Furthermore, in hypothesis 11, fear of missing out as a moderator of the relationship between metacognitive awareness and learning personal competence has a positive and significant effect (β = 0.029, ρ = 0. 020) where the feeling of not being left behind can have an influence on the relationship between metacognitive awareness and independent learning competence, this can occur with students who have friends in the same classroom or on the same subject, so it is possible

for this to happen, where the effect of this relationship is small, even so, the feeling of fear of missing out can have a good influence on improving students' learning abilities, in hypothesis 12, the moderating variable, fear of missing out which moderates the relationship between smartphone habit and learning personal competence has a positive and significant effect (β = 0. 028, *p* = .036), with the feeling of fear of being left behind, will influence the way students use smartphones that could be oriented towards learning, so as to improve the independent learning ability of these students, where the effect of this relationship is small.

Table 7. Summary of Structural Models

Hypothesis	β	t	ρ	Results
H1. Digital Literacy -> Metacognitive Awareness	0.049	8.711	.000	Accepted
H2. Digital Literacy -> Meaningful Learning	0.038	12.863	.000	Accepted
H3. Digital Literacy -> Smartphone Habit	0.045	4.748	.000	Accepted
H4. Digital Literacy -> Learning Personal Competence	0.048	2.901	.004	Accepted
H5. Meaningful Learning -> Learning Personal Competence	0.046	9.306	.000	Accepted
H6. Meaningful Learning -> Metacognitive Awareness	0.045	4.731	.000	Accepted
H7. Smartphone Habit -> Meaningful Learning	0.039	3.987	.000	Accepted
H8. Smartphone Habit -> Metacognitive Awareness	0.038	0.914	.361	Rejected
H9. Smartphone Habit -> Learning Personal Competence	0.033	0.733	.464	Rejected
H10. Metacognitive Awareness -> Learning Personal Competence	0.039	5.656	.000	Accepted
H11. Fear of Missing Out x Metacognitive Awareness -> Learning Personal Competence	0.029	2.327	.020	Accepted
H12. Fear of Missing Out x Smartphone Habit -> Learning Personal Competence	0.028	2.101	.036	Accepted

Table 8. Effect Size

Hypothesis	f-square	Effect
H1. Digital Literacy -> Metacognitive Awareness	0.187	Moderate
H2. Digital Literacy -> Meaningful Learning	0.332	Large
H3. Digital Literacy -> Smartphone Habit	0.047	Small
H4. Digital Literacy -> Learning Personal Competence	0.022	Small
H5. Meaningful Learning -> Learning Personal Competence	0.234	Moderate
H6. Meaningful Learning -> Metacognitive Awareness	0.047	Small
H7. Smartphone Habit -> Meaningful Learning	0.033	Small
H10. Metacognitive Awareness -> Learning Personal Competence	0.066	Small
H11. Fear of Missing Out x Metacognitive Awareness -> Learning Personal Competence	0.008	Small
H12. Fear of Missing Out x Smartphone Habit -> Learning Personal Competence	0.007	Small

Discussion

This study aims to examine the impact of digital literacy, meaningful learning, metacognitive awareness, and smartphone habits on learning personal competence. Additionally, it will explore the role of fear of missing out as a moderator in the relationship between metacognitive awareness and learning personal competence, as well as the relationship between smartphone habits and learning personal competence. Rapid technological advancements have a substantial impact on students, especially those who are in the age group where they are capable of being productive. This is particularly accurate in this age of omnipresent smartphones. Based on the results of a study conducted among college students, the presence of internet access is a crucial factor to take into account when selecting a location. Additionally, the extent to which individuals rely on their mobile phones greatly influences their interpersonal relationships. Utilizing technology to personalize one's educational experience is not a new concept when implemented in this way. Personalized learning experience is achieved when an online course considers the unique background, interests, skillset, and learning style of each student (Saari et al., 2024). Learning and lecture quality assurance unit should prioritize the engineering education process in higher education (Rizal et al., 2022). Thus, this will ensure that students are sufficiently equipped to compete in the digital workforce upon completing their education.

A student's awareness of managing the learning process and following every learning process that exists both in class and outside class hours is very important. Knowledge about digital technology is very important and affects one's metacognition. It can also be seen that self-control, which is a form of good awareness, will increase one's metacognition. In this study, it was found that digital literacy has a significant effect on metacognitive awareness. This is in line with the findings obtained by (Mucha et al., 2020).

Where metacognition is closely related to the ability of students to be able to decide the direction of their learning outcomes, in this study, the effect of smartphone usage habits on metacognitive awareness was not significant. This finding contradicts research conducted by (Saritepeci, 2020; Wilmer et al., 2017). The habit of using excessive

smartphones and their use that does not follow daily needs will have an adverse impact on the learning process of students.

To get a good experience in the learning process to be able to make meaning of their learning, students are guided to maintain focus and continue to deepen their understanding of certain concepts related to their lessons, this is also an important part of the meaning contained in the learning process, students' metacognitive awareness will also increase. This study found that learning has a significant impact on metacognitive awareness, it provides individuals with the opportunity to acquire and hone metacognitive abilities such as strategizing, monitoring, and evaluating their learning process. Enhancing metacognitive awareness empowers students to assume responsibility for their learning, identify their strengths and shortcomings, and adapt their strategies accordingly, this is in line with the findings of research conducted by (Agra et al., 2019).

Smartphones can be part of the learner's experience in learning a concept, in this study, the effect of smartphone habits on meaningful learning found a significant effect, and this finding is in line with the findings of research conducted by (Tsai & Wilson, 2020). A person's awareness and ability to associate one knowledge with others knowledge is interpreted as having good metacognition.

In this study, metacognitive awareness was designed to have an impact on personal competency learning, and it was found that the effect had a significant effect, this finding agrees with the findings of the research carried out by (Baltaci et al., 2016), which can be seen here. The ability of learners to engage in planned self-learning is impacted positively by their level of metacognitive awareness. It is necessary to have metacognitive awareness, which influences students' abilities to remain consistent with the teaching materials they are learning. Given that the effect of metacognitive awareness on learning personal competence is measured in this study, and it is found that the effect is significant and that these findings are also in line with the findings from research conducted by (DeMink-Carthew et al., 2020), it can be said that these findings support one another. Thus, awareness of good metacognitive will also have a good impact on learning conducted by students independently.

This study measured the effect of meaningful learning on learning personal competence, and it was found that the effect is significant. These results are also in line with previous research conducted by (Basham et al., 2016). A positively meaningful learning process will also have a positive impact on the learning carried out by students themselves.

Metacognitive awareness affects students' ability to remain consistent with the teaching materials they learn, so the effect of metacognitive awareness on self-learning competence was measured in this study and found to have a significant effect, and this finding is also in line with the findings of research conducted by (DeMink-Carthew et al., 2020). Thus, good metacognitive awareness will also have a good impact on students' self-directed learning. The influence of FOMO on the relationship between metacognitive awareness and learning personal competence is a very important thing to note, considering the dependence of students' teaching outcomes on the impact that exists in the new normal era as it is today depends on students' ability to learn independently. FOMO can hurt students' metacognitive awareness and impact their learning competence. The results of this study give us important information about the factors that affect how a person's skills improve. Still, it is very important to think about the possible flaws and ideas for more study. When convenience sampling is used, the sample size that is needed is smaller, which could make it harder to apply the results to a bigger group of people. To avoid this problem, it is suggested that any future study on this subject use a bigger sample size and a random sampling method. In addition, it is very important to think about the possibility of bias and the reliability of statistics that people report themselves. The researchers had trouble making sure that the participants' answers were in line with what they had learned in school while they were doing their studies.

The habit of using smartphones is an important part of students' learning orientation that has an impact on their learning outcomes and knowledge, especially in the field of engineering, which requires caution and considerable risk. Students need to pay attention to the habit of using smartphones with the existence of FOMO, which can hurt excessive smartphone use and not useful use. Good use can have a positive impact on students' ability to learn independently and enable them to get good grades. In this study, it was found that the fear of missing out significantly influenced the relationship between smartphone habits and learning personal competence, this finding is in line with research conducted by Gökçearslan et al. (2016), where it was also found to be significantly positive in this study.

Conclusion

In recent years, there has been a significant rise in the application of technology in educational settings. As a result of the rapid spread of technology and the increased convenience it offers, the educational environment needs to be able to adapt to keep up with the changes. This presents a promising opportunity to enhance the educational system worldwide. Our work contributes to various actors with authority in the world of education, particularly in the education of engineers, and this contribution is particularly important to us. When students have to be able to learn offline and also take part in online events, the effect is much more serious. This affects the teaching pattern, which means that it needs to be adapted so that it is suitable for each learner who is taking part in the process of being taught. The smartphone has quickly become one of the most popular electronic devices in today's society because of its portability and friendliness to its users. In addition, it is an important part of the learning process for the students themselves, making it an essential component.

To be more specific, with regards to digital literacy, metacognitive awareness, meaningful learning, smartphone habit, learning personal competence, and the moderator, FOMO. Because of the current state of technology and the internet, which is advancing at an astonishing rate and has become an essential component of every aspect of human life, these factors play an important role in the process of teaching and learning in the field of education across the globe. In light of all of these factors, this holds especially true for the field of engineering education.

Technical education students need motivation to learn. The traditional curriculum emphasizes cognitive learning and is influenced by theory. Engineering students must study theory and practice. Technology has become crucial to students' learning abilities, especially when they can use it appropriately and have a passion for learning, including independent learning. Student-centered learning methods that boost students' motivation to learn. The importance of autonomous support, proper feedback, and emotional support in the digital age has led to rapid progress and motivation.

Our findings can inform educational planners of the importance of emphasizing study skills to empower students to manage their education. To improve learning and enthusiasm for engineering, we found that self-regulation can be taught in engineering classes. This research sought to better understand students' self-directed learning abilities, which have been linked to academic success. Engineering education may improve with improving technology and students' awareness of their preferred learning style.

Limitations

The results of this study give us important information about the factors that affect how a person's skills improve. Still, it is very important to think about the possible flaws and ideas for more study. When convenience sampling is used, the needed sample size is smaller, which could make it harder to apply the results to a bigger group of people. To avoid this problem, any future study on this subject is suggested to use a bigger sample size and a random sampling method. In addition, it is very important to think about the possibility of bias and the reliability of statistics that people report themselves. The researchers had trouble ensuring that the participants' answers aligned with what they had learned in school while they were doing their studies.

The actual results of this study also show that using smartphones did not affect the metacognition or learning skills of the people who took part in the study. As one of the possible outcomes of this research, the current study could be expanded to include more factors that affect how well kids do in school. The researchers weren't able to find out how much schooling the people who took part in the study had. You can greatly improve your ability to learn on your own in engineering by making sure that the information you are studying is very important. One of the best things about it is that it serves as a strong reminder and an inspiration for their academic journey. For students to be able to remember things and use them in a useful way, they need to understand the theory they are learning and be able to put that theory into practice. This should still be the most important thing for all students, even the ones who are really into their studies and getting a lot done. In a future study on the topic, it might be interesting to see how strongly multidimensional tests of self-awareness are linked to effective learning strategies. More studies need to be done to find out what uses mobile phones might have in the field of education.

Recommendations

This study sheds light on the factors that decide a person's ability. But it is important to think about ideas properly. When convenience sampling is used, the sample size is smaller, which makes it harder to draw broad conclusions. So, bigger samples and random selection should be used in future studies on this topic. Also, it's important to think about bias and how reliable self-reported data is. The researchers had a hard time finding a link between the subjects' answers and what they had learned in school.

According to the results of this study, using smartphones did not change the way the subjects thought or learned. The scope of this study could be expanded to look into other things that affect how well students do in school. It wasn't known what kind of schooling the people in the study had. Getting involved with important school material is a great way to improve self-directed learning in engineering. This is a great way to keep them motivated and serve as a steady reminder of their academic goals. For students to remember and use theory well, they need to fully understand it and know how to use it well. All students, even those who do well in school, must make this a priority. In the future, researchers may look into the link between multiple self-awareness tests and good ways to learn. More research needs to be done to find out what uses mobile phones might have in the field of education.

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Authorship Contribution Statement

Hendra Hidayat: Concept and design, supervision, final approval, Zadrian Ardi: Data acquisition, technical or material support, Ahmad Istiqlal Ahlunnazak: Drafting the manuscript, Dani Harmanto: Statistical analysis, Chibueze Tobias Orji: Critical revision of the manuscript, Mohd Rizal Mohd Isa: Technical or material support.

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