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Importance of Metacognitive Awareness in Learning and Instruction for Engineering Students' Education

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Abstract

This study explores eight key themes: Self-control, personalized learning, smartphone habits, future-time perspective, information overload, digital literacy, meaningful learning, and metacognitive awareness. The primary objective is to investigate the correlations among these factors. Virtual presence serves as a moderating variable, influencing the connections between smartphone habits and digital literacy, as well as between self-control and digital literacy. Additionally, it moderates the relationship between self-control and information overload. The study collected data from 597 engineering students, utilizing a quantitative research approach and employing a questionnaire as the research instrument. Statistical analysis was conducted using a partial least squares structural equation model, implemented with SmartPLS version 4. The study's hypotheses showed a significant impact on each variable, with only the relationships between information overload and meaningful learning, and smartphone habit and metacognitive awareness showing no significant effects, as indicated by the findings.

Keywords: *Self-Control, Information Overload, Digital Literacy, Meaningful Learning, Metacognitive Awareness, Virtual Presence*

Introduction

Throughout human history, educational institutions have continually striven to enhance themselves, aiming to equip students with the essential skills and knowledge needed to navigate the global labor market and meet society's demand for proficient and skilled workers. For those aspiring to pursue a career in engineering, proficiency in critical thinking and mathematics is imperative. Key attributes essential for success in this field include creativity, adaptability, a

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keenness for continuous learning, proactive problem-solving, and the ability to observe and analyze (Hidayati et al., 2022; Makgakga, 2023; Molomo, 2023). Identifying the primary factors affecting the academic performance of engineering students in a specific educational setting is a critical challenge that demands attention (Gonzalez-Nucamendi et al., 2021). Recent years have witnessed noteworthy progress in educational psychology, accompanied by the advent of robust data analysis technologies such as data mining and learning analytics (Devika & Singh, 2019). These advancements have proven advantageous for education. As highlighted by Muller-Frommeyer et al. (2017), the learning center, advocating for a teaching concept emphasizing practical application, offers students numerous opportunities to enhance their competencies through a self-controlled learning process grounded in competency models.

Cervin-Ellqvist et al. (2021) discovered a significant impact of extracurricular activities on students' learning outcomes in engineering. These activities are pivotal, holding the potential to profoundly influence the teaching and learning processes. Emphasizing the importance of aligning industry and engineering education, Ganefri et al. (2019) stress the need to harmonize both realms. To meet the evolving needs of the community, it is essential to adapt acquired knowledge and skills accordingly (Bentri et al., 2022). Creating an educational environment that nurtures students' intrinsic motivation to learn and aligns with their individual competencies can amplify the recognition of the significance of their creative abilities (Hidayat, 2017). This cultivation of each student serves as a blueprint for educational institutions seeking to establish a conducive learning setting that promotes academic success, subsequently enhancing student retention, as highlighted by González-Nucamendi et al. (2021). Adopting this approach can be instrumental for educational institutions striving to achieve these objectives. The study conducted by Su et al. (2017) revealed that students engaged in online classes generate a substantial amount of data pertaining to their academic pursuits, including a significant volume of multimedia data. This information proves highly valuable for comprehending the intricacies of the human learning process (Samala & Amanda, 2023). Leveraging these insightful learning curves enables individuals to facilitate learning for others, laying the groundwork for robust personalized online learning system services (Kim et al., 2014). This underscores the rationale behind the current landscape where many individuals leverage emerging technologies, such as augmented reality and virtual reality, along with user-friendly software solutions (Samala et al., 2023). The virtual nature of an individual prompt's questions about its impact on determinants like self-control, digital literacy, smartphone usage habits, and information overload. Do the learning strategies devised by institutions emerge as crucial factors for students to exercise mental discipline, especially given the necessity for instructional methods to adapt to technology? Furthermore, does the value students place on their learning for meaningful comprehension contribute significantly to their development of metacognitive awareness? A deeper understanding of the intricate dynamics between students and teachers has the potential to enhance the educational experience for both parties, leading to improved outcomes. The research findings provide valuable insights, emphasizing the potential benefits of implementing enhanced programs in educational institutions, including colleges and universities.

Literature Review

Metacognitive Awareness

The term "metacognitive," introduced by Flavell in 1976, sparked considerable debate regarding its definition. Essentially, metacognitive activity involves thinking about thinking—a conscious control of one's cognitive processes (Flavell, 1976). Metacognitive activities encompass thinking processes that involve planning, monitoring, and reflecting on how to solve problems (Jaleel & Premachandra, 2016). The close relationship between metacognition, strategies, and student learning outcomes is evident; students with stronger metacognitive abilities tend to achieve better learning outcomes (Baltaci et al., 2016). In the context of the engineering environment, where accurate and precise problem-solving is paramount, metacognition plays a crucial role (Whisler et al., 2019).

Researchers claim that metacognitive thinking involves having control over the mental processes students employ in their learning (Barnes & Stephens, 2019). For students to work independently, effective self-control is important. Metacognition affects how students develop their strategies when considering self-examination, cognitive strategies, knowledge, and planning (Vettori et al., 2018). The utilization of metacognitive techniques proves beneficial for students aiming to enhance their learning outcomes. Additionally, Barenberg and Dutke (2019) emphasize that students can acquire metacognitive skills to improve the quality of their learning.

Meaningful Learning

The meaningful learning theory (MLT) posits that meaningful learning is a powerful method for teaching in formal environments. It involves the deliberate interaction between novel information and relevant prior knowledge, conducted in a systematic manner that goes beyond mere randomness or literal interpretation (Ausubel, 1963). As the learning process undergoes rapid transformations, various resources have emerged to aid students in their assignments. Meaningful learning, a technique that incorporates linking new information with significant concepts already entrenched in an individual's mind, presents itself as a promising approach to formal teaching (Moreira, 1999).

According to Somyürek (2015), meaningful learning occurs when students acquire information and engage in the mental processes required to solve problems. It is viewed as a learning approach that enhances students' comprehension of learning goals (Huang & Chiu, 2015). Additionally, meaningful learning has the potential to encourage students to be more mindful of how they utilize the Internet for learning purposes (Tsai et al., 2020).

Digital Literacy

As everyday life becomes increasingly digital, the impact on education is substantial. While numerous new digital gadgets and teaching apps are available, schools and teachers are still navigating how to effectively integrate them into the classroom, preparing students for their digital future (Hamakali & Josua, 2023; Özel, 2023; Pangrazio et al., 2020). In response to these challenges, digital literacy has emerged as a critical concept for educators, specialists, and government officials overseeing education. It is essential to understand the diverse requirements of students and schools in the digital era (Japar et al., 2023; Moyo et al., 2022; Sánchez-Cruzado et al., 2021). Gilster's seminal research was a pioneering effort to outline the essential skills needed for discerning information in an increasingly digitized environment (Gilster, 1997). Several challenges and issues observed in literacy studies are mirrored in digital literacy, as the latter is derived from the study of literacy itself (Farihin 2022; Tejedor et al., 2020).

Information Overload

Information overload occurs when an individual is confronted with an excessive amount of information that surpasses their capacity to manage effectively (Sweller, 1988). This phenomenon occurs when individuals are exposed to an overwhelming volume of knowledge that exceeds their ability to process and comprehend. Also, communication excess takes place when a person's communication abilities are inundated by the demands of information media engagement (Maier et al., 2015). Information overload, characterized by an excessive amount of information that surpasses one's capacity to process and utilize effectively, can lead to a sense of failure. Concerns have emerged regarding the accuracy of the information provided, given its diminishing quality, and establishing its authenticity is expected to take a significant amount of time. Prolonged waiting periods for valuable information may evoke negative emotions in individuals (Asif & Anwar, 2020). This delay can notably influence children's perception of the future they will inhabit. The abundance of information among students often results in feelings of confusion and tension (Zhang et al., 2016).

Smartphone Habits

Cell phones, among the most extensively utilized gadgets in contemporary society, have undergone substantial advancements, now serving a multitude of purposes beyond mere communication. They have evolved into instruments that furnish individuals with virtual environments and digital personas for recreational purposes. Furthermore, these tools facilitate online shopping, knowledge acquisition, narrative exchange, and financial management (Augner & Hacker, 2012). This transformation has led individuals to use their mobile devices in diverse manners, potentially giving rise to complications (Gokcearslan et al., 2016).

Frequent use of cell phones can escalate into an addiction. To maintain focus, it is crucial to exercise restraint in using these gadgets and limit their usage to appropriate circumstances. Many individuals consider their smartphones as more than just telecommunication devices. According to Kwon et al. (2013), individuals use them for activities such as gaming, online shopping, story sharing, and various other purposes. To elaborate, Lin et al. (2015) assert that excessive smartphone usage has the potential to evolve into addiction.

Personalized Learning

Personalized learning is defined as the process in which e-learning systems endeavor to establish learning environments tailored to the individual requirements, objectives, abilities, and interests of each student (Klašnja-Milićević et al., 2011). The learning and lecture quality inspection unit plays a vital role in vigilantly monitoring the learning process, ensuring that graduates possess the necessary skills and are prepared to thrive in the digital realm. The challenges posed by the COVID-19 pandemic have impacted individuals in accessing and acquiring knowledge through online platforms such as the Internet (Rizal et al., 2022).

The advent of "big data" in the classroom has led to online learners generating vast amounts of data about their experiences. This data becomes valuable for identifying and analyzing learning patterns and trends (Su et al., 2017). The significance lies in the potential use of these substantial learning curves to facilitate the learning process for others and develop intelligent strategies to enhance the personalization of online learning systems (Kim et al., 2014). Personalized learning can be achieved by assessing the individual strengths and abilities of students in utilizing technology (Xie et al., 2019).

Self-Control

Self-control involves the intentional act of disregarding or managing one's own desires and external influences to achieve long-term objectives (Tangney et al., 2004). Possessing this crucial personality feature is integral to developing both personal and societal adaptive responses. The current teaching approach often diminishes individuals' autonomy by prioritizing the completion of effective learning activities, aiming to enhance students' self-assurance and alleviate their apprehension (Gelles et al., 2020). Individuals with high levels of self-control aspire to attain improved physical and mental well-being, enhanced academic achievements, and increased financial prosperity (Xiang et al., 2020).

The current findings suggest that self-control extends beyond merely avoiding temptation (Troll et al., 2021). Presently, the majority of students predominantly use their computers for recreational purposes rather than academic or professional tasks (Lepp et al., 2013). Individuals with high levels of self-discipline report a reduced frequency of succumbing to impulsive behaviors in their daily activities (Imhoff et al., 2014). As noted by Imhoff et al. (2014), those with elevated self-control levels report a diminished occurrence of resisting their impulses in everyday activities. Instead, they excel in developing and maintaining positive behaviors, eliminating the need to evade or abstain from certain items (Galla & Duckworth, 2015).

H1: There is a correlation between self-control (SC) and personalized learning (PL)

H2: There is a correlation between self-control (SC) and smartphone habit (SH)

H3: There is a correlation between self-control (SC) and digital literacy (DL)

H4: There is a correlation between self-control (SC) and information overload (IO)

H5: There is a correlation between self-control (SC) and future-time perspective (FTP)

Future-Time Perspective

Individuals who can strategically plan ahead and delay immediate gratification for the sake of future benefits are said to possess a future-time perspective (FTP) (Zimbardo & Boyd, 2015). FTP is a component of the broader concept known as time perspective. Time perspective involves how individuals categorize their personal and social experiences into distinct time periods. This organizational framework allows individuals to effectively organize, connect, and attribute significance to each occurrence, enabling them to pursue their objectives using their available resources (Zimbardo & Boyd, 2015). The future-time viewpoint is associated with both positive and negative emotions. On one side, it is associated to retirement planning and a positive emotional state (Hidayati et al., 2023). Conversely, it is also associated with stress, sadness, anxiety, and a pessimistic mood (Mooney et al., 2017). Zajenkowski et al. (2016) identified a positive correlation between control and FTP. This is because FTP is a cognitive skill specialized in processing specific types of knowledge, and its effective utilization may require the allocation of cognitive resources.

H6: There is a correlation between smartphone habit (SH) and personalized learning (PL)

H7: There is a correlation between smartphone habit (SH) and digital literacy (DL)

H8: There is a correlation between digital literacy (DL) and personalized learning (PL)

H9: There is a correlation between information overload (IO) and future-time perspective (FTP)

Virtual Presence

Makransky and Petersen (2021) define virtual presence as a sophisticated media system capable of replicating or imitating the physical environment. It includes specific technological configurations and advanced methods of displaying information. According to Mystakidis et al. (2021), virtual presence is a viable method for cultivating student engagement in learning by enhancing the meaningfulness of virtual classroom experiences. By leveraging advanced technologies like virtual reality (VR) or augmented reality (AR), students can immerse themselves in realistic and immersive experiences, a phenomenon referred to as virtual presence (Han, 2020).

With the emergence of contemporary technologies such as virtual reality and augmented reality, coupled with the widespread availability of programming tools, individuals now have the capability to create captivating and enjoyable virtual experiences (Makransky & Petersen, 2021). This is particularly significant in fields such as education, where traditional methods have faced criticism for their inability to adapt to the challenges and advancements of the 21st century (Omodan, 2022; Scott, 2015).

H10: There is a correlation between information overload (IO) and digital literacy (DL)

H11: There is a correlation between information overload (IO) and meaningful learning (ML)

H12: There is a correlation between digital literacy (DL) and meaningful learning (ML)

Metacognitive Awareness

According to Ibrahim et al. (2017), metacognitive strategies are considered crucial for academic success and learning. This underscores the significance of metacognition in enabling students to strategically plan, organize, and adjust their cognitive processes and academic abilities, making it a paramount factor for students. This strategy is associated with intrinsic motivation, cognitive growth, employing appropriate methodologies, educational outcomes, and establishing links between prior knowledge and new learning (Young & Fry, 2008). Metacognition refers to a form of cognitive activity that involves the regulation and control of mental processes employed by students to facilitate meaningful learning (Barnes & Stephens, 2019). Additionally, this strategy proves beneficial in assisting children to excel academically and acquire problem-solving skills. Metacognition influences the development of students' modeling techniques when they engage in self-examination, cognitive processes, information acquisition, and planning (Vettori et al., 2018). Proficiency in modeling is shaped by cognitive strategies and strategic planning abilities.

H13: There is a correlation between meaningful learning (ML) and metacognitive awareness (MA)

H14: There is a correlation between smartphone habit (SH) and metacognitive awareness (MA)

H15: There is a correlation between future-time perspective (FTP) and metacognitive awareness (MA)

Virtual Presence

According to Biocca et al. (2001), our perception of physical space, our mental representation of space, and our virtual experience of space all contribute to our sense of presence. "Sense of presence," also known as "telepresence," refers to the psychological experience of perceiving oneself as being physically located in a digital environment (Grüter & Myrach, 2012). Researchers such as Mollen and Wilson (2010) have reported that being involved in technological advancements is akin to being in an environment mediated by computers. Individuals are considered to experience presence in a computer-mediated setting only when they cease to be aware of the technology, fully engage with the environment, and feel transported to a virtual location (Haans & IJsselsteijn, 2012). The experience of presence significantly affects individuals' emotions and behaviors within virtual environments (Faiola et al., 2013). As part of virtual existence, individuals use Internet-based gadgets like cell phones. In this constructivist approach, students have the opportunity to inquire, generate and evaluate hypotheses, and conduct independent experiments (Bogicevic et al., 2019). While students may possess adaptability, it is crucial for them to maintain self-discipline to enhance the quality of their educational pursuits.

H16: Virtual presence (VP) affects the relationship between smartphone habit (SH) and digital literacy (DL)

H17: Virtual presence (VP) affects the relationship between self-control (SC) and digital literacy (DL)

H18: Virtual presence (VP) affects the relationship between self-control (SC) and information overload (IO)

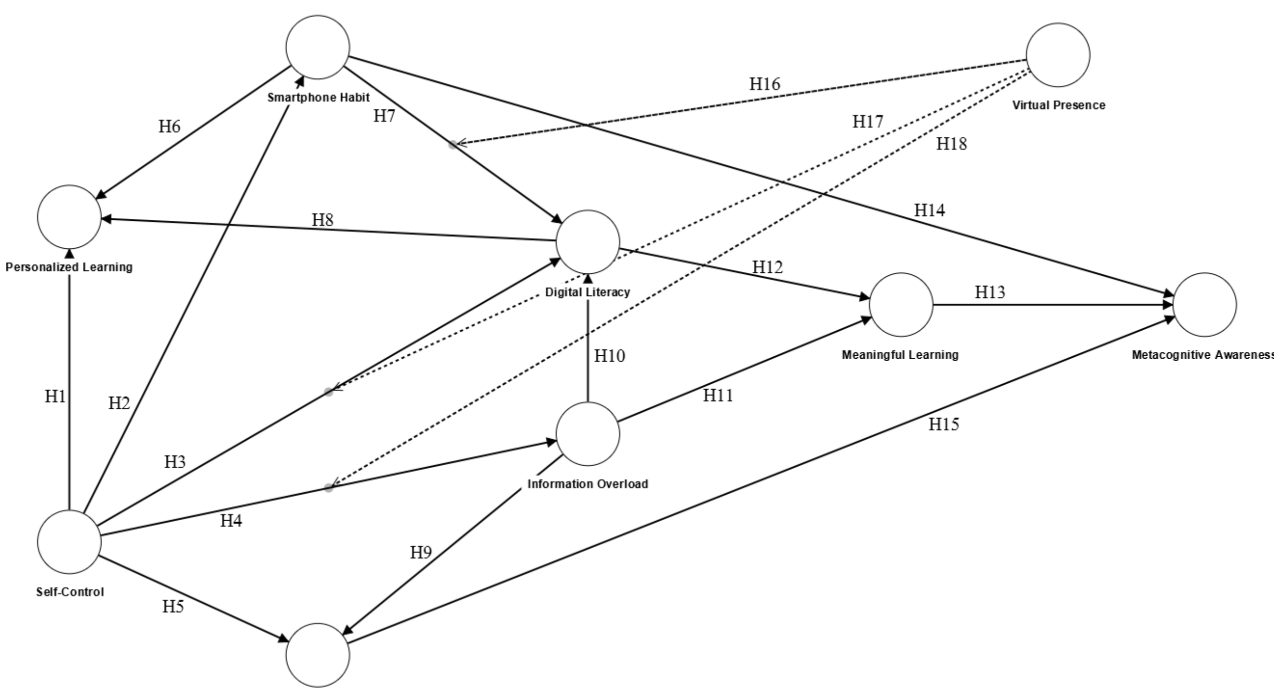

Figure 1. Hypothesis Models

Method

Research Design

This study employed a quantitative research method, utilizing a questionnaire administered through Google Forms. According to Showkat and Parveen (2017), this choice was made because the quantitative method allows for a thorough investigation of the connections between all the components being studied. The total number of students enrolled in the engineering faculty of Universitas Negeri Padang is 5,721. The convenience sampling approach was adopted due to the substantial size of the population. As mentioned by Zikmund (2000), the selection of an appropriate sample size is one of the most crucial components of any study as a small group may not be representative of the entire population and may not yield useful results.

Sample

The study included a total of 597 participants, out of a population of 5,721. We distributed the instrument to 597 people, and all of them were returned by participants. The study employed convenience sampling, a method involving the gathering of information from individuals in the general population who willingly provided it. By using this approach, any individual willing to submit the necessary instrument to the researcher could be included as a sample in the study, as long as the respondent was prepared to disclose the information. Table 1 provides information on the characteristics of the participants involved. In this study, the parameters established by Krejcie and Morgan (1970) were utilized to determine the sample size. The optimal group size falls within the range of 30 to 500 individuals (Roscoe, 1975). Consequently, there is a diminished correlation between the sample data and the overall attributes of the entire population. In this study, the sample size exceeds the population under investigation.

Table 1

Characteristics Participants

Gender	**Number**	**Percentage**
Male	308	51,59%
Female	289	48,41%
Total	**597**	**100,00%**
Age (Years Old)		

> 24	4	0,67%
17 – 18	109	18,26%
19 – 20	245	41,04%
21 – 22	193	32,33%
23 -24	46	7,71%
Total	**597**	**100,00%**

Instrument

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 self-control, personalized learning, the use of smartphones, future orientation, information overload, digital literacy, meaningful learning, metacognitive awareness, and virtual presence. For the purpose of evaluating the measurement items in this study, a questionnaire based on the Likert Scale was utilized. It is possible to assign a rating of one point to each item on a scale of five points, with one point indicating strong disagreement and five points indicating strong agreement. In order to measure nine different variables, the study employs the structural equation modeling (SEM) method. The questionnaire is comprised of forty-one questions, each of which corresponds to a different independent variable. The Smart-PLS app evaluates the accuracy of each question by examining its factor loading value. We used standardized item loadings in SmartPLS to calculate the average variance extraction (AVE) for assessing convergent validity. The criterion and predictor validity were evaluated using the heterotrait-monotrait correlation ratio (HTMT). We assessed the internal consistency of the research components using Cronbach's alpha and CR. The following describes each variable and the number of questions.

The measurement method for self-control refers to the measurement items used in the research conducted by Lindner et al. (2015). In this study, four questions from the previous research are utilized to represent the self-control variable, assessing how effectively students can exercise self-control over their bad habits. To measure personalized learning in this research, the researchers adopted a literature-based approach from Kwan et al. (2010), who investigated the growth of interest in learning and the desire for personal development in their respective fields through independent learning. Seven questions from this research were adopted as measurements for personalized learning, with these items representing independent learning. To measure the smartphone habit variable in this study, the researchers referred to literature conducted by Van Deursen et al. (2015). In this literature, participants were asked for their insights on using the smartphones they own. Three questions that could represent the smartphone habit variable were adapted for this study. Participants were asked to state how smartphones are integrated into their daily lives and how dependent they are on smartphones.

In measuring the future-time perspective variable, this study adopted previous research conducted by Brothers et al. (2014), who examined how adults view the future using a multidimensional questionnaire. From this study, four questions were adopted, which were predicted to represent the future-time perspective variables in this study. In this study, to measure the information overload variable, three questions predicted to represent this variable were adopted from the research conducted by Benselin and Ragsdell (2016). This variable assesses the extent to which students acquire information and how the impact of the excessive information they receive can interfere with their daily lives. For measuring the digital literacy variable, this study used six questions from the study conducted by Son et al. (2017). These items aim to identify user skills in using digital media, such as online networks, contact tools, and so on. User proficiency in digital literacy implies the ability to find, work on, assess, use, create, and use it in a smart, careful, and precise way that fits its purpose.

In this study, the measurement of meaningful learning was conducted by adopting previous research conducted by Fan et al. (2015), which examined the impact on students who used game media as a medium to enhance their learning abilities. This study adopted six questions from the mentioned study to represent meaningful learning. To measure the metacognitive awareness variable, this study refers to previous research conducted by Jaleel and Premachandran (2016), a study conducted on school children. Five questions from this research were adopted in this study, aiming to represent metacognitive awareness. These items relate to students who can pay attention to every detail of the learning process they go through, such as tasks carried out systematically. For the virtual presence variable, this study uses three questions from previous research by Grassini et al. (2020). These items are considered to represent virtual presence in this study regarding learning and instruction. Respondents were presented with statements on how they can feel a virtual presence that keeps them from feeling alone and can sense the presence of someone or others even when communicating only through virtual conditions.

Validation

The instrument was analyzed using the Structural Equation Modeling (SEM) and the Partial Least Square (PLS) approach, utilizing SmartPLS version 4 software. PLS is designed to address issues that arise with Ordinary Least Square (OLS) regression analysis when dealing with problems like small data, missing values, unusual data distribution, and multicollinearity symptoms. SmartPLS was employed to ensure that measures and structure models were accurate. Anderson and Gerbing's (1988) two-step method were used to examine the data for this study. The first step was to ensure that the study concept and the measurement model were valid and reliable. AVE and standard item loading were used to assess if the test was correct. The heterotrait-monotrait correlation ratio (HTMT) was employed to evaluate the discriminant validity of the test. The internal consistency of the study models was assessed through the utilization of composite reliability (CR) and Cronbach's alpha. The second step involved using the bootstrap method with 5,000 samples to determine if the structural relationship between the study constructs was statistically significant. Table 2 displays the loadings of each instrument in this study. According to the research conducted by Hair et al. (2012), Table 2 shows convergent validity, evident as all the factor loadings of the indicators on the corresponding latent construct exceeding 0.60.

Where digital learning has 6 instruments of which DL5 has the highest loadings with a value of 0.806. Next is the future-time perspective where this variable has 4 instruments which have the highest loadings value of 0.812 which is contained in FTP2. In the information overload variable, 3 instruments are measured, where the results are all valid and reliable instruments where the highest loadings value is in IO2 with a value of 0.921. Then, on the personalized learning variable, in this study, there are 7 instruments where all values exceed 0.6 and the highest loadings value is on PL5 with a loadings value of 0.785. Meanwhile, the metacognitive awareness variable has 5 instruments with the highest loadings value on MA5 with a value of 7.65 and all instruments are valid and reliable.

Furthermore, in the meaningful learning variable, there are 6 instruments measured in this study, with ML5 having the highest loadings value with a value of 0.796, and all instruments in this variable are valid and reliable. Furthermore, on the self-control variable, there are 4 instruments measured in this study and all of these instruments are valid and reliable, where SC4 with a value of 0.775 is the instrument with the highest value. Then, on smartphone habit, there are 3 instruments measured in this study, with all instruments declared valid and reliable, and SH2 is the instrument with the highest loadings value of 0.893. Furthermore, in the virtual presence variable, there are 3 instruments measured in this study, where the highest loadings value is in VP2 with a value of 0.929. The hypothesis in this study is tested by calculating a P value for each path coefficient. The P value can be one-tailed or two-tailed based on the researcher's prior knowledge about the path's direction and the sign of its coefficient.

Table 2

Instrument and Loadings

Instrument	Loadings
DL1. I actively respond to discussions through feedback in online discussion forums.	0.672
DL2. I can write reports or papers to be uploaded to e-Learning.	0.678
DL3. I can use special software for scientific writing (e.g., Mendeley, EndNote, MindMaple lite).	0.746
DL4. I can use special statistical software (e.g., SPSS, Excel, and Minitab).	0.761
DL5. I can create video content with special software (Camtasia, Animoto, WeVideo, Powtoon, or others) to support lectures.	0.806
DL6. I use special image processing software (paint, photoshop, CorelDRAW, and the like) to do lecture support assignments.	0.753
FTP1. I believe that every morning should be started with an activity plan.	0.772
FTP2. When I want to achieve something, I set a target and how to achieve that goal.	0.812
FTP3. Before making a decision, I weighed the pros and cons.	0.772
FTP4. I will work on assignments that can support my progress even though it is difficult.	0.787
IO1. I am often annoyed by the amount of unfiltered information on the Internet.	0.861
IO2. I feel overwhelmed by the amount of information that is useless to me every day from various Internet sources.	0.921
IO3. I receive too much misinformation from the Internet.	0.827
PL1. I can predict lecture demands well.	0.758
PL2. I know my own learning style.	0.727
PL3. I can understand the learning problems that I experience.	0.746
PL4. I have a good memory.	0.782
PL5. I can manage time effectively.	0.785
PL6. I am not afraid of the demands of lectures.	0.722
PL7. I am confident in my ability to pass exams/tests.	0.701
MA1. I am aware when I understand something.	0.636
MA2. I make up for weaknesses by using good study skills.	0.711
MA3. I think of the easiest way to complete academic assignments.	0.700
MA4. I confirmed the necessary steps for completing the task before initiating the work.	0.756
MA5. I double check my work to make sure it gets done on time.	0.765
ML1. I can relate the information I learn in one subject to other subjects.	0.716

ML2. I have a favorite subject matter.	0.767
ML3. In my opinion, studying is a useful activity.	0.751
ML4. In my opinion, it is important to understand what is being studied.	0.752
ML5. I learn by combining various sources and information (e.g., lecture notes, textbooks, scientific journals, and others).	0.796
ML6. I believe that the knowledge acquired today has practical applications.	0.754
SC1. I have a hard time breaking bad habit.	0.755
SC2. My work is hampered by bad habits.	0.769
SC3. I find it challenging to maintain focus.	0.767
SC4. I act without thinking about the repercussions.	0.775
SH1. Using smartphone is part of my daily routine.	0.773
SH2. My activity depends on my smartphone.	0.893
SH3. Using a smartphone is a habit that I can't give up.	0.872
VP1. For me, social media feels more real than the outside world.	0.879
VP2. When connected through social media, it's like I'm with my friends in the same place.	0.929
VP3. When I use social media, I feel like I'm seeing or listening to my friends for real.	0.915

The researchers employed PLS-SEM, a widely utilized technique in SEM, to determine the PLS bootstrapping factors. Readings were acquired using resampling techniques in this method. Evaluating the Cronbach's alpha, AVE, composite reliability, and standardized item loadings for each category enabled the assessment of the accuracy and reliability of the measurements. As per Hair et al. (2012), all the composite reliability and Cronbach's alpha values in Table 3 are equal to or greater than 0.70. According to the findings of Hair et al. (2012), the results demonstrate convergent validity as the factor loadings on each latent construct exceed 0.60, and AVE for each construct surpasses 0.50.

Table 3

Cronbach's Alpha, Composite Reliability, AVE

	Cronbach's alpha	Composite reliability	AVE
Digital Literacy	0814	0814	0.523
Future-Time Perspective	0.794	0.795	0.617
Information Overload	0.840	0.865	0.758
Meaningful Learning	0.852	0.857	0.572
Metacognitive Awareness	0.760	0.765	0.511
Personalized Learning	0867	0.873	0.557
Self-Control	0.766	0.769	0.587
Smartphone Habits	0.805	0.835	0.719
Virtual Presence	0893	0896	0.824

The AVE for each construct is higher than 0.50. According to Hair et al. (2012), while the minimum acceptable value is 0.50, all the results in Table 3 surpass this threshold, ranging from 0.765 to 0.896 on the composite reliability

scale and from 0.760 to 0.893 on the Cronbach's alpha scale. Please refer to Table 4, where the condition for discriminant validity is met when the HTMT correlation ratio is below 0.90, as stated by Hair et al. (2012).

Table 4

Heterotrait-Monotrait Ratio of Correlations (HTMT)

	DL	FTP	IO	ML	MA	PL	SC	SH	VP	VP x SC	VP x SH
DL											
FTP	0.548										
IO	0.231	0.158									
ML	0.528	0.583	0.110								
MA	0.585	0.906	0.110	0.603							
PL	0.696	0.616	0.206	0.678	0.637						
SC	0.175	0.118	0.241	0.117	0.170	0.110					
SH	0.269	0.138	0.143	0.290	0.124	0.215	0.467				
VP	0.404	0.166	0.295	0.137	0.132	0.269	0.403	0.440			
VP x SC	0.333	0.201	0.169	0.202	0.202	0.305	0.295	0.132	0.196		
VP x SH	0.243	0.120	0.072	0.170	0.128	0.217	0.147	0.095	0.143	0.451	

Data Collection

The research documentation process should encompass the research context, research sample, study scope, and the procedures for data collection and analysis (Burns and Grove, 2003). Furthermore, the research sample must be included. The questionnaire was distributed to all current engineering faculty students, and they all returned it. Survey participants submitted their information via an online form and were directed to complete the survey through a hyperlink. The questionnaires were returned by the respondents in satisfactory condition, meeting the eligibility requirements to proceed to the tabulation phase. We tabulated the data using SPSS software based on the Likert scale. Normality, Multicollinearity, Autocorrelation, and Heteroscedasticity tests were conducted. This was followed by hypothesis testing.

Data Analysis

For the data analysis phase of this project, we will employ SPSS to conduct a normality test on the questionnaire responses, determining their adherence to a normal distribution. Subsequent examinations will include tests for multicollinearity, autocorrelation, heteroscedasticity, and scatterplots. Following this, the data undergoes analysis using SEM with the application of PLS technique. The positive outcomes from the SPSS analysis justified the necessity for further examination, leading to the execution of this analysis. The study utilized SmartPLS version 4 for the analysis. Potential challenges in regression analysis using the OLS technique include limited data sets, missing values, skewed data distribution, and multicollinearity. These challenges can be effectively addressed through the application of PLS analysis method. The dependability of the study design was initially assured through the utilization of the measurement model, following the procedures delineated by Anderson and Gerbing (1988). In the second phase, we generated 5,000 bootstrapping samples to assess the dependability of field-to-field connections. In conducting hypothesis testing, we conducted bootstrapping analysis using SmartPLS software.

Findings

Assumption Test

Normality

A normality test, as defined by Ghozali (2016), is employed to assess whether the residuals or influencing factors in a regression model adhere to a normal distribution. For the regression model to function effectively, it is imperative that the residuals conform to a normal distribution. Although not mandatory for all variables, normality checks are essential for all numerical values. It is a standard practice to verify the normality of each variable in a regression model. It should be noted that, unlike regression models, the variables under analysis in this study do not require the residual values to adhere to a normal distribution. The distribution of an ideal regression model adheres to or closely approximates the normal distribution. In this study, the Kolmogorov-Smirnov test was utilized to determine whether the residuals conform to a normal distribution. A data set is considered regularly distributed if the probability value exceeds 0.05.

One-Sample Kolmogorov-Smirnov Test

		Unstandardized Residual
N		597
Normal Parameters[a,b]	Mean	.0000000
	Std. Deviation	2.01574163
Most Extreme Differences	Absolute	.056
	Positive	.027
	Negative	-.056
Test Statistic		.056
Asymp. Sig. (2-tailed)		.107[c]

a. Test distribution is Normal.

b. Calculated from data.

Figure 2. Normality Test Output

Figure 2 illustrates the One-Sample Kolmogorov-Smirnov Test with a test statistic of 0.05. This result suggests that the data appears to follow a normal distribution. In this study, an assessment of normality was conducted through graphical analysis. If the residuals adhere to a normal distribution, the line representing the observed data will closely align with the observed data. Figure 3 presents a P-plot graph depicting the data, showcasing a normal distribution.

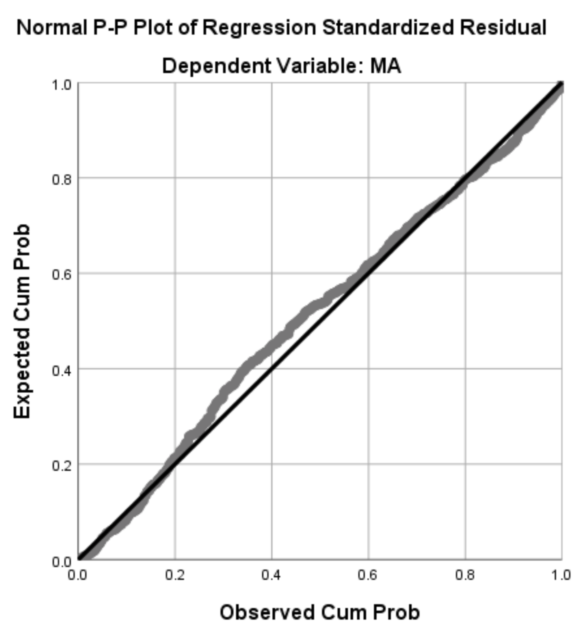

Figure 3. Normality Test Graphic

Multicollinearity

To validate the presence of multicollinearity in the processed data, it is important to examine the correlation matrix, compute the variance inflation factor (VIF), and evaluate the tolerance values. The multicollinearity test is employed to discern any correlation among the independent variables within a regression model. In regression analyses, these tests detect correlations among the predictor variables, also known as independent variables. During the examination of coefficients, the t-count is expected to be smaller than the t-table value due to the significant standard error. Consequently, we lack substantial evidence to draw definitive conclusions regarding the potential connection, if any, between the two factors. Progressing with the investigation is contingent upon initially establishing the interconnections among the different elements. When the tolerance value exceeds 0.05, no statistically significant relationship is observed between the independent variables. Notably, none of the components exhibit a correlation coefficient equal to or exceeding 95%. According to the VIF study, all the independent variables have VIF values below 10, indicating the absence of identifiable correlations between the variables. Table 5 shows the absence of multicollinearity among the independent variables in the regression analysis.

Table 5

Multicollinearity, Autocorrelation, Heteroscedasticity Test

Model	Multicollinearity		Autocorrelation	Heteroscedasticity		Results
	Tolerance	VIF	DW	t	Sig.	
1 Multicollinearity						No Multicollinearity
FTP	0,766	1,306				
VP	0,698	1,432				
IO	0,901	1,110				
SC	0,834	1,200				
DL	0,618	1,618				
SH	0,701	1,426				
ML	0,504	1,983				
PL	0,492	2,031				
2						No Autocorrelation
Durbin-Watson			2,039			
3 Glejser Test						No Heteroscedasticity
FTP				-0,863	0,388	
VP				2,139	0,329	

IO	0,128	0,898
SC	-0,609	0,543
DL	-1,566	0,118
SH	-1,000	0,318
ML	-0,065	0,948
PL	-0,219	0,827

Regression analysis approaches can improve the reliability of the Glejser test. In this scenario, the magnitude of the residue is defined as the independent variable. This characteristic enhances the test's proficiency in identifying statistically significant correlations, thereby increasing its effectiveness. In this inquiry, the results obtained from all the metrics employed were deemed statistically significant when the score exceeded 0.05, as indicated by the data presented in Table 4. The autocorrelation test is employed to establish a connection between errors at time "t" and errors at time "t-1" in a linear regression model. The primary objective of this study is to identify any potential correlation between these two events and uncover indications of bias within the data. A regression model can only be considered legitimate if there are no correlations present in the dataset, commonly referred to as an autocorrelation issue. The Durbin-Watson table shows that the lower limit, dL, is 1.82, and the upper limit, dU, is 1.88, both of which are presented in the "magnitude" section of the paper. The "magnitude" column displays two distinct integers. This study aims to determine the extent of the disparity between the 4-dU and Durbin-Watson scores, as well as the dU and Durbin-Watson score. Given the current circumstances, this implies that the data does not exhibit any statistically significant autocorrelation.

The heteroscedasticity test is utilized to identify the cause when the residuals from a regression model lack a consistent dispersion pattern. Homoscedasticity, a fundamental statistical concept, is satisfied when the residual variance remains constant across all datasets. In contrast, heteroscedasticity occurs when the residual variance varies over time. It's important to note that there is no inherent contradiction between the two types of distributions commonly referred to as homoscedastic and heteroscedastic. Homoscedasticity, characterized by a constant standard deviation, is a fundamental property in statistics. Also, heteroscedasticity, often referred to as the absence of homoscedasticity, stands out as a significant distinguishing factor across various regression models. It is common for people to assert the absence of heteroscedasticity when discussing homoscedasticity.

Hypothesis Testing Results

The outcomes of the analysis conducted through SmartPLS are presented in Figure 4, depicting the paths of all hypotheses formulated in this study derived from the results of the PLS analysis. Additionally, Table 6 presents each hypothesized relationship in the study, revealing that almost all hypotheses exhibit a positive and significant correlation. However, two hypotheses were rejected. Hypothesis 11, addressing the impact of information overload on meaningful learning, and Hypothesis 14, investigating the influence of smartphone habit on metacognitive awareness, were both found to lack a statistically significant effect. Table 6 presents the outcomes of the PLS analysis conducted using SmartPLS, which were employed to assess all the formulated direct effect hypotheses in this study. The findings of the study provide evidence in favor of Hypothesis 1 ($\beta = 0.035$, $\rho = 0.000$), which states that self-control has a positive and significant influence on personalized learning. When it comes to the process of developing and putting into action personalized learning plans, these observations highlight how important it is to take into consideration the concept of self-regulation. Self-control has a positive and significant impact on smartphone habit, meaning that the degree of self-control an individual possesses directly affects their capacity to manage and limit their use of smartphones. This is supported by the hypothesis that self-control has a positive and significant impact on smartphone habit. In the third hypothesis ($\beta = 0.046$, $\rho = 0.021$), it is found that self-control has a positive and significant impact on digital literacy. Individuals who possess high levels of self-control are able to effectively manage the information they take in, establish priorities, and manage tasks, which enables them to navigate through information overload more effectively. Self-control has a positive and significant impact on information overload, as demonstrated by the hypothesis H4 ($\beta = 0.050$, $\rho = 0.025$). Self-control is essential for effectively managing an excessive amount of information and improving the efficiency of learning. Self-control has a positive and significant impact on future-time perspective, as demonstrated by the fact that individuals who have a broader future-time perspective exhibit better time management skills and task performance within the self-regulatory framework of time perspective ($\beta = 0.040$, $\rho = 0.002$).

Hypothesis 6 demonstrates a positive and statistically significant relationship ($\beta = 0.042$, $\rho = 0.013$), wherein the habit of using a smartphone has an impact on personalized learning. Similarly, Hypothesis 7 demonstrates a positive and statistically significant effect ($\beta = 0.045$, $\rho = 0.003$), wherein the habit of using a smartphone has an impact on digital literacy, thereby enhancing students' performance in their learning processes. Furthermore, it is worth noting that Hypothesis 8 demonstrates a positive and statistically significant relationship (β = 0.033, ρ = 0.000), which suggests that positive digital literacy has a positive influence on personalized learning. According to research, the use of smartphones results in a more significant improvement in academic performance in individualized learning environments than the use of traditional methods. The fact that students can easily access information through their smartphones is another way in which smartphones contribute to the improvement of students' digital literacy. The activities of recognizing, gathering, and evaluating digital information are considered to be essential components of the learning process. Not only do smartphones make mobile learning easier, but they also provide valuable information about careers. On the other hand, it is essential to keep in mind that excessive use of smartphones can result in addiction and have a detrimental effect on academic performance.

There is statistical evidence that Hypothesis 9 is true, as shown by a β value of 0.042 and a ρ value of 0.000. This supports H10 (β = 0.042, ρ = 0.019) by showing that too much information has a positive and significant effect on digital literacy. Hypothesis 11 (β = 0.037, ρ = 0.390), on the other hand, shows that too much information doesn't really help with meaningful learning. Also, Hypothesis 12 (β = 0.035, ρ = 0.000) shows that knowing how to use technology well has a big, positive impact on learning that matters. Hypothesis 13 (β = 0.039, ρ = 0.000) also says that meaningful learning has a big, positive impact on metacognitive awareness. Researchers have found that having too much information can make it harder for students to understand and organize what they are studying, which can hurt their test scores. Learning digital literacy helps students get better at finding information, communicating in different ways, and fixing common problems they run into when using digital tools. Research also shows that being aware of how you think and feel about your thoughts can help students learn by making it easier for them to plan, track, and evaluate their own learning. This can lead to better grades and the ability to learn on your own for longer periods of time. The results of Hypothesis 14 (β = 0.029, ρ = 0.521) show that using a smartphone too much doesn't have a big positive impact on metacognitive awareness. The research we did shows that using a smartphone can change other cognitive factors and metacognitive awareness. Next, Hypothesis 15 (β = 0.040, ρ = 0.000) shows that looking into the future has a big, positive impact on being aware of how you think. There is a positive correlation between future-time perspective and increased levels of mindfulness and cognitive self-consciousness, as demonstrated by the search results.

Table 6
Hypothesis testing

Hypothesis	B	t	ρ	Results
H1. Self-Control -> Personalized Learning	0.035	3.627	0.000	Supported
H2. Self-Control -> Smartphone Habit	0.037	10.079	0.000	Supported
H3. Self-Control -> Digital Literacy	0.046	2.309	0.021	Supported
H4. Self-Control -> Information Overload	0.050	2.242	0.025	Supported
H5. Self-Control -> Future-Time Perspective	0.040	3.042	0.002	Supported
H6. Smartphone Habit -> Personalized Learning	0.042	2.478	0.013	Supported
H7. Smartphone Habit -> Digital Literacy	0.045	2,983	0.003	Supported
H8. Digital Literacy -> Personalized Learning	0.033	17.607	0.000	Supported
H9. Information Overload -> Future-Time Perspective	0.042	3.697	0.000	Supported
H10. Information Overload -> Digital Literacy	0.042	2.338	0.019	Supported
H11. Information Overload -> Meaningful Learning	0.037	0.860	0.390	Rejected
H12. Digital Literacy -> Meaningful Learning	0.035	13.441	0.000	Supported
H13. Meaningful Learning -> Metacognitive Awareness	0.039	5.010	0.000	Supported
H14. Smartphone Habit -> Metacognitive Awareness	0.029	0.642	0.521	Rejected
H15. Future-Time Perspective -> Metacognitive Awareness	0.040	15.167	0.000	Supported
H16. Virtual Presence x Smartphone Habit -> Digital Literacy	0.042	2,561	0.010	Supported
H17. Virtual Presence x Self-Control -> Digital Literacy	0.040	4.487	0.000	Supported
H18. Virtual Presence x Self-Control -> Information Overload	0.040	2.020	0.043	Supported

Regarding moderation effects, Hypothesis 16 (β = 0.042, ρ = 0.010) shows a positive and significant relationship, suggesting that the moderating effect of virtual presence on smartphone habit and digital literacy influences smartphone usage on learning efficacy and the potential for smartphones to facilitate digital literacy among students .Similarly, Hypothesis 17 (β = 0.040, ρ = 0.000) shows a positive and significant relationship, highlighting the moderating effect of virtual presence on self-control and digital literacy, emphasizing the importance of teaching effective technology use and the impact of smartphones on learning and memory. Lastly, Hypothesis 18 (β = 0.040, ρ = 0.043) suggests a positive and significant relationship between the moderating effect of virtual presence on self-control and information overload, emphasizing the influence of a virtual moderator on individuals' cognitive processes during remote participation in discussions. This underscores the significance of virtual presence in virtual worlds and social virtual reality platforms. Enhancing students' self-regulation skills is crucial for enhancing the quality of their learning. This will affect students' metacognitive suggestions, which is crucial to consider as it will significantly impact learning outcomes. Refer to Table 7 for the comprehensive results of the hypothesis test in this study.

Table 7

Hypothesis results

Hypothesis	Results
H1	Self-control has an influence on the performance of personalized learning, and it can be implied that with increased self-control, personalized learning can be better.
H2	Self-control has an influence on smartphone habits, and it can be implied, with increasing self-control, the habit of using smartphones will be controlled and directed towards positive things.
H3	Self-control has an influence on digital literacy, and it can be implied that students' digital literacy skills can be improved by increasing self-control.
H4	Self-control influences information overload, and it can be implied that the learner's ability to receive information can be improved by increasing self-control so that the learner can keep information overload from occurring.
H5	Self-control influences future-time perspective, and it can be implied that students' ability to see from a perspective that emphasizes their future can be improved by increasing self-control.
H6	Smartphone habits can affect personalized learning, and it can be implied that students' ability to learn independently can be improved by students' self-awareness to regulate their smartphone usage habits.
H7	The habit of using smartphones can affect digital literacy, and it can be implied that a good pattern of habits in using smartphones will provide an increase in the digital literacy of students, and the ability to process information of students will increase.
H8	Digital literacy influences personalized learning, and it can be implied that good and maintained digital literacy for students, will improve the quality of students' personalized learning.
H9	Information overload influences future perspectives, and can be implied, with the ability to manage good information in good quantities and maintained for students will improve the quality of students' personal learning.
H10	Information overload impacts digital literacy. Managing appropriate amounts of quality information can enhance understanding of digital literacy and improve our ability to process digital information effectively.
H11	Information overload does not affect meaningful learning. Efficiently organizing vast quantities of information for students does not necessarily lead to their comprehension of the underlying significance of their learning.
H12	Digital literacy impacts meaningful learning. Enhancing digital student literacy can lead to a better comprehension of students' learning processes, ultimately influencing their academic performance.
H13	Meaningful learning has impacts on metacognitive awareness. Enhanced comprehension of students' learning processes can enhance the management and oversight of mental processes employed by students to aid learning, thereby impacting their academic performance.
H14	Smartphones habit does not affect metacognitive awareness. Students' smartphone usage patterns do not affect the management and supervision of the mental processes involved in learning.
H15	Future-time perspective influences metacognitive awareness. The student's capacity to perceive the conditions in front of them affects the control and oversight of the cognitive processes engaged in learning.
H16	Virtual presence has a moderating influence on smartphone habits and digital literacy. Perceiving oneself as physically present in a digital environment can impact the connection between smartphone usage habits and digital literacy. This can be seen as a catalyst for enhancing digital literacy.
H17	Virtual presence moderately impacts self-control and digital literacy. Believing one is physically in a digital environment can affect the connection between self-control and digital literacy. Managing your visual appearance can act as an opportunity for enhancing self-control and digital literacy.
H18	Virtual presence moderately affects self-control and information overload. Believing one is physically in a digital environment can affect how self-control relates to information overload. Managing one's visual appearance can act as a catalyst for enhancing self-control and the capacity to process extensive information effectively.

Overall, these observations show how important it is to think about self-control when making and using personalized learning plans. The amount of self-control a person has directly affects how well they can control and limit how much they use their smartphones. It's easier for people with a lot of self-control to handle too much information because they can better control what they take in, set priorities, and do their work. To effectively handle an excessive amount of information and improve the efficiency of learning, you must possess self-control. Within the self-regulatory framework of time perspective, people who have a bigger picture of the future are better at managing their time and getting things done. Personalized learning is helped by knowing how to use technology. Research shows that smartphones improve academic performance more than traditional methods when used in specific learning situations. Recognizing, collecting, and evaluating digital information are all important parts of learning. Smartphones make learning on the go easier and give you useful information about careers. It is important to keep in mind, though, that using your phone too much can become an addiction and hurt your grades. If students know too much, it might be hard for them to understand and organize what they are studying, which could hurt their test scores. Learning digital literacy helps students get better at finding information, communicating in different ways, and fixing common problems they run into when using digital tools. Research also shows that being aware of how you think and feel about your thoughts can help students learn by making it easier for them to plan, track, and evaluate their own learning. This can lead to better grades and the ability to learn on your own for longer periods of time.

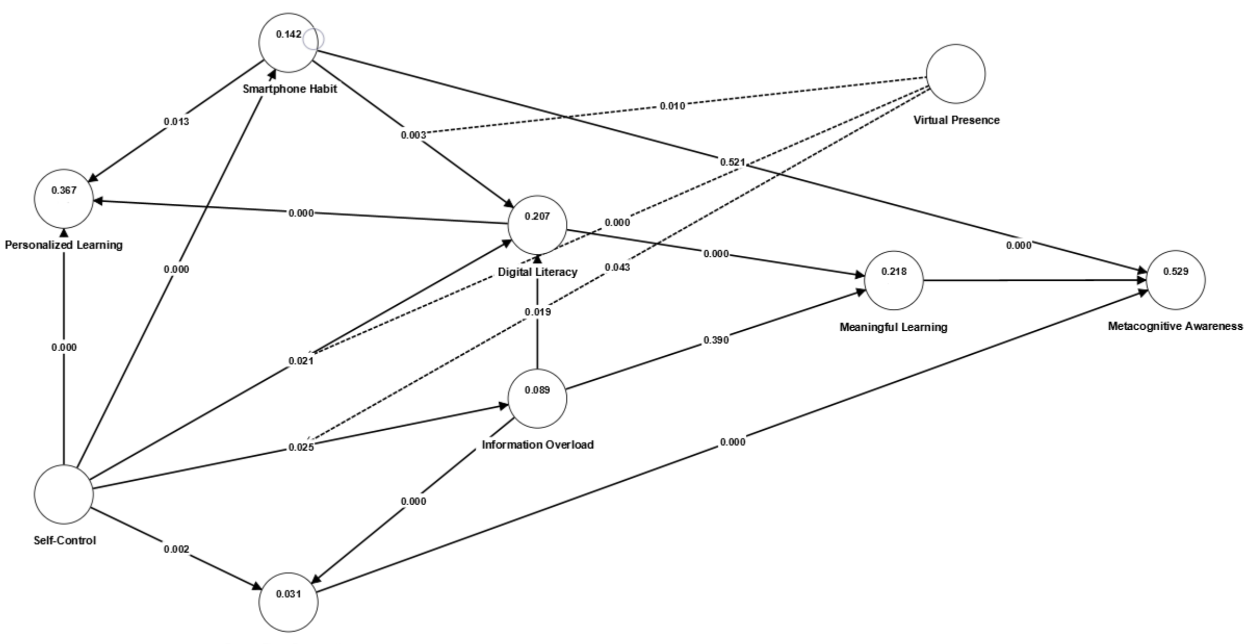

Figure 4. Hypothesis Result

Discussions

This study proposes that self-control has an impact on engineering students, especially those who are actively engaged in learning and striving for improvement. This study highlights the significance of the Internet and smartphones in online learning, expanding on prior research regarding literacy and swiftly advancing technologies. Indicates that students are required to acquire knowledge beyond the traditional school setting and classroom environment. Students are impacted by rapid technological advancements, particularly due to the widespread use of smartphones among the working-age population. Smartphones being widespread amplifies the visibility of this phenomenon. Students are impacted by quickly developing technologies and need to be managed effectively. Improving personalized learning with the internet. Bicen & Arnavut, 2015 discovered that internet access significantly impacts college student decision-making smartphones impact individuals' social interactions.

Because digital literacy can affect a student's ability to control themselves, it is very important to teach responsible online behavior in the classroom. Individualized learning outcomes are improved when self-control is raised. This suggests that higher self-control can lead to better personalized learning, which is supported by Lepp et al. (2013). Students can see the future in a way that prioritizes long-term goals better if they learn to control themselves better. This finding fits with what Hidayati et al. (2023) found. People who are self-disciplined can control how much information they take in, set priorities, and manage their tasks well, showing that they are very good at dealing with the huge amount of information they come across.

Self-control affects how people use their smartphones, and research shows that having more self-control makes people use their smartphones more carefully and on purpose, doing positive things. This finding fits with what Galla and Duckworth found earlier (2015). Lin et al. (2015) say that research shows smartphones may make people less self-controlled and more impulsive. As a result, developing self-control is necessary for managing too much information and learning effectively. Self-control affects digital literacy, which means that teaching students how to be more self-controlled can help them learn how to use technology better. This finding fits with what Pangrazio et al. (2020) found earlier. Also, being able to see the future makes it easier to control your impulses. The study shows that changing how someone thinks about time can affect their ability to control themselves. People who think about the future more often tend to have better cognitive functioning because they can better control their emotions (Van Dursen et al., 2015). People's metacognitive abilities are greatly impacted by how well they can control themselves. In fact, research has shown that people with high levels of self-control also have better metacognitive abilities. Students can deal with too much information and improve their ability to process it effectively by learning how to control themselves better. Asif and Anwar (2020) talk about how this discovery adds to previous research on literacy. The results of this study agree with those of Mucha et al. (2020) in that self-control is a key factor in determining metacognitive awareness. Metacognition, an important part of cognitive learning, is closely linked to students' ability to change the course of their learning outcomes.

Research shows that using technology helps students do better in school when they are personalized learning instead of traditional learning. Xie et al. (2019) also found similar things in their earlier research. To get a balanced approach, it's important to think about the pros and cons of using smartphones for personalized learning. Smartphones are very important for improving students' digital literacy because they make it easy to get information. It is important to learn how to recognize, get, and evaluate digital information. That being said, it's important to remember that relying too much on smartphones can hurt your ability to understand and use digital information, which can hurt your grades. Previous research by Tejedor et al. (2020) also supports these conclusions. Students say that smartphones make mobile learning more flexible and give them access to important career information. Overall, using your phone too much can become an addiction and make it harder to do well in school.

For this reason, it is important to think carefully about both the pros and cons of smartphones to have a balanced approach to personalized learning. When students see the values that will stay with them in the future, their learning activities have real meaning for them. The research shows that students' metacognitive awareness grows when they are actively involved in meaningful learning, which leads to better overall learning outcomes. This agrees with what Gallego-Gómez et al. (2020) found and with what other research has found. Too much information can make it hard for students to understand and organize, which can lower their test scores in the end. Digital literacy is an important part of teaching students how to find information, communicate their ideas, and fix common technical issues that come up with digital tools. This finding is similar to what Pangrazio et al. (2020) found good technology skills allow students to connect with different people and ideas around the world, which helps with learning and personal growth. Students who know a lot about metacognition usually do better in school and are better at learning and controlling themselves.

Metacognitive training has been shown to enhance academic performance and cognitive abilities, especially in children with limited awareness of their own thoughts. Research shows that metacognitive awareness aids students in devising, supervising, and evaluating their learning processes, contributing to enhanced meaningful learning, previous research conducted by Barnes & Stephens (2019) also supports these findings. This, in turn, fosters scholastic achievement and the development of self-regulated learning over time. The expanding and rapid dissemination of information on the Internet is significantly impacting students due to the growing number of internet users. The findings of this study align with earlier research conducted by Alheneidi and Smith (2021), which shows that students are affected by the overwhelming presence of excessive information. When students encounter an excessive amount of information, their ability to absorb and organize knowledge is hindered, impeding their capacity to rely on the information effectively. Considering this, practicing self-control becomes imperative to prevent adverse effects that may result from the use of cellphones and the Internet. The findings of this study reveal that self-control is crucial for maintaining a smartphone usage habit that focuses on applications bringing benefits rather than causing difficulties. This conclusion aligns with research conducted by Gokcearslan et al. (2016), which also observed substantial positive results in a similar context. Similarly, Ko et al. (2016) found results that were consistent with these findings.

This study contributes to existing knowledge in three distinct ways. Firstly, it deepens our comprehension of the role of metacognitive awareness among students in higher education. Secondly, it contributes to the expanding body of evidence that establishes a connection between students' emotional and motivational states and their metacognitive abilities. Thirdly, there are limited initiatives like this one that experimentally investigate how to optimize learning preparation using technology in contemporary higher education. This study suggests that metacognitive processes and success in daily self-control are crucial for managing conflicts that arise during students' learning processes. This process involves an individual's metacognitive awareness of the challenges students encounter, the strategies employed to address them, and the implementation of plans, oversight, and assessment to resolve these issues.

Conclusion and Limitations

This research emphasizes the importance of learning and instruction for engineering students as essential elements of the learning process. It stresses the significance of meaningful learning and metacognitive awareness in students to improve their learning activities and extract significance from each lesson. Various factors influence students' ability to understand the learning material due to their diverse backgrounds and conditions. These factors impact material providers serving engineering students, prompting them to create content that encourages students to extract meaning from each lesson. This study uncovers a significant influence of moderating factors like virtual presence, self-control, and smartphone usage patterns on digital literacy and information overload. Amid unforeseen changes, factors impacting students' learning values gain significance and can greatly affect their academic success. The study emphasizes the ever-changing nature of the learning environment and the significance of taking into account external factors that could impact the learning process. This study provides valuable insights into the factors that affect individual learning. It is crucial to recognize specific constraints and suggest directions for future research.

The study's sample size is restricted because of its random selection, which may restrict the applicability of the results to different contexts. Future research on this topic should use a larger sample size and employ probability sampling to improve the study's external validity. Moreover, utilizing self-reported data can lead to biases like memory bias and various forms of subjectivity. The researchers could not evaluate the agreement between participants' self-reported answers and their real knowledge gain. Assessing the perceived value of acquired knowledge is essential in the learning process as it aids in retaining engineering concepts. Future research could investigate more objective methods for evaluating knowledge retention and acquisition. Self-control significantly impacts individual learning by affecting students' ability to efficiently manage and supervise their own learning procedures.

There is also a strong link between a student's ability to control themselves and how well they do in school. These results make it clear how important it is to think about self-regulation when creating and using personalized learning strategies. The amount of time spent on a smartphone is directly affected by how much control is used and how often the device can be used. There is also a strong link between lack of self-control and using smartphones inappropriately. Self-discipline is important for developing healthy cell phone habits and limiting how often you use your phone. Individuals who can understand and derive meaning from information are more likely to remember and use theoretical ideas they learn effectively. This is a very important point that needs more attention, especially from people who teach students who are very open and quick to learn. Going forward, researchers may look into using various tests to fully comprehend self-control, self-awareness, and the most useful teaching methods for helping students learn. In the future, teachers should look into their students' digital activities in more depth. More research could go into this topic by looking at other aspects of smartphone use that might affect how aware students are of their learning.

References

Anderson, J. C., & Gerbing, D. W. (1988). Structural equation modelling in practice: A review and recommended two-step approach. *Psychological Bulletin, 103*(3), 411–423. https://doi.org/10.1037/0033-2909.103.3.411

Alheneidi, H. H., & Smith, A. P. (2021). Exploring the Influence of Information Overload, Internet Addiction, and Social Network Addiction, on Students' Well-being and Academic Outcomes. DOI:10.1007/978-3-030-91408-0_8

Asif, N, D.M., and Anwar, M. (2020). Towards information anxiety and beyond. *Webology 17*, 65–80. doi: 10.14704/WEB/V17I1/a208

Augner, C., & Hacker, G. W. (2012). Associations between problematic mobile phone use and psychological parameters in young adults. *International Journal of Public Health, 57*(2),437e441. http://dx.doi.org/10.1007/s00038-011-0234-z.

Ausubel, D. (1968) The Psychology of Meaningful Verbal Learning: An Introduction to School Learning. Grune & Stratton, New York.

Barnes, E. M., & Stephens, S. J., (2019). Supporting mathematics vocabulary instruction through mathematics curriculum. curric. J. 1–20. DOI:10.1080/09585176.2019.1614470

Barenberg, J., Dutke, S., 2019. Testing and metacognition: retrieval practice effects on metacognitive monitoring in learning from text. *Memories 27* (3), 269–279. DOI: 10.1080/09658211.2018.1506481

Baltaci, S., Yildiz, A., & Özcakir, B. (2016). The Relationship between Metacognitive Awareness Levels, Learning Styles, Genders, and Mathematics Grades of Fifth Graders. *Journal of Education and Learning, 5*(4), 78. https://doi.org/10.5539/jel.v5n4p78

Bentri A., Hidayati A., and Kristiawan M. (2022) Factors supporting digital pedagogical competence of primary education teachers in Indonesia. *Front. Educ. 7*:929191. doi: 10.3389/feduc.2022.929191

Benselin, J. C., & Ragsdell, G. (2016). Information overload: The difference that age makes. *Journal of Librarianship and Information Science, 48*(3), 284–297. https://doi.org/10.1177/0961000614566341

Bicen, H., & Arnavut, A. (2015). Determining the effects of technological tools use habits on social life. *Computers in Human Behavior*, *48*, 457e462. http://dx.doi.org/10.1016/j.chb.2015.02.012

Biocca, F., Kim, J., & Choi, Y. (2001). Visual touch in virtual environments: An exploratory study of presence, multimodal interfaces, and cross-modal sensory illusions. *Presence: Teleoperators and Virtual Environments*, *10*(3), 247–265. DOI:10.1162/105474601300343595

Brothers, A., Chui, H., & Diehl, M. (2014). Measuring future time perspective across adulthood: Development and evaluation of a brief multidimensional questionnaire. *Gerontologist*, *54*(6), 1075–1088. https://doi.org/10.1093/geront/gnu076

Bogicevic, V., Seo, S., Kandampully, JA, Liu, SQ, & Rudd, NA (2019). Virtual reality presence as a preamble of tourism experience: The role of mental imagery. *Tourism Management, 74*, 55–64. https://doi.org/10.1016/j.tourman.2019.02.009

Burns, N. and Grove, S. K. (2007) Understanding nursing research—Building an evidence-based practice. *4th Edition, Saunders Elsevier*, St. Louis.

Cervin-Ellqvist, M., Larsson, D., Adawi, T., Stöhr, C., & Negretti, R. (2021). Metacognitive illusions or self-regulated learning? Assessing engineering students' learning strategies against the backdrop of recent advances in cognitive science. *Higher Education, 82*(3), 477–498. https://doi.org/10.1007/s10734-020-00635-x

Devika, & Singh, R. (2019). Influence of metacognitive awareness on engineering students' performance: A study of listening skills. *Procedia Manufacturing*, *31*, 136–141. https://doi.org/10.1016/j.promfg.2019.03.021

Fan, K. K., Xiao, P. wei, & Su, C. H. (2015). The effects of learning styles and meaningful learning on the learning achievement of gamification health education curriculum. *Eurasia Journal of Mathematics, Science and Technology Education*, *11*(5), 1211–1229. https://doi.org/10.12973/eurasia.2015.1413a

Faiola, A., Newton, C., Pfaff, M., & Smyslova, O. (2013). Correlating the effects of flow and telepresence in virtual worlds: Enhancing our understanding of user behavior in game-based learning. *Computers in Human Behavior*, *29*(3), 1113–1121. https://doi.org/10.1016/j.chb.2012.10.003

Farihin (2022). The Influence of Digital Literacy on Administration Efficacy for Supervisor Teachers in Cirebon City in the Post-Pandemic. *Journal of Social Studies Education Research, 13* (4), 353 – 380. https://jsser.org/index.php/jsser/article/view/4676/601

Flavell, J.H (1976). Metacognitive aspects of problem solving. *In LB Resnick (Ed.), The nature of intelligence* (pp. 231-235). Hillsdale, NJ: Lawrence Erlbaum.

Fu, Q., Rodríguez-Ardura, I., Meseguer-Artola, A., & Wu, P. (2022). Self-disclosure during the COVID-19 emergency: Effects of narcissism traits, time perspective, virtual presence, and hedonic gratification. *Computers in Human Behavior, 130*. https://doi.org/10.1016/j.chb.2021.107154

Galla, BM, & Duckworth, AL (2015). More than resisting temptation: Beneficial habits mediate the relationship between self-control and positive life outcomes. *Journal of Personality and Social Psychology*, *109*(3), 508–525. https://doi.org/10.1037/pspp0000026

Ganefri, Hidayat, H., Yulastri, A., & Yondri, S. (2019). Design of production-based entrepreneurship technology training model to improve the skills of engineering students. *International Journal of Innovative Technology and Exploring Engineering*, *8*(11), 2042–2047. https://doi.org/10.35940/ijitee.K1930.0981119

Gelles, LA, Lord, SM, Hoople, GD, Chen, DA, & Mejia, JA (2020). Compassionate flexibility and self-discipline: Student adaptation to emergency remote teaching in an integrated energy engineering course during covid-19. *Education Sciences, 10*(11), 1–23. https://doi.org/10.3390/educsci10110304

Gilster, P. (1997), Digital literacy. New York: Wiley Computer Publications.

Gökçearslan, Ş., Mumcu, FK, Haşlaman, T., & Çevik, YD (2016). Modeling smartphone addiction: The role of smartphone usage, self-regulation, general self-efficacy and cyberloafing in university students. *Computers in Human Behavior, 63*, 639–649. https://doi.org/10.1016/j.chb.2016.05.091

Gonzalez-Nucamendi, A., Noguez, J., Neri, L., Robledo-Rella, V., García-Castelán, RMG, & Escobar-Castillejos, D. (2021). The prediction of academic performance using engineering student profiles. *Computers and Electrical Engineering, 93*. https://doi.org/10.1016/j.compeleceng.2021.107288

Gallego-Gómez, JI, Campillo-Cano, M., Carrión-Martínez, A., Balanza, S., Rodríguez-González-moro, MT, Simonelli-Muñoz, AJ, & Rivera-Caravaca, JM (2020). The COVID-19 pandemic and its impact on homebound nursing students. *International Journal of Environmental Research and Public Health, 17*(20), 1-10. https://doi.org/10.3390/ijerph17207383

Grassini, S., Laumann, K., & Rasmussen Skogstad, M. (2020). The Use of Virtual Reality Alone Does Not Promote Training Performance (but Sense of Presence Does). *Frontiers in Psychology, 11*. https://doi.org/10.3389/fpsyg.2020.01743

Grüter, M., and Myrach, T., "UNDERSTANDING VIRTUAL EXPERIENCE AND TELEPRESENCE - A REVIEW AND SYNTHESIS OF LITERATURE" (2012). *ECIS 2012 Proceedings*. 104. https://aisel.aisnet.org/ecis2012/104

Haans, A., & Ijsselsteijn, W. A. (2012). Embodiment and telepresence: Toward a comprehensive theoretical framework. *Interacting with Computers, 24*(4), 211–218. https://doi.org/10.1016/j.intcom.2012.04.010

Hair, J. F., Jr., Sarstedt, M., Ringle, C. M., & Mena, J. A. (2012). An assessment of the use of partial least squares structural equation modeling in marketing research. *Journal of the Academy of Marketing Science*, *40*(3), 414-433.https://doi.org/10.1007/s11747-011-0261-6

Hamakali, H., & Josua, L. (2023). Engendering Technology-Assisted Pedagogy for Effective Instructional Strategy in the University of Namibia Language Centre. *Research in Educational Policy and Management*, *5*(1), 18-32. https://doi.org/10.46303/repam.2023.3

Hidayat, H. (2017). Impact of Learning with the Production-Based Learning Model in Vocational School Designing learning stages of production-based entrepreneurship learning View project Impact of Learning with the Production-Based Learning Model in Vocational School. in*International Journal of Research in Engineering and Social Sciences*(Vol. 301). http://inducedu.org

Hidayati, A., Bentri, A., & Eldarni. (2022). Supporting Factors for the Implementation of Mobile Learning for Elementary School Students Using an Authentic Approach and Real-World Activities. *International Journal of Interactive Mobile Technologies (iJIM), 16*(05), pp. 107–120. https://doi.org/10.3991/ijim.v16i05.26551

Hidayati, A., Eldarni, Solfema, Handrianto, C., & Sunarti, V. (2023). Strategies for integrating a web-based learning environment based on authentic learning in distance learning for elementary school students. *Journal of Education and E-Learning Research, 10*(3), 437–445. https://doi.org/10.20448/jeelr.v10i3.4840

Huang, Y. M., & Chiu, P. S. (2015) The effectiveness of a meaningful learning-based evaluation model for context-aware mobile learning. *Brother J. Edu. Technol. 46*(2), 437–447

Ibrahim, M., Baharun, H., Harun, H., & Othman, N., (2017). Antecedents of intrinsic motivation, metacognition, and their effects on student's academic performance in fundamental knowledge for matriculation courses. Malay. J. *Learning Instructions. 14*(2), 211–246.

Imhoff, R., Schmidt, AF, & Gerstenberg, F. (2014). Exploring the interplay of trait self-control and ego depletion: Empirical evidence for ironic effects. *European Journal of Personality, 28*(5), 413–424. https://doi.org/10.1002/per.1899

Jaleel, S., & Premachandran, P. (2016). A Study on the Metacognitive Awareness of Secondary School Students. *Universal Journal of Educational Research, 4*(1), 165–172. https://doi.org/10.13189/ujer.2016.040121

Japar, M., Hermanto, H., Muyaroah,S., Susila, H.R. & Alfani, H. (2023). Digital Literacy-Based Multicultural Education through Civic Education in Indonesian Junior High Schools, *Journal of Social Studies Education Research, 14(*4), 328-349. https://jsser.org/index.php/jsser/article/view/5281/651

Khaleel, I., Wimmer, B. C., Peterson, G. M., Zaidi, S. T. R., Roehrer, E., Cummings, E., & Lee, K. (2020). Health information overload among health consumers: A scoping review. *In Patient Education and Counseling (Vol. 103,* Issue 1, pp. 15–32). Elsevier Ireland Ltd. https://doi.org/10.1016/j.pec.2019.08.008

Kim R., Olfman L., & Ryan T., (2014), Leveraging a personalized system to improve self-directed learning in online educational environments, *Computers & Education 70* (1) (2014) 150–160.

Klašnja-Milićević, A., Vesin, B., Ivanović, M., & Budimac, Z. (2011). E-Learning personalization based on a hybrid recommendation strategy and learning style identification. *Computers & Education, 56*(3), 885–899

Ko, M., Yang, S., Lee, J., Heizmann, C., Jeong, J., Lee, U., et al. (2015, February). NUGU: a group-based intervention app for improving self-regulation of limiting smartphone use. *In Proceedings of the 18th ACM conference on computer supported cooperative work & social computing* (pp. 1235e1245). ACM.

Kwan, H. K., Mao, Y., & Zhang, H. (2010). The impact of role modeling on protégés' personal learning and work-to-family enrichment. *Journal of Vocational Behavior, 77*(2), 313–322. https://doi.org/10.1016/j.jvb.2010.04.009

Kwon, M., Lee, J.-Y., Won, W.-Y., Park, J.-W., Min, J.-A., (2013). Development and validation of a smartphone addiction scale (SAS). *PLoS ONE, 8*(2), e56936. http://dx.doi.org/10.1371/journal.pone.0056936

Lepp, A., Barkley, JE, Sanders, GJ, Rebold, M., & Gates, P. (2013). The relationship between cell phone use, physical and sedentary activity, and cardiorespiratory fitness in a sample of US college students. *International Journal of Behavioral Nutrition and Physical Activity, 10*(1), 79. https://doi.org/10.1186/1479-5868-10-79

Lin, YH, Lin, YC, Lee, YH, Lin, PH, Lin, SH, Chang, LR, Kuo, TB (2015). Time distortion associated with smartphone addiction: identifying smartphone addiction via a mobile application (App). *Journal of Psychiatric Research, 65*, 139e145. http://dx.doi.org/10.1016/j.jpsychires.2015.04.003.

Lindner, C., Nagy, G., & Retelsdorf, J. (2015). The dimensionality of the Brief Self-Control Scale-An evaluation of unidimensional and multidimensional applications. *Personality and Individual Differences, 86,* 465–473. https://doi.org/10.1016/j.paid.2015.07.006

Longo, DR, Schubert, SL, Wright, BA, LeMaster, J., Williams, CD, & Clore, JN, (2010), Health information seeking, receipt, and use in diabetes self-management, *Ann. Fam. med. 8*(4) 334–340.

Maier, C., Laumer, S., Eckhardt, A., & Weitzel, T. (2015). Giving too much social support: Social overload on social networking sites. *European Journal of Information Systems, 24*(5), 447–464. doi:10.1057/ejis.2014.3

Makgakga, T. (2023). Twinned Teachers' Mathematical Discourse Using Problem-Solving. *Journal of Culture and Values in Education, 6*(2), 138-157. https://doi.org/10.46303/jcve.2023.13

Makransky, G., & Petersen, GB (2021). The Cognitive Affective Model of Immersive Learning (CAMIL): a Theoretical Research-Based Model of Learning in Immersive Virtual Reality. *In Educational Psychology Review (Vol. 33*, Issue 3, pp. 937–958). Springer. https://doi.org/10.1007/s10648-020-09586-2

Mollen, A., & Wilson, H. (2010). Engagement, telepresence, and interactivity in online consumer experience: Reconciling scholastic and managerial perspectives. *Journal of Business Research, 63*(9–10), 919–925. https://doi.org/10.1016/j.jbusres.2009.05.014

Molomo, P. (2023). Renewal in Educational Spaces as a Relational Aspect: Making Way for a New Culture of Reasoning Innovation and Sustainability. *Journal of Curriculum Studies Research, 5*(1), 82-94. https://doi.org/10.46303/jcsr.2023.7

Mooney, A., Earl, JK, Mooney, CH, & Bateman, H. (2017). Using a balanced time perspective to explain well-being and planning in retirement. *Frontiers in Psychology, 8,* 1781.

Moreira, MA (1999). Meaningful Learning (Aprendizagem Significativa). Brasilia: UnB

Morgenroth, O., Keck, M., & Gensicke, M. (2021). Time will tell: Time perspective as a source for metacognitive emotion-focused coping and its measurement. *Personality and Individual Differences,* 168. https://doi.org/10.1016/j.paid.2020.110367

Moyo, R., Ngidi, S., Koai, M., & Lemeko, P. (2022). Online Teaching and Learning Experiences of Higher Education Lecturers and Students in the COVID-19 Era: A Leap to Digital Pedagogies?. *Journal of Culture and Values in Education, 5*(1), 23-42. https://doi.org/10.46303/jcve.2022.4

Mucha, M., Wiśniewska, M., & Nęcka, E. (2020). Time perspective and self-control: Metacognitive management of time is important for efficient self-regulation of behavior. *Current Issues in Personality Psychology, 8*(2), 83–91. https://doi.org/10.5114/cipp.2020.97286

Müller-Frommeyer, LC, Aymans, SC, Bargmann, C., Kauffeld, S. & Herrmann, C. (2017), Introducing competency models as a tool for holistic competency development in learning factories: Challenges, examples, and future applications, *Procedia Manufacturing*, *9* (2017) 307–314.

Mystakidis, S., Berki, E., & Valtanen, JP (2021). Deep and Meaningful E-Learning with Social Virtual Reality Environments in Higher Education: A Systematic Literature Review. *Applied Sciences*, *11*(5), 2412. doi:10.3390/app11052412

Omodan, B. (2022). Virtual Management of Students' Unrest During the COVID-19 New Normal: The Need for an Innovative Approach. *Journal of Culture and Values in Education*, *5*(1), 1-12. https://doi.org/10.46303/jcve.2022.2

Özel, A. (2023). Examining Media Literacy Perceptions of Preservice Social Studies Teachers in Turkey. *Journal of Curriculum Studies Research, 5*(2), 86-117. https://doi.org/10.46303/jcsr.2023.21

Pangrazio, L., Godhe, AL, & Ledesma, AGL (2020). What is digital literacy? A comparative review of publications across three language contexts. *E-Learning and Digital Media, 17*(6), 442–459. https://doi.org/10.1177/2042753020946291

Rizal, F., Hidayat, H., Jaya, P., Waskito, Hendri, & Verawardina, U. (2022). Lack of E-Learning Effectiveness: An Analysis Evaluating E-Learning in Engineering Education. *International Journal of Instruction, 15*(4), 197–220. https://doi.org/10.29333/iji.2022.15412a

Samala, A. D., & Amanda, M. (2023). Immersive Learning Experience Design (ILXD): Augmented Reality Mobile Application for Placing and Interacting with 3D Learning Objects in Engineering Education. *International Journal of Interactive Mobile Technologies*, *17*(5), 22–35. https://doi.org/10.3991/ijim.v17i05.37067

Samala, A. D., Usmeldi, Taali, Ambiyar, Bojic, L., Indarta, Y., Dewi, I. P. (2023). Metaverse Technologies in Education: A Systematic Literature Review Using PRISMA. *International Journal of Emerging Technologies in Learning (iJET), 18*(05), pp. 231–252. https://doi.org/10.3991/ijet.v18i05.35501

Sánchez-Cruzado, C., Santiago Campión, R., & Sánchez-Compaña, MT (2021). Teacher digital literacy: The indisputable challenge after covid-19. *Sustainability (Switzerland), 13*(4), 1–29. https://doi.org/10.3390/su13041858

Scott, CL (2015). The futures of learning 3: What kind of pedagogies for the 21st century? *Education Research and Foresight, 1*–21.

Sweller, J. (1988), Cognitive load during problem-solving: effects on learning, *Cogn. sci. 12*(2). 257–285.

Son, JB, Park, S.-Soon., & Park, Moonyoung. (2017). Digital literacy of language learners in two different contexts (Vol. 13, Issue 2).

Su, YS, Ding, TJ, & Lue, JH, (2017), Applying big data analysis technique to students learning behavior and learning resource recommendations in a MOOC course, *in Proceedings of International Conference on Applied System Innovation*, pp. 1229–1230.

Tangney, JP, Baumeister, RF, and Boone, AL (2004). High self-control corresponds to good adjustment, fewer pathologies, better grades, and interpersonal success. *J. Pers. 72*, 271–324. doi: 10.1111/j.0022-3506.2004. 00263. x

Tejedor, S., Cervi, L., Pérez-Escoda, A., & Jumbo, FT (2020). Digital literacy and higher education during COVID-19 lockdown: Spain, Italy, and Ecuador. *Publications, 8*(4), 1–17. https://doi.org/10.3390/publications8040048

Tsai, MC, Shen, P. di, Chen, WY, Hsu, LC, & Tsai, CW (2020). Exploring the effects of web-mediated activity-based learning and meaningful learning on improving students' learning effects, learning engagement, and academic motivation. *Universal Access in the Information Society, 19*(4), 783–798. https://doi.org/10.1007/s10209-019-00690-x

Troll, ES, Friese, M., & Loschelder, DD (2021). How students' self-control and smartphone-use explain their academic performance. *Computers in Human Behavior, 117*. https://doi.org/10.1016/j.chb.2020.106624

Van Deursen, AJAM, Bolle, CL, Hegner, SM, & Kommers, PAM (2015). Modeling habitual and addictive smartphone behavior: The role of smartphone usage types, emotional intelligence, social stress, self-regulation, age, and gender. *Computers in Human Behavior, 45*, 411–420. https://doi.org/10.1016/j.chb.2014.12.039

Vettori, G., Vezzani, C., Bigozzi, L., Pinto, G., (2018). The mediating role of conceptions of learning in the relationship between metacognitive skills/strategies and academic outcomes among middle-school students. *Front. Psychol*. 9.

Whisler, L., Stephan, A., & Stephan, E. (2019). Promoting Metacognitive Awareness in a First-Year Learning Strategies Course for Cohorted General Engineering Students.

Xiang, MQ, Lin, L., Wang, ZR, Li, J., Xu, Z., Hu, M. (2020). Sedentary behavior and Problematic Smartphone Use in Chinese Adolescents: The Moderating Role of Self-Control. *Frontiers in Psychology*. https://doi.org/10.3389/fpsyg.2019.03032

Xie, H., Chu, HC, Hwang, GJ, & Wang, CC (2019). Trends and development in technology-enhanced adaptive/personalized learning: A systematic review of journal publications from 2007 to 2017. *Computers and Education,* 140. https://doi.org/10.1016/j.compedu.2019.103599

Young, A., Fry, JD, 2008. Metacognitive awareness and academic achievement in college students. J. Scholarsh. Teach. learn. 8(2), 1—10.

Zajenkowski, M., Stolarski, M., Witowska, J., Maciantowicz, O., & Łowicki, P. (2016). Fluid intelligence as a mediator of the relationship between executive control and balanced time perspective. *Frontiers in Psychology*, 7, 1844.

Zhang, S., Zhao, L., Lu, Y., & Yang, J. (2016). Do you get tired of socializing? An empirical explanation of discontinuous usage behavior in social network services. *Information & Management, 53*(7), 904–914. doi:10.1016/j.im.2016.03.00

Zimbardo, PG & Boyd, JN (2015). Putting time in perspective: A valid, dependable individual-differences metric. Time Perspective Theory: Review, Research and Application Essays in Honor of Philip G Zimbardo. https://doiorg/10.1007/978-3-319-07368-2_2