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Empowering Global Citizens with Digital Literacy: Modeling the Factor Structure

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Digital literacy is an important skill for global citizens to possess in the 21st century in the creation of information media using appropriate digital tools. The purpose of this research is to investigate the components of digital literacy of global citizens using a second-order confirmatory factor analysis. The key finding of this research was that the digital literacy of global citizens consisted of four components: (1) Self-initiation, (2) Trendiness, (3) Usefulness, and (4) Good attitude. The study found that the factor loading of all latent variables was positive, ranging from 0.82 to 1.06. The trendiness component had the highest factor loading (β = 1.06), followed by the self-initiation component (β = 0.87), the usefulness component (β = 0.86), and the good attitude component (β = 0.82), respectively. Participants in this study consisted of 633 higher education students selected from a nationwide survey representing populations in six regions of the country using a multistage sampling method. The results of the study found that the trendiness component had the highest factor loading, followed by self-initiation, usefulness, and good attitude. Therefore, to promote digital literacy, when designing learning or learning tools, self-learning should be emphasized together with the use of smart wearable devices to provide flexible learning. Students will thus be able to learn anywhere anytime according to their individual needs, and this also maximizes their good attitudes toward the digital literacy. This study contributes to the understanding of the components of the digital literacy of global citizens. It can provide policymakers and educators insight into the critical skills needed in the 21st century toward the creation of information media using appropriate digital tools in Thai higher education.

Keywords: self-initiated learning, self-initiation, ubiquitous environment, smart wearable technology, CFA, digital literacy, global citizens

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INTRODUCTION

Digital literacy is the ability of a person to access, understand, manage, and integrate information and create innovation through the use of digital tools. It emphasizes cooperation in activities and the creation of innovative works that benefit the society the person lives in, as well as has application to person's daily life (Veugelers, 2011; Evoy, 2016; UNESCO, 2013; UNESCO, 2015; UNESCO, 2018; DQ Institute, 2021). This is consistent with the view of the DQ Institute (2021), which found that digital skills should consider and focus on the context of everyday life, in terms of use, safety, emotional intelligence, digital literacy, communication, and human rights. Learners should be nurtured so that they can (1) achieve global citizenship with the basic skills needed to operate technology responsibly, safely, and ethically; (2) engage in creative problem-solving to create new knowledge, technology, and content; and (3) possess the ability to compete in a global society. The Organization for Economic Cooperation and Development (2019) noted the skills necessary for future learning in 2030. In the current age of digital transformation and big data, digital literacy has become a priority that can enhance student well-being. A study by Kusumastuti and Nuryani (2019) examined the level of digital literacy among Association of Southeast Asian Nations countries since entering the 4.0 revolution. It was found that Thailand ranked second out of eight countries, after Singapore, in the ability to create digital content, apply technology, and manage media and information in various situations. The World Economic Forum (2016) presented a new framework of 21st-century learning with 16 essential skills, categorized into three subgroups: (1) foundational literacies that involve the application of core skills such as literacy, numeracy, and ICT literacy in daily life; (2) competencies such as critical thinking, creativity, and communication in complex contexts; and (3) character qualities such as leadership and social and cultural awareness that will help learners improve the quality environment. Clearly, these three subgroups are consistent and aim at learners adapting and living as global citizens, as well as encourage lifelong learning for learners. The framework also emphasizes active learning by engaging learners in learning and allowing them to learn according to their own interests. Therefore, the development of the digital literacy of global citizens through 21st-century learning should emphasize enabling learners to draw on self-initiation and self-direction. They can control their learning and set their own learning styles. Learning is flexible and can take place anytime, especially learning on the Internet. Learners can learn by using appropriate technology, enabling them to develop digital literacy (Penland, 1977; Tour, 2017; Naydanova, Beal & Doty, 2018; Upper Secondary Education Bureau, 2016).

A ubiquitous learning environment is one that responds to self-initiation. It provides learning in a real environment context through the use of a mobile phone and a wireless communication system. Students can share information, communicate, and learn anywhere, anytime. They can learn according to their own needs and learning styles (Ogata & Yano, 2004; Sakamura & Koshizuka, 2005; El-Bishouty et al., 2010; Hwang et al., 2011; Ahmed, Abdelouahed, & Kazar, 2017; Chareeporn Phooma, 2010). In addition, the use of wearable devices in teaching and learning helps promote a personalized learning environment. Learners can control their own learning. This improves work efficiency and promotes student participation in learning (Buchem et al.,

2015; Fesol, Salam, & Bakar, 2018). Wearable devices can be conveniently carried and worn on the body. They support interaction and information access at any time. In considering the adoption of wearable technology, research by Li et al. (2019) examined factors affecting the adoption of this technology and found that (1) facilitation of conditions; (2) compatibility; (3) social influence, (4) perceived ease of use (PEU), and (5) perceived usefulness (PU) affect intention to use. This is consistent with Mohammed and Redzuan (2020), who stated that PU, PEU, and trust influence intention to use. Apart from these factors that have had an impact on intention to use, satisfaction, enjoyment, and flow state, cost also played a role in technology acceptance (Park, 2020). Nkonko et al. (2019) mentioned that factors affecting purchase intentions included the quality, design, and trendiness of wearable technology. This is consistent with Khakurel et al. (2017), who found that in addition to the design, other factors such as social influence, privacy and trust, and performance expectations also had an impact on the use of smart technology devices. Lukitasari et al. (2022) studied the digital literacy components affecting learning achievement of university students and found that there were three components, including (1) communicating digital content, (2) exploring digital content and (3) creating digital content. Therefore, the present study aims to conduct a confirmatory factor analysis on the digital literacy of global citizens that consists of four components: (1) self-initiation, (2) trendiness, (3) usefulness, and (4) good attitude.

Literature Review

Self-initiation

Self-initiated learning is based on the learner's interests and results from the learner looking for resources and doing various activities. Learners can design their own learning and set learning goals according to their interests. It is flexible learning that promotes lifelong learning. The learning process comprises three steps: (1) Self-planning, where learners explore their needs or topics of interest to investigate, and then set objectives and goals for studying and design their learning; (2) Self-experiment, where students examine their topics of interest as planned by searching for information from learning sources and media; and (3) Self-evaluation, which is an assessment of learning through various methods that are consistent with the context of the learners (Stefani & Elton, 2002; Barron, 2006; Inventado et al., 2014; Matsumoto, 2021). For the purposes of the present study, self-initiated learning components can be grouped into three indicators: (1) Self-planning, (2) Self-experiment, and (3) Self-evaluation.

Trendiness

A ubiquitous learning environment is one in which learners can learn anywhere, anytime, and learn and seek knowledge independently as needed. It provides quick and easy access to various resources. Learners can use this information to solve problems effectively. Learners teach themselves in real-world environments and situations via mobile learning devices and wireless connectivity. They can receive feedback on their learning and communicate and collaborate with others (El-Bishouty, Otaga, & Yano,

2006; Chen, Yang, & Zhang, 2006; Huang et al., 2011; Virtanen et al., 2018; Jintavee Khlaisang, 2018)

Technology that promotes learning in a ubiquitous learning environment is smart technology and wearable technology, such as a small computer device that can be carried and is easy to wear on the body. Functioning wirelessly, such technology improves work efficiency and enables interaction and information access at all times (Tehrani, Kiana, & Michael, 2014; Grant & Tiles, 2018). Implementing such smart technology in teaching and learning provides learners with quick access to resources. It promotes a personal learning environment and interaction and collaboration. Learners are in control of their own learning (Buchem et al., 2015; Fesol, Salam, & Bakar, 2018; Ciolacu et al., 2019). A study by Motti and Caine (2014) stated that factors related to the design of wearable devices, such as aesthetics, shape design, affordability, customization, ease of use, fashion, and wearability, affected user acceptance of technology. Therefore, in the current study, the trendiness component consists of three indicators: ubiquity, smart technology, and wearability.

Usefulness

Regarding the usefulness of technology and smart devices, research by Kim and Shin (2015) found that factors affecting PU were (1) effective quality of wearable technology and (2) relative advantage. Factors that influenced PEU were (1) mobility and (2) availability. This is consistent with a study by Li et al. (2019) in which the results showed that the factors (1) facilitation of conditions, (2) compatibility (level of information transfer from one device to another, such as a smartphone and tablet to a wearable device), (3) social influence, (4) PEU, and (5) PU played a role in intention to use. Mohammed and Redzuan (2020) also identified the factors of (1) PU, (2) PEU, and (3) trust as affecting intention to use.

Digital literacy consists of access to information, ability to determine the scope of information according to users' needs, information assessment, data management, integration of information, information generation, and collaboration with others (UNESCO, 2013; DQ Institution, 2021) through the use of technology and smart devices. This is consistent with Kim and Shin's study (2015) on availability and performance expectancy, which found that technology adoption, helps users achieve their daily goals (Khakurel et al., 2017; Felea et al., 2021). In the present study, the components of usefulness are categorized into four indicators: (1) Availability, (2) Compatibility, (3) Perceived usefulness, and (4) Perceived ease of use.

Good Attitude

The research on attitudes toward the use of technology and smart devices includes Khakurel et al. (2017), who examined factors contributing to attitudes regarding the use of technology, and found that (1) performance expectancy, (2) social influence, (3) privacy and trust, and (4) wearability of device design and physical features affect attitude. These results are in accordance with a study by Mohammed and Redzuan (2020), which showed that the factors of (1) PU, (2) PEU, and (3) trust influenced the intention to use. Yang et al. (2016) also indicated that factors of (1) PU, (2) enjoyment,

and (3) social image affected played a part in the acceptance of the value of use. The good attitude component also corresponds to elements related to the needs of global citizens, consisting of awareness of equality, morality and ethics, responsibility to local communities, ability to work with others, understanding of social differences, and participation in social activities (UNESCO, 2015; Evoy, 2016; DQ Institution, 2021), in using technology and smart devices. Therefore, in the current study, the components of good attitude consist of three indicators: (1) social influence, (2) trusting belief, and (3) enjoyment.

Based on the literature review related to the development of digital literacy for global citizens, four components and 13 indicators are employed in this study, as follows:

Component 1 Self-Initiation consists of three indicators: Self-planning, Self-experiment, and Self-evaluation.

Component 2 Trendiness consists of three indicators: Ubiquity, Smart technology, and Wearability.

Component 3 Usefulness consists of four indicators: Availability, Compatibility, Perceived usefulness, and Perceived ease of use.

Component 4 Good Attitude consists of three indicators: Social influence, Trusting belief, and Enjoyment, as shown in Figure 1.

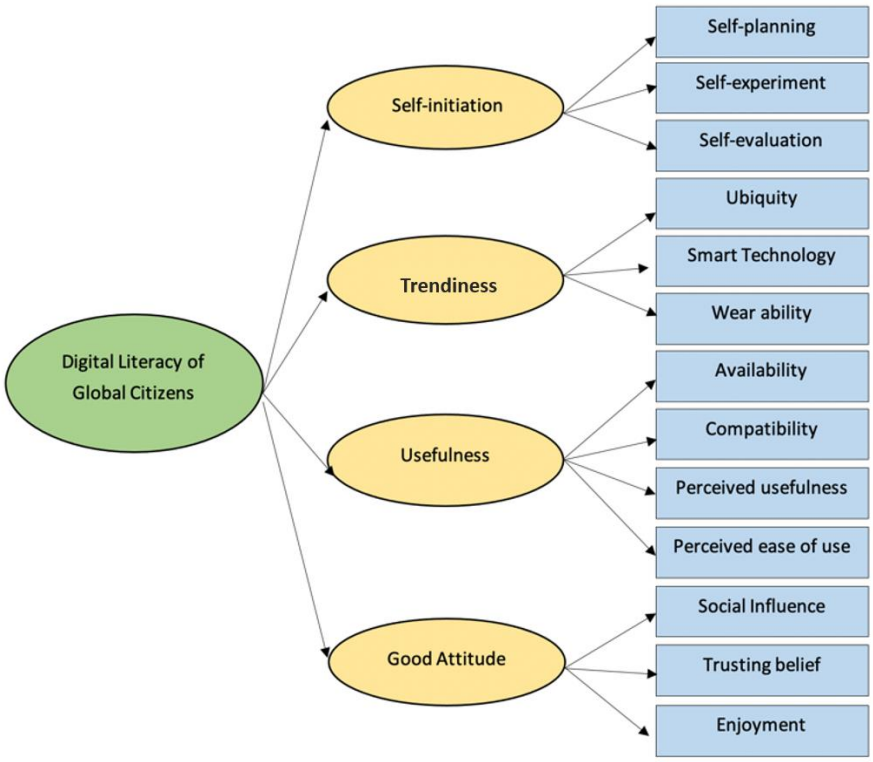

Figure 1
Theoretical model

METHOD

In this study, the LISREL 8.70 software was used to analyze the components of digital literacy of global citizens that consisted of four main components and 13 indicators.

Participants

Participants in this study consisted of 633 higher education students, of whom 465 were female (73.5%) and 168 male (26.5%). Most of the participants were 20–21 years old and studied in the fields of Humanities and Social Sciences (79.6%), followed by Science and Technology (19.1%), and Health Sciences (1.3%). The participants were selected from nationwide surveys representing populations in six regions of the country for confirmatory factor analysis (Hair et al., 2006) by using a multistage sampling method based on the region. Then, the sample group was selected by quota sampling in each region and simple random sampling.

Measure

The research instrument was a questionnaire to analyze the appropriate second-order confirmatory factors for the design and development of self-initiated learning management in a ubiquitous environment with the use of wearable technology to promote the digital literacy of global citizens. The questionnaire was a seven-level rating scale consisting of Component 1 Self-initiation (32 items) (adapted from Naydanova, Beal & Doty, 2018; Inventado et al., 2014; Barron, 2006) divided into three indicators: (1) Self-planning (15 items), (2) Self-experiment (10 items), and (3) Self-evaluation (7 items); Component 2 Trendiness (19 items) (adapted from Motti and Caine, 2014; Khakurel et al., 2017; Virtanen et al., 2018) divided into three indicators: (1) Ubiquity (8 items), (2) Smart technology (6 items), and (3) Wearability (5 items); Component 3 Usefulness (24 items) (adapted from Buchem et al., 2015; Fesol, Salam, and Bakar, 2018; Ciolacu et al., 2018) divided into four indicators: (1) Availability (6 items), (2) Compatibility (5 items), (3) PU (8 items), and (4) PEU (5 items); and Component 4 Good Attitude (20 items) (adapted from UNESCO, 2013; DQ Institute, 2019) divided into three indicators: (1) Social influence (8 items), (2) Trusting beliefs (6 items), and (3) Enjoyment (6 items) (Cronbach's Alpha coefficient = 0.97). The Kaiser-Meyer-Olkin value (KMO) was .943 and Bartlett's test of sphericity value was 10003.206 (p = .000).

Ethical consideration

The researchers obtained consent from the participants to give their responses. The informed consent form was distributed to the teachers involved in our survey and the signed privacy consent forms were collected. The researchers ensured the anonymity of the participants as well as their freedom to withdraw from the study at any time, with no need to explain the reason. The data were kept during the study and were destroyed upon completion of the study. Only researchers would have access to the data.

Finding

Self-initiation: KMO = .781, Bartlett's test of sphericity = 2155.93. The results of the confirmatory factor analysis showed that the model was consistent with the empirical data, with Chi-square = 0 (df = 0, p = 1.00), Root Mean Square Error of Approximation (RMSEA) = 0.00, Root Mean Square Residual (RMR) = 0, Goodness of Fit Index (GFI) = 1, and Adjusted Goodness of Fit Index (AGFI) = 1.

Trendiness: KMO = .719, Bartlett's test of sphericity = 1596.93. The results of the confirmatory factor analysis showed that the model was consistent with the empirical data, with Chi-square = 0 (df = 0, p = 1.00), RMSEA = 0.00, RMR = 0, GFI = 1, and AGFI = 1.

Usefulness: KMO = .859, Bartlett's test of sphericity = 2132.09. The results of the confirmatory factor analysis showed that the model was consistent with the empirical

data, with Chi-square = 0.87 (df = 2, p = 0.646), RMSEA = 0.00, RMR = 0.0028, GFI = 0.999, and AGFI = 0.997.

Good attitude: KMO = .740, Bartlett's test of sphericity = 1261.793). The results of the confirmatory factor analysis showed that the model was consistent with the empirical data, with Chi-square = 0 (df = 0, p = 1.00), RMSEA = 0.00, RMR = 0, GFI = 1, and AGFI = 1.

FINDINGS

Descriptive analysis

The digital literacy characteristics of global citizens consisted of four main components and 13 indicators. On consideration of each component, it was found that component 1 self-initiation in self-experiment had the highest mean (Mean = 4.777, SD = 1.485), followed by self-planning and self-evaluation, respectively (Mean = 4.747, 4.493, SD = 1.493, 1.492). Component 2 trendiness found that smart technology had the highest mean (Mean = 5.068, SD = 1.543), followed by ubiquity and wearability, respectively (Mean = 5.001, 4.602, SD = 1.474, 1.592). Component 3 usefulness found that availability and PEU had the highest mean (Mean = 5.095, 5.095, SD = 1.553, 1.431), followed by PU and compatibility, respectively (Mean = 5.036, 4.942, SD. = 1.533, 1.515). Component 4 good attitude found that social influence had the highest mean (Mean = 5.106, SD = 1.389), followed by trusting belief and enjoyment, respectively (Mean = 5.104, 5.099, SD = 1.416, 1.482).

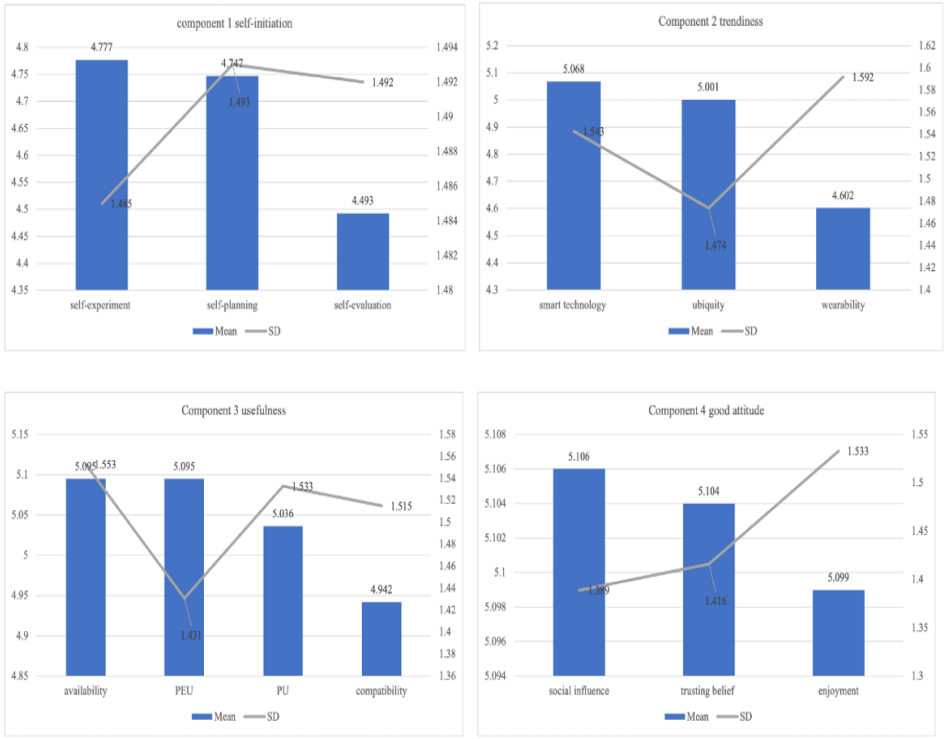

Figure 2
Component of digital literacy of global citizens

Test of the measurement model

Self-initiation

The three variables of the self-initiation components were positively correlated with statistical significance at the .01 level for all pairs and had a value between 0.887 and 0.896. The pair with the highest correlation was self-planning and self-experiment (KMO = .781, Bartlett's test of sphericity = 2155.93). The results of the confirmatory factor analysis showed that the model was consistent with the empirical data, with chi square = 0 (df = 0, p = 1.00), RMSEA = 0.00, RMR = 0, GFI = 1, and AGFI = 1. When considering the factor loading of the indicators, it was found that all indicators had positive factor loading, ranging from 0.94 to 0.95. Each indicator had similar factor loading. The indicators with the highest factor loading were self-experiment (β = 0.95), followed by self-planning (β = 0.94) and self-evaluation (β = 0.94), respectively.

Trendiness

The three variables of the trendiness components were positively correlated with statistical significance at the .01 level for all pairs and had a value between 0.729 and

0.890. The pair with the highest correlation was ubiquity and smart technology (KMO = .719, Bartlett's test of sphericity = 1596.93). The results of the confirmatory factor analysis showed that the model was consistent with the empirical data, with chi square = 0 (df = 0, p = 1.00), RMSEA = 0.00, RMR = 0, GFI = 1, AGFI = 1.0. When considering factor loading of the indicators, it was found that all indicators had factor loading, ranging from 0.94 to 0.95. Each indicator had similar factor loading. The indicators with the highest factor loading were smart technology (β = 0.98), followed by ubiquity (β = 0.91) and wearability (β = 0.80), respectively.

Usefulness

The four variables of the usefulness components were positively correlated with statistical significance at the .01 level for all pairs and had a value between 0.710 and 0.837. The pair with the highest correlation was compatibility and PU (KMO = .859, Bartlett's test of sphericity = 2132.09). The results of the confirmatory factor analysis showed that the model was consistent with the empirical data, with chi square = 0.87 (df = 2, p = 0.646), RMSEA = 0.00, RMR = 0.0028, GFI = 0.999, and AGFI = 0.997. When considering factor loading of the indicators, it was found that all indicators had positive factor loading, ranging from 0.83 to 0.93. Each indicator had similar factor loading. The indicators with the highest factor loading were compatibility (β = 0.98), followed by PU (β = 0.90), availability (β = 0.86), and PEU (β = 0.83), respectively.

Good attitude

The three variables of the good attitude components were positively correlated with statistical significance at the .01 level for all pairs and had a value between 0.714 and 0.818. The pair with the highest correlation was compatibility and PU (KMO = .740, Bartlett's test of sphericity = 1261.793). The results of the confirmatory factor analysis showed that the model was consistent with the empirical data, with chi square = 0 (df = 0, p = 1.00), RMSEA = 0.00, RMR = 0, GFI = 1, and AGFI = 1. When considering factor loading of the indicators, it was found that all indicators had positive factor loading, ranging from 0.81 to 0.93. Each indicator had similar factor loading. The indicators with the highest factor loading were trusting belief (β = 0.93), followed by social influence (β = 0.88) and enjoyment (β = 0.81), respectively.

Digital literacy of global citizens

The second-order confirmatory factor analysis results were based on the measurement model of the digital literacy of global citizens, which consisted of four components and 13 indicators. The model was shown to be consistent and harmonious with the empirical data, with chi square = 39.17, df = 32, p-value = 0.179, RMSEA = 0.019, RMR = 0.012, RMSEA = 0.019, GFI = 0.991, and AGFI = 0.974. When considering each indicator, it was found that all 13 indicators had positive factor loading, ranging from 0.83 to 0.98. As for digital literacy of global citizen features, a second-order confirmatory factor analysis found that factor loadings of all latent variables were positive. They ranged from 0.82 to 1.06, with the trendiness component having the highest factor loading (β = 1.06), followed by self-initiation (β = 0.87), usefulness (β = 0.86), and good attitude (β = 0.82), respectively. Details are shown in Table 1 and Figure 3.

Table 1
Results of second-order confirmatory factor analysis of digital literacy of global citizens

Variables	Factor loading		t	R^2	Factor score coefficient
	b(SE)	β			
First-order confirmatory factor analysis					
SELF-INITIATION					
SPLAN	0.982	0.98	-	0.967	0.640
SEXPER	0.983 (0.02)	0.98	50.675**	0.970	0.653
SEVA	0.903 (0.02)	0.90	39.153**	0.814	-0.238
TRENDINESS					
UBIQ	0.857	0.86	-	0.733	0.025
SMTECH	0.870 (0.02)	0.87	45.388**	0.755	0.029
WEARABI	0.852 (0.03)	0.85	28.404**	0.726	0.118
USEFULNESS					
AVAILA	0.949	0.95	-	0.900	0.555
COMPAT	0.909 (0.03)	0.91	32.885**	0.828	0.156
PERUSFUL	0.921 (0.03)	0.92	30.328**	0.849	0.386
PEREASE	0.828 (0.03)	0.83	25.614**	0.684	0.233
GOOD ATTITUDE					
SOCINF	0.828	0.83	-	0.684	0.229
TRUST	0.860 (0.03)	0.86	32.520**	0.742	0.349
ENJOY	0.868 (0.04)	0.87	24.831**	0.753	0.411
Second-order confirmatory factor analysis					
SELFINI	0.872 (0.03)	0.87	26.630**	0.760	-
TRENDY	1.065 (0.04)	1.06	28.892**	1.133	-
USEFUL	0.861 (0.04)	0.86	24.684**	0.742	-
GOODATT	0.824 (0.04)	0.82	19.884**	0.679	-

Chi square = 39.17, df = 32, p-value = 0.179, RMR = 0.012, RMSEA = 0.019 GFI = 0.991, AGFI = 0.974

Remark ** p < .01 The numbers in parentheses are standard error (SE) means SE and t values are not reported as constrained parameter

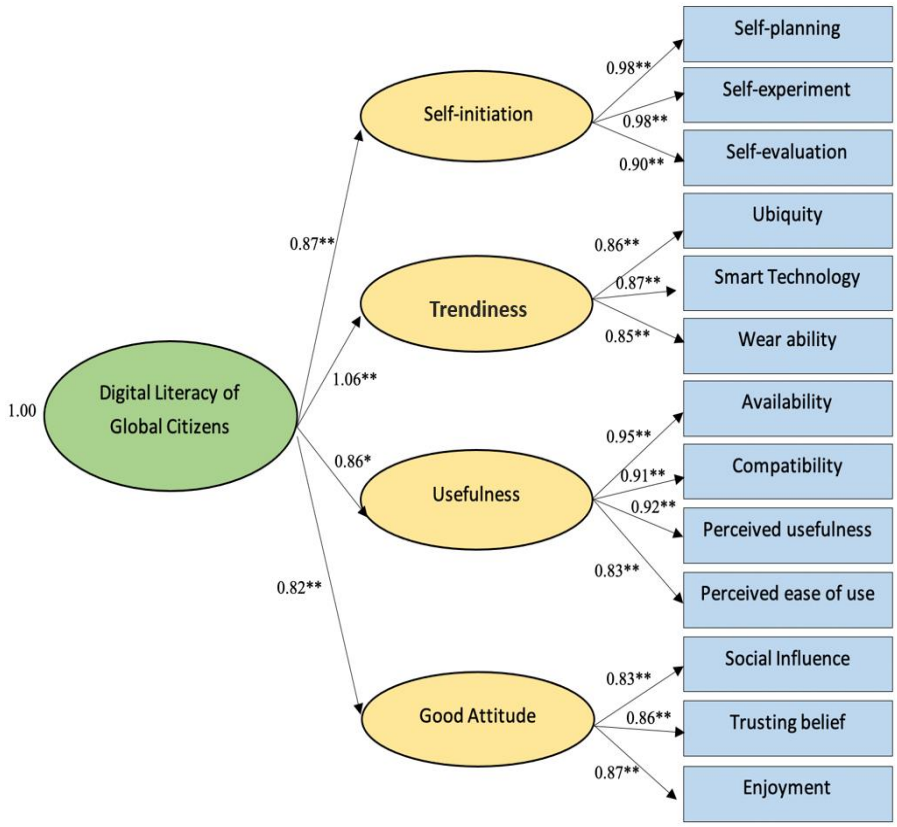

Figure 3
Second-order confirmatory factor analysis of digital literacy of global citizens
Note: ** p < .001

DISCUSSION

The four key components of digital literacy for global citizens consist of (1) Self-initiation, (2) Trendiness, (3) Usefulness, and (4) Good attitude. Self-initiation is learning according to learners' interests by searching for information and doing activities. Learners design their own learning. Learning goals and time management are based on individual needs. Learning is flexible, allowing students to learn anytime. It encourages lifelong learning, which enables learners to develop their skills and knowledge. The component consists of three indicators: self-planning, self-experiment, and self-evaluation. It also includes promoting digital literacy among learners in terms of learning how to learn, digital literacy, digital tools, and digital citizenship. This is consistent with the research of Tour (2017) that combined self-initiated learning with

personal learning networks to promote the digital literacy of teachers. The Tour study found that there was development of teacher participation and working collaboration. Learning was flexible, allowing teachers to design their own learning, learn freely, and improve teaching and learning by using appropriate technology.

The trendiness component is learning and doing activities through smart technology. Learners can choose to use smart technology such as a smart watch, virtual reality glasses, a headband or wrist band, and more to communicate. This technology provides learning in a real environment, enabling the creation of self-knowledge (Ubiquity). Smart technology is used for learning with others as well as personal learning (Wearability). This component promotes the digital literacy of learners in terms of digital tools and digital citizenship. This is consistent with research by Virtanen et al. (2018) and Jintavee Khlaisang (2018), which observed that learning in a ubiquitous environment of learners in higher education, should focus on individual learning (Personalization) and emphasize flexibility in learning through information access via mobile devices. In addition, Ciolacu et al. (2019) stated that the adoption of smart wearable technology in a ubiquitous learning environment not only increased personalized learning but also enabled learners to take control of their own learning.

Usefulness is instructional management where learners can learn anywhere, anytime. It encourages learners to learn and build self-knowledge by employing smart technology to learn about digital literacy and how to evolve as global citizens. It provides videos and learning resources that allow learners to search for information based on topics of interest. Learners can access resources quickly and communicate with tutors and experts via Chat Expert. It enables learners to comment on each other's work, letting them receive real-time feedback (Availability), as well as emphasizes ease of use (PEU). In addition, learners can connect smart technology with other technology (Compatibility). This helps learners work efficiently (PU). It also promotes learners' digital knowledge regarding digital literacy and digital tools. This is in line with a study by Kim and Shin (2015) that examined factors that influence the adoption of smart wearable technology. It found that availability and mobility contributed to the acceptance of ease of use and of the feeling of using smart wearable devices, which had an impact on the acceptance of its usefulness. The results of a study by Li et al. (2019) showed that factors related to compatibility and to transferring data between smart technology devices, PU, and PEU affected technology acceptance.

Good attitude is the design of learning and technology equipment that takes into account the usefulness of the technology and social influence to help learners accept technology in terms of both ease of use and ease of data transfer. This enables learners to have a good attitude in learning as well as feel enjoyment and have trusting beliefs. Also, it promotes digital literacy and how to adapt as global citizens among learners in digital citizenship. This is consistent with research by Yang et al. (2016) concerning enjoyment and social influences that can influence the acceptance of the value of use. The research of Park (2020) found that satisfaction, enjoyment, and smoothness factors affected the intention to use.

CONCLUSION

The four key components of digital literacy for global citizens consist of (1) self-initiation, (2) trendiness, (3) usefulness, and (4) good attitude. The latent variable of trendiness had the highest factor loading, followed by self-initiation, usefulness, and good attitude. Not only does self-initiation promote digital literacy of global citizens, it also helps develop self-regulation and create own learning styles, resulting in self-development of learners (Tour, 2017; Naydanova, Beal & Doty, 2018). In addition, this may lead to media literacy of digital citizens who are not only capable of using or interacting with media or making use of technological devices but also able to examine the context of digital citizens, especially in terms of social and cultural differences and respect for the rights of others (Mateus, 2021). Therefore, when teachers design learning or learning tools, they should focus on self-learning together with the use of smart wearable technology devices to provide flexible learning. Students will thus be able to learn anywhere, anytime according to their individual needs. It should also promote lifelong learning. The ubiquitous environment supports this learning style to promote the digital literacy of global citizens. The results of the study found that the trendiness component had the highest factor loading. Therefore, the use of smart technology should be promoted so that students have sufficient smart devices and can use them effectively. Smart wearable devices should be easy to use and designed for comfort (Wearability). When learners are equipped with ready-to-learn technology, teachers should encourage self-initiation, which will allow the learners to explore their own needs and topics of interest that they want to learn about. Students should be involved in deciding on, designing, and planning their own learning (Self-planning) and receive encouragement to study or search for more information (Self-experiment). There should also be appropriate and varied assessments of learning according to the learning context of each learner (Self-evaluation). Teachers should design learning so that learners are aware of the benefits of the technology used. The design of technology should be effective so that learners accept its role in their learning, such as allowing for ease of use, convenience in transferring information, and so on. Finally, teachers must design learning and technology equipment for learners in order to support a good attitude, such as a willingness to participate in social activities, having a moral and ethical foundation, and so on. The findings of this study can be used to boost the digital literacy of global citizens which is one of the essential abilities required for learning in the 21st century and developing digital citizenship. In addition, the use of technology in learning is a direct response to learning need in the digital era. The four components discovered in this study can be used to design both online learning and learning activities. This is in line with the study of Sharp (2018) who integrated collaborative digital literacy practices into learning design in the digital learning environment for adult learners to learn from experience; however, the study's focus was on learners' personal development. Therefore, soft skills, such as communication among learners and association with social organizations, could be promoted as part of the development of digital citizenship in the future.

Disclosure statement

No potential conflict of interest was reported by the authors.

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