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Digital Literacy, Pedagogical Insight, and Self-Belief: An Exploration of Pre-Service Teacher Z-Generation

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ABSTRACT

Generation Z currently dominates the student population in pre-service teacher education programs. Analysing the differences in characteristics between Generation Z pre-service teachers and those from previous generations is crucial. In the ever-evolving digital era, Generation Z pre-service teachers need to possess strong digital literacy, deep pedagogical understanding, and adequate self-confidence to meet the demands of the digital age. This study aims to investigate the role of digital literacy and self-efficacy among pre-service teachers as mediators in their relationship with technological pedagogical content knowledge (TPACK). This research is quantitative in nature. Data were collected from 105 Generation Z pre-service teachers from various study programs across two different provinces in Indonesia. The instruments used to measure the variables included questionnaires on digital literacy, self-efficacy, and TPACK. The Structural Equation Model (SEM) was employed to analyse the structural relationships. The findings reveal that Generation Z pre-service teachers have a strong inclination towards digital literacy, which influences their pedagogical insights in implementing technology in teaching and learning processes. The development of pre-service teacher training programs is necessary to adapt to the needs of Generation Z and the rapid technological advancements in the future. A solid grasp of digital literacy and pedagogical insights can effectively prepare qualified educators.

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A. INTRODUCTION

The Pre-service teacher Generation Z is a teacher education program student born between 1995 - 2010, who is widely known as the millennial generation?. Adjustments in the curriculum of teacher education programs need to be made to be able to accommodate the differences in the characteristics of generation Z (Colaco & Antao, 2023). Increasing teacher capacity in aspects of modern, innovative, and creative learning strategies is the most needed thing in learning in today's digital era (Whitehead, 2023). Innovative learning strategies are needed to deliver meaningful learning experiences for learners. Innovative learning can be done using a combination of various learning strategies with the latest technology in the field of learning. Changes in new understandings of education and individual expectations arise as a result of rapidly evolving technological advances (Andrea et al., 2016; Csobanka, 2016). This new paradigm shift in the field of education goes hand in hand with technological advances that have broad implications for changes in the way of learning and teaching. Pre-service teachers' understanding

of teacher professionalism is an important part of preparing for the transition from pre-service teacher students to actual teachers in the field (Tran & Dee, 2023).

E-learning or digital learning by integrating has been massively used throughout the world after the implementation of emergency learning during the Covid-19 pandemic (Ucar & Yilmaz, 2023). TPACK in teacher education programs illustrates a significant qualification for pre-service teacher students to understand the integration of contemporary technological advances into school learning practices (Engin et al., 2023). TPACK consists of several elements including technology knowledge, content knowledge, pedagogical knowledge, pedagogical content knowledge, technological content knowledge, technological pedagogical knowledge (Abbitt, 2011; Schmidt et al., 2009). Several studies discuss important elements in TPACK in learning, including Koh & Chai (2016) which states that aspects of content and pedagogy play an important role in consideration of choosing the right learning technology, on the other hand Rodrigues (2020) states that aspects of context and pedagogy are the main things to encourage technology integration in learning. While research Mishra & Koehler (2006) considers that all components in TPACK are equally important in integrating technology in learning. The rapid and massive development of technology also has implications for the education sector which requires teachers to have good digital skills (Greaves et al., 2012; Güneş & Bahçivan, 2018; Yoon, 2022).

Teacher education programs are required to conduct a comprehensive evaluation to present educators who have the cognitive, teaching and digital competencies needed in learning (Alnasib, 2023). The development of digital literacy in education and teaching can be understood as the development of teacher self-competence driven by technology that facilitates learning activities (Tomczyk, 2020). A good understanding of digital literacy will have a direct impact on teachers' intentions to use technology in learning (Jang et al., 2021). Pre-service teachers who have digital literacy are indicated by literacy related to data information literacy, communication, security, problem solving and productivity (Reisoğlu & Çebi, 2020). Pedagogy as a major aspect in integrating technology should be a major consideration for teachers (Duttdoner et al., 2005). These considerations are important for teachers when they want to use technology in learning so that good two-way communication can be established between teachers and students in learning. In particular, special training is needed for teachers to be able to develop their digital literacy, so as to provide meaningful learning experiences for students (Porat et al., 2018; Zimmer & Matthews, 2022). The design of the teacher digital literacy development program aims to be able to produce the output of a teacher who masters technology, pedagogy compatibility and good social awareness (Instefjord & Munthe, 2016).

The digitization process in learning should also need to pay attention to the negative impact of excessive internet use which currently occurs in generation Z (Purnama et al., 2021). Self-efficacy as a form of self-regulation effort which is understood as a self-confidence in the ability to face academic challenges in education can affect student learning success (van Zyl et al., 2022). Self-regulation of internet use in learning the latest technology is an integral part of digital literacy (Blau et al., 2020). Self-regulation in the use of the internet will make students wiser in using internet access for self-development and competency development. Self-efficacy in digital era learning can simply be interpreted as self-efficacy in using computers, learning management systems, internet use, and data information (Calaguas & Consunji, 2022). In addition, in digital learning, an active learning environment can also be influenced by social anxiety factors and the belief that students can complete an academic task (Hood et al., 2021). In generation Z, self-efficacy needs to be firmly instilled in the context of academic ability, so that students have firm confidence despite the many disruptions that may occur in the digital learning environment.

One of the effects of technological disruption that commonly occurs in the academic and learning fields is academic procrastination. A high level of self-efficacy is believed to reduce the level of academic procrastination and increase intrinsic motivation (Bozgun & Baytemir, 2021; Parmaksız, 2023). Studies on digitalization in learning have been carried out by several studies such as (Angraini et al., 2023; Hsu & Chen, 2023; Maipita et al., 2023; Perkmen et al., 2023; Savuran & Akkoç, 2023). Specifically (Cevik & Bektas, 2023; Narinasamy et al., 2023; Polly et al., 2023; Tiba & Condy, 2021; Yildiz Durak, 2021) explained the level of readiness and confidence of pre-service teacher students towards integrating technology in learning. Meanwhile, (Marin & White, 2023) states that although generation Z is digital native, they often show an attitude of lack of knowledge towards technology and its integration in aspects of pedagogy. What has been missed in some previous research is analyse the relationship between digital literacy and technology integration and pedagogy in learning. To bridge the gap in theoretical and empirical studies, specifically this study aims to analyse the pre-service characteristics of generation Z on the integration of technology in learning and self-confidence in presenting digital-based learning.

B. METHODS

This study is a quantitative research with a survey research design. This study used questionnaires as an instrument for data collection through the results of measurements of observed objects. Quantitative research is used to conduct research on a certain population or sample by producing data in the form of generalized numbers in the form of a picture of the phenomenon under study (Creswell, 2014). Quantitative research was also conducted to investigate the causal hypothesis by comparing one or more groups with comparison groups to see the difference (Wang & Chang, 2018). The subjects of this study were Generation Z pre-service teacher students from several different study programs located in two different provinces, namely Banten Province and Jakarta province. The research subjects were active students of the pre-service teacher program at both state universities and private universities totalling 106 students in semesters 5 to 8 who were selected using simple random sampling techniques. Research data was collected through surveys on a rating scale (1-5), which were distributed via Google form to respondents.

The instruments in this study were developed by referring to previous research studies that underlie theoretically and empirically. In the dimension of measuring technological pedagogical content knowledge (TPACK), variables refer to survey instruments according to Abbitt (2011); Schmidt et al. (2009) consisting of technology knowledge (tpack1), content knowledge (tpack2), pedagogical knowledge (tpack3), pedagogical content knowledge (tpack4), technological content knowledge (tpack5), technological pedagogical knowledge (tpack6). In the manifest of self-efficacy measurement, measurement instruments are arranged according to the basic theory (Bandura, 1977)(Bandura, 2006)(Pajares, 2007)(Dixon et al., 2020), including magnitude (se1), generality (se2), strength (se3). The digital literacy variable measurement manifest consists of 5 statements with reference to Carretero et al. (2017), namely: Information and data literacy (dl1), communication and collaboration (dl2), digital content creation (dl3), safety (dl4), problem-solving (dl5). The hypothesis test framework is presented in Figure 1.

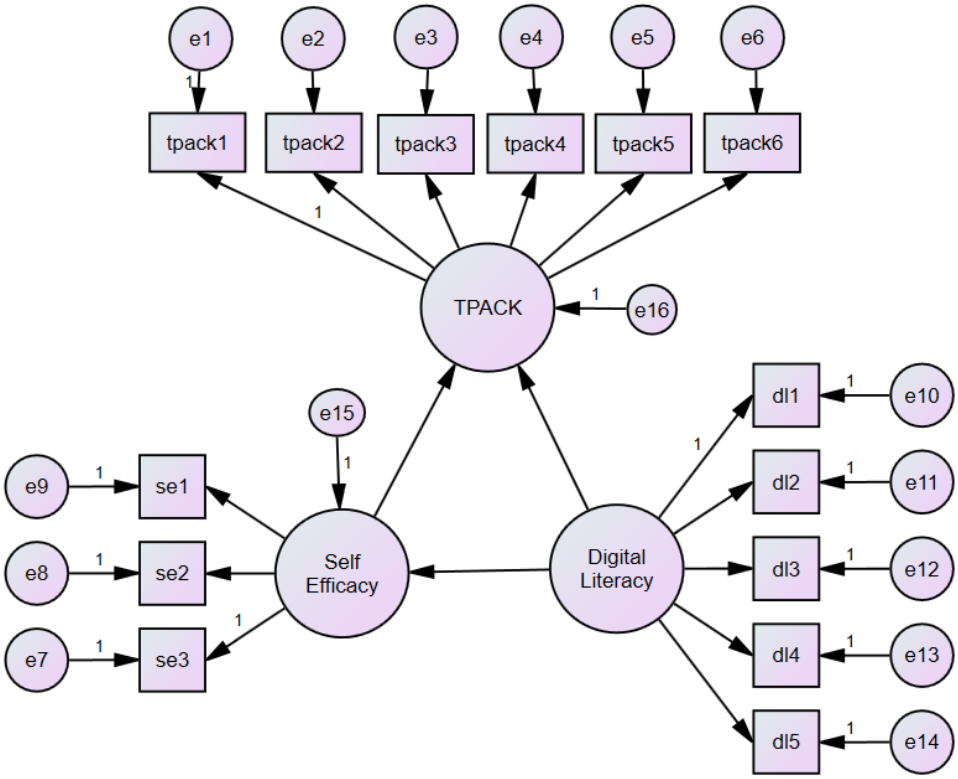

Figure 1. Overall model of interrelation of digital literacy, self-efficacy and TPACK

Model identification is essential to determine whether the model is over-identified, identified, or under-identified, ensuring accurate measurement and structural model estimations. After establishing model identification, the next step is to evaluate the model's performance against various quantitative criteria for goodness of fit (GoF), such as χ2, RMSEA, CFI, GFI, NFI, and other indices. If necessary, the model is then modified to enhance its suitability. To support SEM calculations, Structural Analysis using AMOS software from IBM SPSS is employed. In addition to SEM, other statistical techniques were used to analyse the survey data collected. These techniques included descriptive statistics to summarize the data, exploratory factor analysis (EFA) to identify underlying relationships between measured variables, and reliability analysis to assess the consistency of the measurement scales.

C. RESULT AND DISCUSSION

The results of the study based on the reference value of mean, standard deviation, and category are presented in Table 1.

Table 1. Mean manifest digital competency, self-efficacy, TPACK

Manifest variable	Mean	SD	Category
Technological pedagogical content Knowledge			
Technology Knowledge (tpack1)	16.36	2.002	High
Content knowledge (tpack2)	12.29	1.505	High
Pedagogical knowledge (tpack3)	24.53	3.057	High
Pedagogical content knowledge (tpack4)	4.08	.552	High

Manifest variable	Mean	SD	Category
Technological content knowledge (tpack5)	4.19	.552	High
Technological pedagogical knowledge (tpack6)	16.71	1.903	High
Self-Efficacy			
Magnitude (se1)	12.54	1.766	High
Generality (se2)	12.36	1.744	High
Strength (se3)	8.85	1.139	High
Digital Literacy			
Information and data literacy (dl1)	4.29	.476	High
Communication and collaboration (dl2)	4.15	.656	High
Digital content creation (dl3)	4.15	.724	High
Safety (dl4)	3.86	.806	High
Problem Solving (dl5)	3.92	.741	High

Based on Table 2 above it is known that perceptions about digital literacy, academic self-efficacy, and technology pedagogical content knowledge can be categorized as high. More in-depth analysis of the relationship between variables is carried out through the structural equation model (SEM). In SEM analysis, confirmatory factor analysis (CFA) aims to ensure and evaluate that a variable in a model can reflect the right indicators. Table 2 presents the evaluation and calculation of models that are hypothesized in sequence through SEM AMOS 22.

Table 2. Model Estimate of Interrelation of digital literacy, academic self-efficacy, and TPACK

		S.E.	C.R.	P	Estimate	Loading Factor
TPACK	→ tpack1				1,000	0,638
TPACK	→ tpack2	,137	7,147	***	,981	0,817
TPACK	→ tpack3	,285	7,132	***	2,030	0,851
TPACK	→ tpack4	,051	6,702	***	,344	0,826
TPACK	→ tpack5	,051	6,918	***	,351	0,821
TPACK	→ tpack6	,174	6,860	***	1,192	0,801
SE	→ se1				1,000	0,623
SE	→ se2	,792	4,283	***	3,391	1,038
SE	→ se3	,598	4,533	***	2,713	0,734
DL	→ dl1				1,000	0,717
DL	→ dl2	,259	4,645	***	1,203	0,665
DL	→ dl3	,280	3,973	***	1,111	,615
DL	→ dl4	,327	4,961	***	1,623	,624
DL	→ dl5	,308	5,434	***	1,675	,736

Description: *** is < 0,001. Based on Table 2 above, all constituent indicators in each TPACK variable, self-efficacy and digital literacy are declared valid based on the criteria of Critical Ratio (CR) value >1.96 and probability (P Value) < 0.05 (Hair et al, 2017), the *** sign shows a significant value of < 0.001. While the validity convergent test > 0.5, from the table above it is stated that all have qualified. As for the construct reliability test, it can be fulfilled if the CR value > 0.06, based on the results of statistical calculations, the CR value on the TPACK variable is 0.7, the self-efficacy variance is 0.75 and the digital competency variable is 0.79. Data normality tests with univariate and multivariate normality are known to have CR values at +2.58. Based on the results of the data

analysis above, it is stated that the data obtained has been distributed normally, valid, and reliable. Overall, within the framework of the hypothesis test model, all indicators have a loading factor of > 0.6, so it can be stated that the value can reflect each construct well. In the theoretical framework model there are three hypotheses tested as presented in Table 3.

Table 3. Hypothesis Test

Hypothesis Way				C.R.	P	Result
H^1	Digital Literacy	→	Self Efficacy	1.993	0.046	Accepted
H^2	Self Efficacy	→	TPACK	1.628	0.104	Rejected
H^3	Digital Literacy	→	TPACK	4.566	***	Accepted

Based on Table 3 above in the structural model, with CR value criteria > 1.98 and P value < 0.05 it is known that H^1 digital literacy has a positive and significant influence on academic self-efficacy. Pre-service teacher students have more confidence in teaching and interact well with technology. Student self-efficacy can increase because students can present an interesting learning experience by combining technology, which ultimately can lead students to achieve academic success. While H^2 for self-efficacy academic variables does not directly affect TPACK. This briefly explains that a Generation Z pre-service teacher who has high self-efficacy may have confidence in developing his TPACK skills, but in this case, it may still depend on several other factors such as technology integration training in learning and strengthening digital pedagogy courses. H^3 stated that digital literacy affects TPACK, this briefly explains that digital literacy plays an important role in creating the foundation for effective TPACK development. To confirm the conformity of the model and that all constructs and sub-constructs meet the requirements as presented in Table 4.

Table 4. Goodness of fit

GoF Indices	Criteria	Estimates	Fitness
Chi-Square	Small value	$\chi 2$ = 76,552	*Good fit*
P	P > 0.05	0.306	*Good fit*
NCP	Small value	5,552	*Good fit*
RMSEA	<0.08	0,027	*Good fit*
ECVI	Small value and close to saturated ECVI	D: 1,363 S: 1,981 I:8,315	*Good fit*
AIC	Small value and close to saturated AIC	D: 114,522 S: 210,000 I:881,387	*Good fit*
CAIC	Small value and close to saturated CAIC	D; 269,398 S:595,647 I: 932,802	*Good fit*
CMIN	<2,0	1,078	*Good fit*
GFI	>0,9	0,915	*Good fit*
AGFI	>0,9	0,974	*Good fit*
TLI	>0,95	0,991	*Good fit*
CFI	>0,95	0,993	*Good fit*
IFI	>0,9	0,993	*Good fit*
NFI	>0,9	0,910	*Good fit*

In general, based on Table 4 above model suitability indicates that the model can produce data well and consistently, so it does not require adjustments or modifications to improve model suitability. Generation Z is those who grew up in an environment where there is a lot of flexibility, the internet, social networks, and global communication are constantly increasing (Demirbilek & Keser, 2022). this study, digital literacy has a significant effect on the academic self-efficacy of teacher education program students in Generation Z, which is characterized by 1.993 and P value 0.046, this is in line with the findings of previous research according to (ÇETİN & İŞÇİ, 2022; Hairida et al., 2023; Meekaew & Jongnimitsataporn, 2023; Peciuliauskiene et al., 2022). Generation Z tends to be proficient in mastering technology because they are in an all-digital environment. The use and research on digital technology in learning such as artificial intelligence has become a trend in recent years (Zhang et al., 2023). Based on confirmatory factor analysis (CFA), there are five constructs in digital literacy affecting TPACK, namely information and data literacy, communication and collaboration, digital content creation, security, and problem-solving. The loading factor in the construct of information literacy and data obtained is 0.717, this explains that pre-service teachers must be able to assess and know the sources of data, literature, and information needed in integrating technology into learning. Data and information literacy is considered an important competency that must be possessed in digitalization which is closely related to everyday life (Gebre, 2022).

Communication and collaboration skills as one of the constructs of digital literacy have a loading factor of 0.665. Good digital literacy skills will bring Generation Z pre-service teacher students to use various collaborative digital learning platforms on technology integration and pedagogy. A digital environment that allows for collaboration spaces can help students to solve learning problems (Siripan & Noirid, 2022). High-achieving students tend to have high access to digital learning platforms (Le et al., 2022). The digital content creation construct has a Loading Factor value of 0.615. This indicates that the importance of digital content creation skills for teachers is related to the implications of TPACK in learning to be able to create interesting digital content so as to facilitate students learning in a digital environment. Interesting digital content can help students obtain better academic performance (Bessadok et al., 2023). The safety construct has a loading of 0.624, reflecting the importance of safety elements as an important part of integrating technology into learning. The problem-solving construct has a loading factor of 0.736, indicating that problem-solving skills in the digital literacy component are important in their integration with technology.

Strong digital literacy will bring students to have confidence in teaching using technology (Erdem et al., 2023; Hwang et al., 2023; Tzafilkou et al., 2022). The level of pre-service teacher confidence can also be influenced by their competence in the field of information and communication technology (ÇETİN & İŞÇİ, 2022). In this case, it is also necessary to pay attention to how lecturers who teach pre-service teacher students can provide good examples of technology-based learning to their students. Digital-based learning implied by lecturers in the classroom can also have a direct impact on student self-efficacy in using digital technology that support learnings (Shaikh et al., 2023). Digital literacy is a mandatory skill that must be possessed in 21st-century learning (Hairida et al., 2023). Students can design student-centered learning experiences, use digital resources, and increase student understanding of the subject matter. Digital literacy is an important factor in improving the academic self-efficacy of Generation Z pre-service teacher students. The curriculum in teacher education programs on an ongoing basis needs to be evaluated to be able to create teachers who have the cognitive, teaching, and digital competencies needed in the technological era in the future (Alnasib, 2023).

In this study, TPACK indicators are influenced by digital literacy and are not directly influenced by self-efficacy, while the TPACK manifest is as follows: technology knowledge, content knowledge, pedagogical knowledge, pedagogical content knowledge, technological content knowledge, and technological pedagogical knowledge. The manifest technology knowledge obtained a loading factor of 0.638, indicating that the level of Z-Generation teacher candidates does not directly affect their ability to integrate technology into teaching. Although self-confidence is an important factor in learning and teaching, in the context of TPACK, it seems that digital literacy has a more dominant role in shaping the ability of prospective teachers to teach with technology. This is in line with research that a strong digital literacy concept will encourage the integration of appropriate technology in learning (Wohlfart & Wagner, 2023). Manifest content knowledge has a loading factor of 0.817, identifying that their level of self-confidence has no direct impact on their level of understanding of the subject matter. In this context, content knowledge may be influenced more by digital literacy than by confidence levels. The manifest pedagogical knowledge had a loading factor of 0.851, indicating that their confidence levels had no direct impact on their understanding of effective teaching strategies. In this context, pedagogical knowledge may be influenced more by digital literacy than by levels of self-confidence.

The efficient use of technology by teachers in the classroom is an important issue, this is because the current learning environment is strongly influenced by rapid developments in aspects (Kapici & Akcay, 2023). The manifest pedagogical content knowledge has a loading factor of 0.826, explaining that their level of self-efficacy has no direct impact on their ability to teach material effectively. In this case, knowledge content pedagogy may be influenced more by digital literacy than by levels of self-efficacy. The manifest technological content knowledge has a loading factor of 0.821, explaining that their level of self-efficacy does not have a direct impact on their ability to understand how to integrate technology in teaching subject matter. In this case, content technology knowledge may be influenced more by digital literacy than by levels of self-efficacy. The manifest technological pedagogical knowledge has a loading factor of 0.801, explaining that their level of self-efficacy has no direct impact on their ability to design and implement teaching strategies involving technology. In this case, pedagogical technological knowledge may be influenced more by digital literacy than by levels of self-efficacy. In an effort to achieve effective learning objectives, technology in learning should be integrated into a comprehensive learning management system (Polly et al., 2023).

Digital technology is a major factor in driving innovation in learning practices in educational institutions (Lin et al., 2023). Therefore, it is important to pay attention to the development of digital literacy in training Generation Z teachers to produce better education and be relevant to the digital era. Teaching using technology is a necessary skill for teachers today and TPACK serves as a general framework for evaluating such skills (Akyuz, 2022). TPACK has become an important focus in modern education today, so it is especially needed, balanced, and in-depth support for teachers in developing their TPACK (Valtonen et al., 2023). Pre-service teacher Z generation may have better technology skills naturally, not just rely on self-efficacy. They have wider access to technological devices and the internet. They can easily access a variety of online resources and digital learning tools, so they have technological resources available to support TPACK development. Teachers need to make effective lesson planning through technology that contributes to providing meaningful learning experiences for students (Elmaadaway & Abouelenein, 2023). The implications of TPACK in learning practices need to pay attention to several important elements such as pedagogical content knowledge, models, technology integration, education, and frameworks to create innovative learning (Net, 2023).

D. CONCLUSION AND SUGGESTIONS

The results showed that pre-service teachers of Generation Z have a strong tendency in digital literacy aspects. TPACK is positively influenced by digital literacy, but not by the level of self-efficacy. This explains that students' ability to design and implement teaching strategies that integrate technology is more influenced by digital literacy skills than the level of self-efficacy. Generation Z pre-service teachers who have strong digital literacy tend to be better able to integrate technology into learning more effectively. While the level of self-efficacy is an important factor in learning, the analysis of this study shows that in the context of TPACK implementation, digital literacy plays a very dominant role. Therefore, the development of teacher education programs in Generation Z needs to focus on developing digital literacy to improve and equip pre-service teacher students to provide effective learning with the integration of the latest technology. Although the level of self-efficacy is an important factor in teaching and learning activities, in this perception analysis self-efficacy has a more limited impact on the ability of pre-service teacher students to integrate technology into learning practices.

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