Contents lists available at GrowingScience

International Journal of Data and Network Science

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Determinants of teacher digital competence: Empirical evidence of vocational schools in Indonesia

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CHRONICLE

Article history:
Received: November 20, 2023
Received in revised format: January 2, 2024
Accepted: March 18, 2024
Available online: March 18, 2024

Keywords:
Teacher's digital competence
Individual characteristics of teachers
School context
Vocation

ABSTRACT

The goal of this study is to find and analyze the factors that affect teachers' digital competence, consisting of teacher personal characteristics (gender, age, experience, vocational teachers, and attitudes towards technology) and school context (school status, school accreditation, school leadership support, and curriculum support). The research method uses a quantitative approach with a causal design. The study included a total of 444 teachers from vocational high schools (SMK) located in western Indonesia. The characteristics of teachers that influence digital competence are attitudes towards technology and vocational teachers, and this means that teachers who teach vocational subjects have better digital competence than teachers who teach general basic subjects and local content. Curriculum support has a significant impact on vocational school instructors' digital competency. Improved curricular support enhances teachers' digital competence through effective lesson design, execution of teaching and learning activities, and utilization of digital-based practical resources. Meanwhile, age, gender, and school status are not determinants of teacher digital competence. The findings of this investigation recommend that the government, especially the Ministry of Education and the director general of vocational education, include teacher digital competence in evaluating teacher performance and become a consideration for school principals and related offices to improve technology facilities and improve the digital literacy of vocational teachers. This study distinguishes itself from previous research by investigating the determinants that impact teachers' digital proficiency in vocational education. It specifically considers the influence of school status and vocational school accreditation, taking into account the unique combination of school-based and work-based education with diverse teaching approaches.

1. Introduction

In the digital 4.0 era, digital competence is the main key and foundation that every teacher must have to improve innovative learning media. Teachers must be prepared to communicate and interact using technological advancements such as computers with the internet, smartphone learning applications, and so on. This is an educator's capital for improving the ability of teachers to manage learning (pedagogic competence) in digital learning. An extraordinary event, namely the COVID-19 pandemic, accelerated this condition, spreading to almost the entire world and affecting all aspects of life. School administrators face a challenge in managing and measuring teacher performance as offline learning transitions to an online format (Adedoyin & Soykan, 2020; Cai, 2020). Teachers' digital capabilities encourage innovative thinking in education, enhancing the creativity and effectiveness of learning content. This enables students to apply information technology, absorb new and foreign technologies, analyze and solve problems, thus becoming proficient users. Individuals should be responsible, competent, confident, and creative in information and communication technology (Savage & Barnett, 2015). Digital competence encompasses several key components. Firstly, it entails possessing technical proficiency in utilizing digital technology. This includes the ability to navigate and operate digital tools effectively. Secondly, it involves purposefully employing digital technology across various domains, such as work, education, and daily life. This entails utilizing digital tools to facilitate meaningful engagement

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ISSN 2561-8156 (Online) - ISSN 2561-8148 (Print)

doi: 10.5267/j.ijdns.2024.3.014

in diverse activities. Thirdly, digital competence necessitates the capacity to critically assess digital technology. This entails evaluating its merits, limitations, and potential implications. Lastly, it encompasses the motivation to actively participate in digital culture, embracing its opportunities and challenges (Ilomäki et al., 2011). The digital index encompasses various dimensions of teachers' digital competencies, including their self-perception of digital skills, proficiency in fundamental ICT skills, proficiency in subject-specific ICT skills, utilization of digital learning methodologies, and overall level of digital competence (Krumsvik & Jones, 2013). Cattaneo et al. (2022) researched factors influencing teacher digital competence, revealing that attitudes towards technology, frequency of digital tool use, workload, teacher work, curriculum support, and personal factors affect teacher digital competence.

Within the realm of corporate learning, digital media and digital devices are gaining more acceptance compared to the education system, particularly in vocational schools. These institutions face the challenge of adapting to the digitization occurring in various sectors and professions. The teacher's poor digital proficiency is a contributing factor to the underdevelopment of technology-based learning in schools. Most teachers acquire expertise in utilizing digital media for studying and teaching through informal means (Seufert & Scheffler, 2016). Multiple studies have demonstrated that the level of digital proficiency among schoolteachers in different countries remains inadequate (Hinojo-Lucena et al., 2019). Teachers in Spain demonstrate low competence in creating digital content, and curriculum documents do not emphasize the integration of technology (Artacho et al., 2020; Hinojo-Lucena et al., 2019). Krumsvik et al. (2016) expressed the same idea in Norway. According to Instefjord and Munthe (2016), the learning outcomes for technology integration indicate that teacher professional competency does not currently prioritize digital competency. Ertmer et al. (2012) consider teachers to be the 'real gatekeepers' of digital transformation in schools. Researchers have conducted various studies to identify the characteristics that promote the development of digital competencies, as they play a crucial role in integrating technology into education (Hatlevik, 2017). Factors that influence digital competence in previous research include the background and personal characteristics of teachers (teacher's characteristics) such as age, gender, attitude, and belief in technology, as well as school-related elements such as school development and availability of related technical infrastructure. Almerich et al. (2016), Cattaneo et al. (2022), Ghomi & Redecker (2019), Gil-Flores et al. (2017), Guillén-Gámez et al. (2021), Hatlevik (2017), Krumsvik et al. (2016), Lucas et al. (2021), and Tondeur et al. (2018) examined the digital technology competencies.

The objective of this study is to identify and analyze the factors that affect teachers' digital competence, which consists of the teacher's characteristics (gender, age, experience, and attitudes toward technology) and the school context (school status, school accreditation, school leadership support, and curriculum support). Many teachers in vocational schools, especially in rural areas, still experience constraints on the use of technology, making this research necessary and important. This research is also important because it supports government programs to increase digital knowledge and competence, especially among teachers, who have a central and strategic role in the success of education and regeneration in Indonesia. This research differs from previous studies by investigating the factors influencing teacher digital competence in vocational education, where school-based and work-based education have distinct teaching profiles, through the examination of school status and vocational school accreditation, a novel approach not undertaken in prior research. This research fills in the gaps in previous research that examined factors that influence teachers' digital competence with different determinants (Almerich et al., 2016; Cattaneo et al., 2022; Ghomi & Redecker, 2019; Gil-Flores et al., 2017; Guillén-Gámez et al., 2021; Hatlevik, 2017; Krumsvik et al., 2016; Lucas et al., 2021; Tondeur et al., 2018), so this research has high originality. This research aims to provide input to the government, especially the Ministry of Education and the Directorate General of Vocational Studies, to include digital teacher competence in evaluating teacher performance and to be a consideration for school principals and related agencies to improve technology facilities and enhance the digital literacy of SMK teachers.

2. Literature review

Technology Pedagogical Content Knowledge Model (Rosenberg & Koehler, 2015) and the Will Skill Tool Pedagogy Model are theories that underlie teacher digital competence research (Knezek & Christensen, 2016). The TPACK model draws inspiration from Shulman's (1986) ideas about the information a teacher needs to deliver certain subjects. Seven components of the model, three of which correspond to the main knowledge domain (related to disciplinary content, pedagogy and teaching methods and processes, and use of technology), and four additional competencies assumed to be mastered by digitally competent teachers (understanding of pedagogical content, comprehension of technological content, familiarity with the integration of technology and pedagogy, and expertise in the combination of technology and pedagogy). This approach specifically pays attention to the environment in which the teacher works and uses the seven components. According to the Will Skill Tool Pedagogy model, successful integration of technology in the classroom requires four essential components, one of which is an individual's attitudes and perspectives toward the utilization of technology in education (Will), their technical expertise, capabilities, and readiness, their access to hardware, software, and infrastructure, and teaching methods and pedagogical practice (Pedagogy). The term "digital competence" has gradually replaced "digital literacy" and developed into a connotative and historically stratified, product-independent, transversal, and multidimensional concept. Calvani et al. underlined the interaction of three aspects of digital technology, ethics, and cognitive competence in 2010. Ilomäki et al. (2016) suggest that digital competence consists of four elements: "1. Technical skills and practices in using digital technology, 2. Ability to use and apply digital technology in meaningful ways, 3. Ability to understand digital technology phenomena, and 4. Motivation to participate and engage in digital culture". Education policy considers the growing knowledge of citizens and lifelong learners about digital literacy. DigComp is one of the most preferred (Carretero et al., 2017). The KMK strategy in Germany (KMK, 2016) and the basic digital competency framework in Switzerland (Swiss Confederation, 2019) have both been developed, referring to the basic competencies that citizens need to fully participate in civic, social, and professional activities (Cattaneo et al., 2022). TDC is particularly affected by various existing education-related policies (Pettersson, 2018). The challenge here is how to structure teacher education and equip educators to successfully incorporate technology into their teaching practice (Artacho et al., 2020). As experts in the field of education, teachers must embrace digital competencies in addition to pedagogical competencies.

2.1 Factors Influencing Teacher's Digital Competence

Guillén-Gámez et al. (2021) examined the variables that impact the level of digital competence in Spain, namely gender, age, and level of education. The findings of his research revealed that the variables of age and gender exerted an influence on the prediction of teaching staff's level of digital pedagogic ability, while the level of education where they taught had no effect. In gender research, several studies have revealed that men are more digitally competent than women (Almerich et al., 2016; Guillén-Gámez et al., 2021). However, on the one hand, these findings have been refuted by research (Krumsvik et al., 2016; Prieto et al., 2020; Tondeur et al., 2018), where gender has no significant effect on teacher digital competence. The examination of disparities in academic performance across genders has emerged as a significant area of inquiry within the field of education, mostly due to its potential to uncover discrepancies and inequities within certain areas. The first research hypothesis is formulated based on the provided description:

Hypothesis 1 (H1): *Gender affects teachers' digital competence.*

Age is a variable that explains differences in digital competence among teachers in several studies (Guillén-Gámez et al., 2021; Krumsvik et al., 2016; Lucas et al., 2021). The results of the study (Krumsvik et al., 2016) stated that there was a significant negative effect of age and gender on teacher digital competence indicating that male teachers and older teachers demonstrated lower digital competence compared to female teachers and teachers who were younger. However, Tondeur et al. (2018) showed different results, where age did not affect the digital competence of teachers in Flanders (Belgium), this could be due to the varied age variance of the samples. The second research hypothesis is formulated based on the provided description:

Hypothesis 2 (H2): *Age affects the teacher's digital competence.*

In several publications about the digital competence of teachers in vocational schools, there is no mention of the specifics of vocational teachers in terms of competency profiles (Guggemos & Seufert, 2021; Prieto et al., 2020). Seufert & Scheffler (2016) focus on the specifics of VET systems and propose a framework for exploiting the interactions between informal and non-formal in addition to formal learning opportunities. This is a solution that also applies to non-VET teaching staff. It then broadens perspectives, referring to the responsibilities of developing a critical and conscious approach to technology and its implications for students' professional and personal/social lives. Both sources are fully consistent with Erfahrraum's pedagogical model (Schwendimann et al., 2015), which integrates technology effectively in the context of VET. The key assumption behind this model is that in the context of VET, technology should be exploited primarily to drive effective connectivity and exchange of learner experiences across learning sites. Based on the assumption that competency increases with practice, teachers who use digital tools in teaching are often more digitally competent (Ghomi & Redecker, 2019). The third research hypothesis is formulated based on the provided description:

Hypothesis 3 (H3): *The teacher's work experience influences the teacher's digital competence*.

Roll and Ifenthaler (2021) present a competency framework for vocational teachers that encompasses transdisciplinary digital skills. The model encompasses various aspects related to digitization, including attitudes towards it, Competence in using digital devices, possessing information literacy, adhering to digital security protocols, actively participating in virtual collaboration, skill in digital troubleshooting, and the capacity to introspect on one's actions within a digitally interconnected environment. Attitudes toward technology are factors that positively influence competency development and technology integration (Cattaneo et al., 2022; Ertmer et al., 2012; Tondeur et al., 2018), the use of digital tools is often associated with higher competence (Hatlevik, 2017; Lucas et al., 2021; Tondeur et al., 2018). Ertmer et al. (2012) noted that the strongest barriers that prevent teachers from using technology are their attitudes and beliefs about technology, as well as their current level of knowledge and skills. The ideas and attitudes of teachers themselves on the use of technology in student learning are believed to have the most significant influence on the success of teachers (Ertmer et al., 2012). Teachers' digital competency is influenced by factors such as ease of use, confidence in utilizing digital technology, and willingness to embrace new technologies (Lucas et al., 2021). The fourth research hypothesis is derived from the provided description:

Hypothesis 4 (H4): *Attitudes toward technology affect teachers' digital competence*.

The profile of vocational schoolteachers varies greatly depending on the context (Misra, 2011). However, the following five common and basic profiles were identified across the country: Individuals employed in official educational institutions such as schools or colleges; a person who acts as an instructor working in the school environment, especially in a vocational laboratory; Individuals employed in corporate settings with the specific duty of providing training to apprentices; individuals employed in publicly-funded labor market training institutions; and individuals employed in organizations overseen by employers' associations or firm alliances (Grollmann, 2008). This also applies to the Swiss context, where there are two main types of VET schoolteachers: those who teach general knowledge (called Language, Communication, and Society [LCS] in some contexts) and those who teach profession-specific knowledge (Berger & D'Ascoli, 2012). The profile of Vocational High School teachers in Indonesia was identified as Normative, namely teaching religious education, Citizenship Education, Indonesian Language, and General Basic Subjects, Adaptive, namely teaching Physics, Mathematics, and English, Productive, namely teaching vocational-related subjects, where teachers are productive have the competence and practical experience in the industry on these subjects, and local content. Depending on the case, they are identified as teachers, trainers, or instructors between general subject teachers, who usually hold a bachelor's degree, and vocational subject teachers who have vocational qualifications and work experience (Misra, 2011). STEM and non-STEM instructors exhibit notable disparities in their digital skills (Ghomi & Redecker, 2019). Productive teachers are considered to have better digital competency compared to other teacher profiles because they are considered to have vocational qualifications, training, and work experience in the industry. The fifth research hypothesis is derived from the provided description:

Hypothesis 5 (H5): *Vocational (productive) teachers influence teacher digital competence.*

Several previous studies focused more on individual factors and tended to ignore factors related to school. Although technological infrastructure and support for teacher digital competency development are essential for the competent pedagogical use of digital technology in teaching and learning, studies on the effects of organizational infrastructure, leadership support, and school digital development on teacher digital competency are scant. Several studies reveal that the availability and quality of school digital infrastructure (e.g. classroom equipment, internet access, availability of computers) are not related to technology use (Gil-Flores et al., 2017) or teachers' digital competence (Lucas et al., 2021). The quality and infrastructure of schools in Indonesia are often associated with school status and accreditation (school quality ranking), where the status of public vocational high schools (public schools) generally has better facilities and infrastructure than the private sector because they are facilitated by the state, as well as the quality of infrastructure in schools. Public schools are better than private schools. The sixth research hypothesis is derived from the provided description:

Hypothesis 6 (H6): *School status affects the digital competence of teachers in vocational schools*.

School accreditation in Indonesia shows the quality of schools which are divided into 4 categories namely Excellent, Good, Adequate, and Not Accredited (Guidelines for Accreditation of Schools and Madrasas in 2023, 2023). Schools with superior accreditation generally have better quality digital infrastructure than other accreditation statuses. There is still no previous research that examines the effect of school status and school accreditation on teacher digital competence. The seventh research hypothesis is derived from the provided description:

Hypothesis 7 (H7): *School accreditation affects the digital competence of teachers in vocational schools.*

The findings of the study by Nguyen et al. (2022) indicate that educators who employ and utilize the fundamental KKU Smart Learning technology, content, and instructional strategies for classroom management, such as tailoring teaching activities to accommodate student characteristics, can foster an engaging learning environment that enhances students' abilities. This approach aims to enhance cognitive abilities, expand knowledge, and cultivate practical skills. It involves the structuring of educational tasks and the resolution of complex issue scenarios. Additionally, it seeks to bolster learners' motivation to acquire knowledge and foster the assessment and development of their competencies. Nevertheless, the management of teacher classrooms encounters various challenges about restricted internet connectivity, insufficient availability of digital devices, and inadequate digital literacy among both teachers and pupils. According to Ertmer et al. (2012), the provision of assistance from many sources, such as administrators and personal learning networks, is a crucial factor in influencing the level of digital competence among instructors. Management support or school leadership largely determines the digital competence of vocational schoolteachers. According to Lucas et al. (2021), The quantity of instructional resources employed for educational purposes is the most influential determinant of a teacher's proficiency in digital skills. According to the findings of Gil-Flores et al. (2017), various factors impact the adoption of information and communication technology (ICT) in educational environments. These factors include the accessibility of educational software, the level of ICT training among teachers, the extent of collaboration between teachers, individuals' beliefs in their capabilities (self-efficacy), and the incorporation of teaching concepts. School hardware and internet connection infrastructure are less significant. The eighth research hypothesis is derived from the provided description:

Hypothesis 8 (H8): *The support of school leaders influences the digital competence of teachers in vocational schools*.

Lucas et al. (2021) discovered a substantial impact of students' access to technology on all digital competencies evaluated and a positive effect of curriculum support on digital competencies related to empowering students and facilitating their digital competencies. However, evidence of the positive influence of school technology development on teachers' digital competence is still lacking. The contradictory results of previous research on teacher digital competency, as well as the fact that some of this research has been conducted, and not with VET teachers, highlight the need for further research. The results of the study by Cattaneo et al. (2022) show that curriculum support is a determining factor of teachers' digital competence in vocational schools. The ninth research hypothesis is derived from the provided description:

Hypothesis 9 (H9): *Curriculum support affects the digital competence of teachers in vocational schools.*

3. Research method

The research methodology employs a quantitative technique with a causality design. The sample in this study was Vocational High School (SMK) teachers, a total of 444 teachers in Indonesia. Independent variables consist of (i) Variablesteacher's characteristics consisting of age, gender, education, experience, attitude towards technology, teaching field (vocation); (ii) School context variables consist of school status, school accreditation, school leadership support, and curriculum support. The dependent variable is the teacher's digital competency. Data analysis was performed using multiple regression, after testing the validity and reliability of the questionnaire instrument.

Table 1
Operational Research Variables

Variable	Dimension & Indicator	Reference
Dependent Variable: Teacher Digital Competence	Communication and Collaboration (DC1.1 – DC1.6) Professional Development (DC2.1 - DC2.3) Digital Power Source Selection (DC3.1 - DC3.3) Digital Resource Creation (DC4.1 - DC4.4) Data Protection (DC5.1 - DC5.6) Teaching and Learning (DC6.1 - DC6.9) Rating (DC7.1 - DC7.5) Empowerment of Learners (DC8.1 - DC8.6) Student Educational Media (DC9.1 - DC9.4) Facilitating Student Digital Competence (DC.10.1 - DC.10.6)	(Ally, 2019; Krumsvik, 2014) Karsenti et al. (2020)
Independent Variables Teacher Personal:		
Gender	Dummy Variable: 1 = Male 0 = Female	(Berger & D'Ascoli, 2012; Roll & Ifenthaler, 2021)
Age	1 = Age < 45 Years 0 = Age > 45 years	(Ertmer et al., 2012; Hatlevik, 2017; Lucas et al., 2021; Ton-deur et al., 2018)
Experience	1 = Experience < 10 Years 0 = Experience > 10 Years	
Vocational Teacher's (Course)	1 = Vocational Teacher's 0 = Non Vocational Teacher's	
Attitude towards technology	- Foster and stimulate student learning and creativity, - Create and implement digital learning and assessment activities, - Become a digital-based way of learning and working, - Promote and model responsibility and digital society, - Participate in professional development and leadership.	
School Context: School Status	1 = Public 0 = Private	
Accreditation	1 = Excellent & Good 0 = CenoughGood & Not yet accredited	
Leadership Support	- Leaders provide coaches who are proficient in digital technology. - Providing infrastructure that supports digital technology. - Provide adequate internet bandwidth. - Digital training for teachers on an ongoing basis. - Digital technology training for students.	(Guidelines for Accreditation of Schools and Madrasas in 2023, 2023)
Curriculum Support	- The curriculum supports learning using digital technology. - Teacher attendance using digital technology. - Student attendance using digital technology. - The learning system has been integrated. - Students can access learning through digital technology.	

The research model employed for hypothesis testing is outlined below:

$$DC = \beta 1Gender + \beta 2Age + \beta 3Exp + \beta 4Technology + \beta 5Course + \beta 6Status + \beta 7Accred + \beta 8TSM + \beta 9CS + \varepsilon 1 \quad (1)$$

4. Results and discussion

4.1 Respondent characteristics

Based on the respondent profile table in Table 2 below, most SMK teachers in Cilegon City are women, namely 64.86%, and only 35.14% are male teachers. The average age for vocational schoolteachers is 46-55 years, namely 53.83%, with the most teacher experience being 10-20 years, 51.35%. School teachers who were used as respondents came from State Vocational Schools as much as 32.21% and Private Vocational Schools as much as 67.79% with superior accreditation as much as 54.95%.

Table 2
Demographic Attributes of Survey Participants

Characteristics	Total	Percentage
Gender		
Male	156	35.14%
Female	288	64.86%
Age		
1 = Age > 55 years	68	15.32%
2 = 46 – 55 years	239	53.83%
3 = 30 – 45 years	104	23.42%
4 = Age < 30 Years	33	7.43%
Experience		
Experience < 5 years	89	20.05%
5 - 10 Years	104	23.42%
10 - 20 Years	228	51.35%
20 - 30 Years	22	4.95%
Experience > 30 Years	1	0.23%
School Status		
Public	143	32.21%
Private	301	67.79%
Accreditation		
Superior	244	54.95%
Good	88	19.82%
Enough	84	18.92%
Not Accredited yet	28	6.31%
Vocational Teacher's (Course)		
Vocational Teacher's	207	46.62%
Non Vocational Teacher's	237	53.38%
Total Respondents	**444**	**100.00%**

This shows that SMKs in Cilegon have the majority of Superior accreditation, with the number of vocational (vocational) teachers at 46.62%.

4.2 Assessment of Validity and Reliability

The construct's measurement validity was evaluated through the assessment of content validity, convergent validity, and divergent validity. A test of convergent validity is undertaken to evaluate the degree to which the observable variables effectively explain the latent variables. The evaluation of convergent validity for the measurement model using indicator reflection entailed analyzing the link between the scores of individual items or components and the scores of latent variables or constructs, as estimated by the SmartPLS program. To assess the validity of a measurement instrument, reflective indicator loadings are employed, typically with a predetermined threshold of 0.7. Convergent validity, on the other hand, is evaluated through the examination of the extent to which different indicators of the same construct converge. The concept of average variance refers to the measure of dispersion or variability within a dataset. It quantifies the average deviation of individual data. The assessment of internal consistency reliability is performed via Cronbach's alpha, with the data being extracted at a reliability threshold of 0.50. Additionally, composite reliability is assessed, with a minimum acceptable value of 0.70 (Hair et al., 2019).

The equation model in Fig. 1 above consists of two groups of constructs, namely exogenous constructs and endogenous constructs. exogenous construct (Exogenous Construct) is a variable that is not predicted by other variables in the model also known as the independent variable. The exogenous construct in this study consisted of nine variables, namely age, gender, experience, skills (attitudes towards technology), teaching fields, school status, school accreditation, school leadership support, and curriculum support. Constructs of age, gender, experience, teaching fields, school status, and school accreditation are measured using a nominal scale (dummy), attitudes towards technology are measured by indicators TS1–TS5, support for school leaders is measured using indicators TMS1-TMS6, and curriculum support is measured using indicators CS1 -CS5.

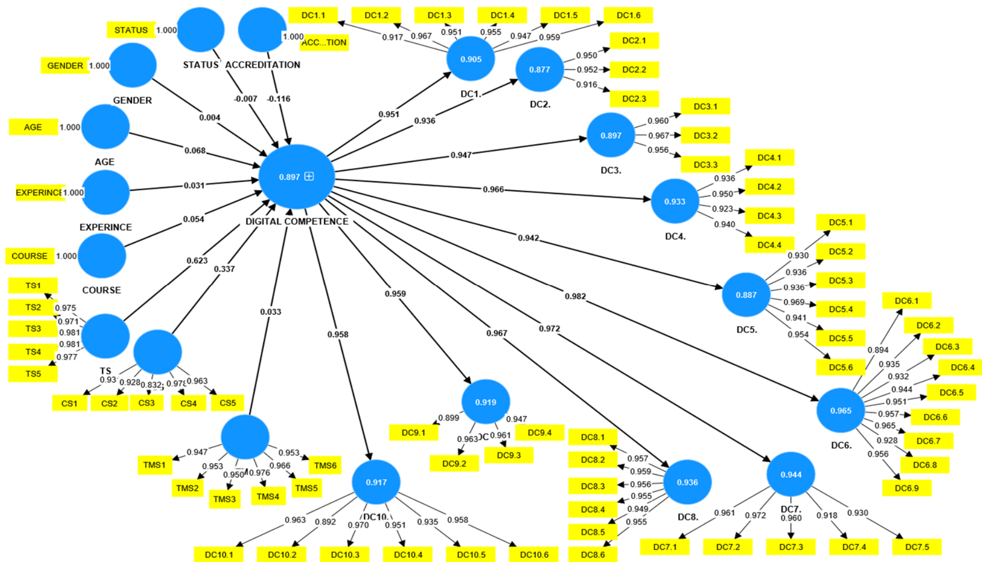

Fig. 1. Validity and Reliability Test Results

Endogenous constructs refer to factors that are anticipated or influenced by one or more constructions. Endogenous constructions can predict one or more other endogenous constructs, while external constructions can independently create causal links with endogenous constructs. The focal construct under investigation in this work is digital competence, which is endogenous. The digital competency construct is described by ten sub-variables or dimensions (Second order confirmatory) namely communication and collaboration as measured by indicators DC1.1–DC1.6, Professional Development as measured by indicators DC2.1 - DC2.3, Selection of Digital Resources as measured by indicators DC3.1 - DC3.3, Resource Creation Digital Power as measured by indicator DC4.1 - DC4.4, Data Protection as measured by indicator DC5.1 - DC5.6, Teaching and Learning as measured by indicator DC6.1 - DC6.9, Rating as measured by indicator DC7. 1 - DC7.5, Student Empowerment as measured by indicators DC8.1 - DC8.6, Student Education Media as measured by indicators DC9.1 - DC9.4, Facilitating Student Digital Competence as measured by indicators DC.10.1 - DC .10.6.

In approaching repeated indicators, the indicator size in the digital competency construct is used twice, where the first is measured by first-order confirmatory and the second to measure second-order confirmatory. The validity of the individual reflexive measure is established when its loading value (λ) with the latent variable under consideration is equal to or greater than 0.7. If the loading value (λ) of an indicator is less than 0.7, it is necessary to discard (drop) the indicator. This is because a loading value below 0.7 suggests that the indicator is not sufficiently reliable for accurately measuring latent variables (Hair et al., 2019).

Table 3
Construct Reliability and Validity

Construct	Outer Loading	
Digital Competence (DC)		
Communication and Collaboration (DC1.1 – DC1.6)		
Use of digital technology to communicate with students (DC1.1)	0.887	0.917
Use of digital technology to collaborate with colleagues at school (DC1.2)	0.925	0.967
Use of digital technology to collaborate with schools (DC1.3)	0.918	0.951
Use of digital technology to communicate with outsiders (DC1.4)	0.893	0.955
Use of digital technology to collaborate with others (DC1.5)	0.903	0.947
Use of digital technology with trainers from companies and course instructors (DC1.6)	0.892	0.959
Professional Development (DC2.1 – DC2.3)		
Proactively develop proficiency in utilizing digital technologies for instructional aims (DC2.1)	0.918	0.950
Engagement in technology-based training methods such as MOOCs, webinars, and online courses (DC2.2)	0.891	0.952
Participation in Training on educational technology in the traditional way (DC2.3)	0.826	0.916
Digital Power Source Selection (DC3.1 - DC3.3)		
Utilizing the Internet to navigate and choose various digital assets (DC3.1)	0.900	0.960
Implement different search strategies for relevant digital resources (DC3.2)	0.906	0.967
Assess the quality of digital resources based on relevant criteria (DC3.3)	0.925	0.956
Digital Resource Creation (DC4.1 - DC4.4)		
Modify and adapt digital materials by pertinent standards (DC4.1)	0.923	0.936
Creating digital resources to support teaching practice (DC4.2)	0.925	0.950
Collaborate with colleagues to create digital resources (DC4.3)	0.880	0.923
Involve students in making digital learning resources (DC4.4)	0.893	0.940

Table 3

Construct Reliability and Validity (Contiuned)

Construct	Outer Loading	
	First	Second
Data Protection (DC5.1 - DC5.6)		
Know the privacy and data protection rules and put them into practice (DC5.1)	0.892	0.930
Protect sensitive school and student data (e.g. exam results, written assignments) (DC5.2)	0.875	0.936
Respect the copyright of the digital educational resources used (DC5.3)	0.914	0.936
Protect personal privacy and the privacy of others online (DC5.4)	0.896	0.969
Recognizing the risks and threats to personal security in the digital world (DC5.5)	0.846	0.941
Restrict access to digital resources appropriately (DC5.6)	0.913	0.954
Teaching and Learning (DC6.1 - DC6.9)		
Ensuring that the technology is used for the learning process (DC6.1)	0.905	0.894
Use interactive digital tools and resources (Quizlets, quizzes on e-learning, etc.) (DC6.2)	0.920	0.935
Use digital collaborative tools and resources (whiteboards with Padlets etc) (DC6.3)	0.902	0.932
Using digital resources to develop innovative teaching strategies (DC6.4)	0.929	0.944
Monitor student activity and interaction in a digital collaborative environment (DC6.5)	0.926	0.951
Utilize digital technologies to enhance collaborative processes and group work. (DC6.6)	0.934	0.957
Integrating digital tools into teaching (DC6.7)	0.944	0.965
Using digital technology to build connections between places of learning (DC6.8)	0.909	0.928
Using digital technology to foster links between theory and practice (DC6.9)	0.941	0.956
Rating (DC7.1 - DC7.5)		
Using digital assessment tools to monitor student progress (DC7.1)	0.929	0.961
Use digital tools to support the formative assessment process (DC7.2)	0.936	0.972
Using digital tools to support the summative evaluation process (DC7.3)	0.935	0.960
Analyze all data held for student identification (DC7.4)	0.892	0.918
Uses digital technology to provide effective feedback (DC7.5)	0.916	0.930
Empowerment of Learners (DC8.1 - DC8.6)		
Consider practical or technical difficulties for learners (DC8.1)	0.927	0.957
Consider practical or technical difficulties for learners (DC8.2)	0.914	0.959
Recalibrate tasks and use other technologies (DC8.3)	0.929	0.956
Using digital technology to offer learning opportunities (DC8.4)	0.917	0.955
Design and implement teaching interventions with digital technology (DC8.5)	0.941	0.949
Using digital technology to stimulate students and actively engage them (DC8.6)	0.916	0.955
Student Educational Media (DC9.1 - DC9.4)		
Teaching students criteria and strategies (DC9.1)	0.877	0.899
Teaching students to use digital technology safely (DC9.2)	0.924	0.963
Make students aware of the consequences of online misconduct (DC9.3)	0.927	0.961
Teach learners to create, adapt, and manage digital identities (DC9.4)	0.886	0.947
Facilitating Student Digital Competence (DC.10.1 - DC.10.6)		
Students use digital devices to communicate and collaborate (DC10.1)	0.925	0.963
Preparing for delivery involves students creating digital content (DC10.2)	0.878	0.892
Encouraging students to use digital technology creatively (DC10.3)	0.933	0.970
Using technology to support students in developing learning documentation (DC10.4)	0.902	0.951
Establish a delivery method that necessitates pupils to utilize digital tools for communication and collaboration (DC10.5)	0.887	0.935
Students utilize digital technologies to inform regarding their professional expertise (DC10.6)	0.905	0.958
Technology Stance (TS1-TS5)		
Foster and stimulate student learning and creativity (TS1)	0.975	-
Create and implement digital learning and assessment activities (TS2)	0.971	-
Become a digital-based way of learning and working (TS3) model	0.981	-
Promote and model responsibility and digital society (TS4)	0.981	-
Participate in professional development and leadership (TS5)	0.977	-
Curriculum Support (CS1-5)		
The curriculum supports learning using digital technology (CS1)	0.931	-
Teacher attendance using digital technology (CS2)	0.928	-
Student attendance using digital technology (CS3)	0.832	-
Integrated learning system (CS4)	0.978	-
Students can access learning through digital technology (CS5)	0.963	-
Top Management Support (TMS1-TMS5)		
Leaders provide trainers who are proficient in digital technology (TMS1)	0.947	-
Providing the infrastructure that supports digital technology (TMS2)	0.953	-
Provide adequate internet bandwidth (TMS3)	0.950	-
Digital training for teachers on an ongoing basis (TMS4)	0.976	-
Digital technology training for students (TMS5)	0.966	-

Source: Author Calculation (Output Smart PLS 4)

According to the outcomes of the validity test on both the first-order confirmatory and second-order confirmatory constructs, all indicators have an outer loading value (λ) above 0.7, so it can be said that all the indicators used in the research variables are valid (see Fig. 1 and Table 3). Reliability testing employs the concept of convergent validity, which is evaluated by the Average Variance Extracted (AVE) criterion. In this criterion, a minimum AVE value of 0.50 is considered indicative of satisfactory convergent validity. The assessment of internal consistency dependability is conducted by the utilization of Cronbach's alpha, which is a statistical measure. Composite reliability, on the other hand, is another metric used to evaluate internal consistency, with a minimum acceptable value of 0.70. (Hair et al., 2019). The following is a table of reliability testing results for each dimension and research variable.

Table 4
Reliability Testing

Variables & Dimensions	Cronbach's alpha	Composite reliability	Composite reliability	AVE
Digital Competence	0.996	0.996	0.996	0.826
DC1.	0.978	0.978	0.982	0.901
DC2.	0.933	0.936	0.957	0.882
DC3.	0.959	0.959	0.973	0.924
DC4.	0.954	0.954	0.967	0.879
DC5.	0.976	0.976	0.980	0.892
DC6.	0.984	0.984	0.986	0.884
DC7.	0.972	0.972	0.978	0.900
DC8.	0.981	0.981	0.984	0.912
DC9.	0.958	0.959	0.970	0.889
DC10.	0.976	0.977	0.981	0.894
Curriculum Support (CS)	0.959	0.962	0.969	0.861
Technology Orient. (TS)	0.988	0.988	0.991	0.955
Management Support (TMS)	0.982	0.982	0.985	0.917

Source: Author Calculation (Output Smart PLS 4)

Based on the findings presented in the reliability analysis, it is observed that both Cronbach's alpha coefficient and composite reliability for all constructs surpass the minimum threshold of 0.7. This suggests a satisfactory level of construct reliability and internal consistency. Consequently, it can be inferred that the selected indicators exhibit favorable reliability and are capable of effectively measuring the respective constructs. All variables in the study exhibit AVE indications that exceed the threshold of 0.5, indicating a high degree of internal consistency and supporting the validity, reliability, and convergent validity of the constructed measuring scale. According to the conclusions drawn from the assessment of validity and reliability, it may be posited that the construct of digital competence, encompassing communication and collaboration, professional growth, digital resource selection, digital resource creation, data security, teaching and learning, assessment, empowering students, educational media for students, facilitating students' digital competencies to have high validity and reliability.

4.3 Analysis and Discussion of Hypothesis Test

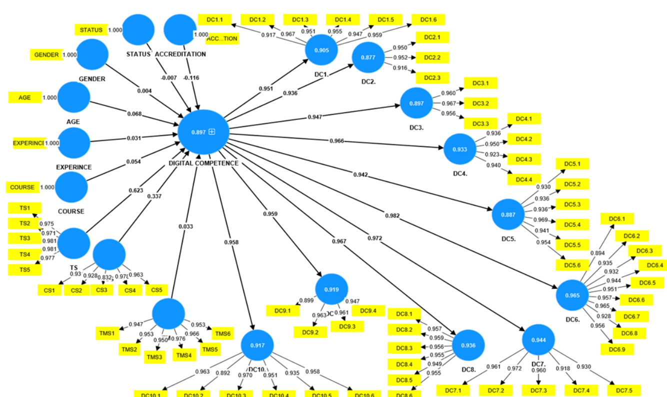

Fig. 2. Hypothesis Test Results

Table 5 provides a detailed explanation of the outcomes obtained from testing the study hypothesis.

Table 5
Testing the Research Variable Dimensions

Variables & Dimensions	Parameter Coefficient	T Statistic	P Value	Information
Digital Competence				
DC1. Communication and Collaboration	0.951	126.328	0.000	Significant***
DC2. Professional Development	0.936	98.133	0.000	Significant***
DC3. Selection of Digital Resources	0.947	115.459	0.000	Significant***
DC4. Creation of Digital Resources	0.966	171.455	0.000	Significant***
DC5. Data Protection	0.942	147.746	0.000	Significant***
DC6. Teaching and learning	0.982	425.249	0.000	Significant***
DC7. Assessment	0.972	237.589	0.000	Significant***
DC8. Student Empowerment	0.967	253.135	0.000	Significant***
DC9. Student Educational Media	0.959	195.785	0.000	Significant***
DC10 Facilitates Student Digital Competence	0.958	176.553	0.000	Significant***

Significant level: *p < 0.1, **p < 0.05, ***p < 0.01

According to the diagram's path in Fig. 2 and Table 5 above, all dimensions of the digital competence variable have a T value $_{statistic}$ which is very high and significant at the 1% level, so these dimensions can measure each construct. Furthermore, to examine the connection between variables (hypothesis testing), the statistical value and p-value are employed. Below is a table displaying the outcomes of the correlation between constructs (variables) and their respective dimensions.

Table 6

Hypothesis Testing Results

Hypothesis		Coeff	t-value	p-value	Test Result	Effect size (f^2)
Digital Competence Model						
H1	Gender	0.004	0.145	0.443	Not Supported	0.000
H2	Age	0.068	0.507	0.148	Not Supported	0.004
H3	Experience	0.031	0.864	0.194	Not Supported	0.002
H4	Technology Stance	0.623	11.853	0.000	Supported***	0.312
H5	Vocational (Course)	0.054	1.651	0.049	Supported**	0.006
H6	School Status	-0.007	0.528	0.299	Not Supported	0.001
H7	Accreditation	-0.116	3.001	0.002	Supported***	0.014
H8	Top Manag. Support	0.033	0.528	0.299	Not Supported	0.001
H9	Curriculum Support	0.337	5.802	0.000	Supported***	0.067
	R-Square (R^2)	0.897	89.70%			
	Adjusted R^2	0.895	89.5%			

Significant level: *p < 0.1, **p < 0.05, ***p < 0.01

Once the reliability and validity of the constructs have been established, the subsequent stage involves assessing the structural measurement model through the utilization of the coefficient of determination (R^2). The coefficient of determination (R^2) quantifies the proportion of the dependent variable's variability that can be accounted for by the variability in the independent variable. R-squared values are classified as weak, moderate, and strong when they approximate 0.25, 0.50, and 0.75, respectively (Hair et al., 2019). Digital competence has an R^2 value of 0.897 or 89.7%, meaning that the teacher's digital competence can be explained by the construct of the teacher's age, gender, experience, attitude towards technology, teaching fields, school status, school accreditation, school leadership support, and curriculum support of 89.7% and the remaining 10.3% affected by additional variables that are not accounted for in the research model.

The explanatory factors in the model explain 89.7% of digital competency variability. This value determines the level of predictability that is satisfactory. According to the data presented in Table 6, the standard path coefficients, t-values, and p-values indicate that out of the nine variables that influence digital competence, four variables are statistically significant. These variables include attitudes towards technology, vocational teachers, school accreditation, and curriculum support. Teacher digital competency is not significantly influenced by gender, teacher age, job experience, school status, and leadership support.

This study not only examines the presence of a significant association between variables but also evaluates the extent of the influence between variables using the Effect Size or f-square. The coefficient of determination (R^2) quantifies the proportion of variability in the dependent variable that can be accounted for by the predictive variable. The utilization of effect size (f^2) is quite valuable in assessing the degree to which independent variables contribute to the variance explained by the dependent variable (R^2). Effect sizes of 0.35, 0.15, and 0.02 are classified as big, moderate, and minor, respectively. When the exogenous construct has a significant impact on explaining the endogenous construct, there will be a comparatively higher difference between the included R^2 and the omitted R^2, resulting in an increased f^2 (Cheah et al., 2018). Table 6 demonstrates that the technological perspective has the most significant impact on teachers' digital competency.

5. Discussion

5.1 The Effect of Teacher's Characteristics on Teacher's Digital Competence

According to the findings of the hypothesis testing, there is no substantial impact of gender on teacher digital competency. Male and female teachers show no disparity in their adoption of digital technology. The findings of this investigation are consistent with the findings of the studies conducted by Krumsvik et al. (2016), Prieto et al. (2020), and Tondeur et al. (2018), where gender has no significant effect on the teacher's digital competence. The results of this study are contrary to previous researchers (Almerich et al., 2016; Cattaneo et al., 2022; Guillén-Gámez et al., 2021; Siddiq & Scherer, 2019), which explains that gender affects teacher digital competence, where male teachers have better digital competence than women. The study findings suggest that there has been gender equality in mastering digital competencies in Vocational High Schools.

The findings of evaluating the hypothesis regarding the impact of age on the teacher's digital competence have no significant effect. Neither young teachers nor senior teachers differ significantly in using digital technology in learning. The results of this study support (Tondor et al., 2018), that the digital competency of teachers in Belgium is not influenced by age. This is contrary to previous researchers (Almerich et al., 2016; Cattaneo et al., 2022; Guillén-Gámez et al., 2021; Siddiq & Scherer,

2019) which shows that age affects the digital competence of teachers. The difference in the results of this study could be due to the varied sample age variants, where this study used a dummy variable in measuring the age construct.

The findings from the hypothesis testing regarding the impact of work experience on teachers' digital competence have no significant effect. The outcomes of this investigation contradict the findings (Ghomi & Redecker, 2019), where it is assumed that competency increases with practice, experienced teachers who use digital tools in teaching are often more digitally competent (Ghomi & Redecker, 2019). The findings from the hypothesis testing regarding the impact of attitudes toward technology (technology stance) have a significant effect on teachers' digital competence at a significance level of 1%. Where is the capable teacher facilitating and stimulates student learning and fosters creativity, designing and developing digital-based learning and assessment experiences, always being a model for digital-based ways of learning and working, being able to encourage and be a model of responsibility and digital society, as well as participating in professional development and leadership has proven to be able to improve teachers' digital competence. The higher the teacher's creativity and innovation in the learning process, the better the digital competency possessed by the teacher. The findings of this study corroborate the research (Cattaneo et al., 2022; Ertmer et al., 2012; Tondeur et al., 2018), where their attitudes and beliefs about technology, as well as their current level of knowledge and skills, have an impact on teacher competence and success (Ertmer et al., 2012). The findings of this study further corroborate the research conducted by Lucas et al. (2021), which suggests that teachers' digital competence can be enhanced by factors such as simplicity of use, confidence in utilizing digital technology, and receptiveness to new technologies. Teachers' attitudes towards technology as 'real gatekeepers' of digital transformation in schools (Ertmer et al., 2012) proven in vocational schools at SMK Cilegon. This empirical evidence also supports the research(Tondor et al., 2018), where technological attitudes have a positive effect on competency development and digital integration. Teachers who often use digital tools in teaching can improve their digital competence through practice (Ghomi & Redecker, 2019; Hatlevik, 2017; Lucas et al., 2021; Tondeur et al., 2018; Carter et al., 2017). The findings from the hypothesis testing regarding the impact of learning profiles (vocational teachers) on teacher digital competence have a positive effect at a significance level of 5%. This means that teachers who teach vocational subjects have better digital competence than teachers who teach general basic subjects and local content. The findings of this research provide evidence in favor of the Technological Pedagogical Content Knowledge theory proposed by Rosenberg and Koehler (2015), and the Will Skill Tool Pedagogy model that underlies teacher digital competence research (Knezek & Christensen, 2016).

5.2 Effect of School Characteristics on Teacher Digital Competence

The findings from the hypothesis testing regarding the impact of school status on teacher digital competence have no significant effect. This means that public and private schools have the same opportunity to increase teacher digital competence. The findings of evaluating the hypothesis regarding the impact of school accreditation on teacher digital competence demonstrate a statistically significant effect at a significance level of 1%. The findings of this study indicate that the better the school's accreditation, the higher its digital competence. This shows that teacher digital competence based on school profiles shows a significant difference where teachers at Vocational High Schools who have Superior and Good Accreditation are proven to have better digital competence compared to teachers at Vocational Schools who have Adequate accreditation and are not yet accredited. Teachers in vocational schools with Excellent and Good accreditation have better digital competencies in all categories, namely: communication and collaboration, Professional growth, digital resource selection, digital resource creation, data protection, teaching and learning, assessment, empowering students, educational media and students, and digital competency facilities. Empirical evidence can answer the phenomenon where schools with Superior accreditation generally have better quality digital infrastructure than other accreditation statuses.

The findings from the hypothesis testing regarding the impact of school leadership support on teacher digital competence have no significant effect. This shows that the support of school leaders is not a determining factor of school digital competence. The results of this study do not follow the research results (Nguyen et al., 2022) educate. (Ertmer et al., 2012) According to (Lucas et al., 2021), management support indicates that support in digital infrastructure influences the teacher's digital competence. Empirical evidence shows that the support of school leaders in providing technology-savvy trainers, infrastructure that supports digital technology, adequate internet bandwidth, periodic digital training, and digital training for students has no significant effect on teachers' digital competence.

The findings from the hypothesis testing regarding the impact of school curriculum support on teacher digital competence exert a substantial impact at a statistical significance threshold of 1%. Better curriculum support which consists of lesson planning, the utilization of digital-based practical tools and the execution of teaching and learning activities can enhance teachers' digital competence. The findings of this study further corroborate the findings of Lucas et al. (2021), who saw a substantial impact of curriculum support in enhancing digital competence.

6. Conclusion

The study findings indicate that the determinants impacting the digital competence of vocational teachers in Indonesia are vocational (productive) teachers, teachers' attitudes toward technology, curriculum support, and school accreditation. Gender, age, work experience, school status, and management or leadership support are not factors that determine the digital competence of teachers in vocational schools.

The findings of this study suggest that the government, particularly the Ministry of Education and the Director General of Vocational Studies, should incorporate teacher digital competence as a criterion for evaluating teacher performance. Additionally, it is recommended that school principals and relevant offices take into account this factor when enhancing technology resources and promoting digital literacy among vocational teachers. The government should take into account the particularity of the vocational education setting, as SMK entails a combination of school-based and work-based education with distinct teaching characteristics.

This research has limitations, as the respondents only came from the western part of Indonesia and did not conduct in-depth interviews after the survey was conducted. Future research is expected to increase the distribution of respondents even more broadly and conduct different tests on vocational teachers and high school teachers to see a more comprehensive comparison of digital competencies, as well as conduct in-depth interviews with informants to refine the research results.

Acknowledgments

Gratitude is extended to the Universitas Teknologi Muhammadiyah Jakarta (UTM Jakarta) for their valuable support in this research endeavor, particularly the Faculty of Economics and Business, as well as the UTM Jakarta Research and Community Service Institute, located in Indonesia.

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