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Digital Competency Development Among merchant Vocational Education Lecturers: An Analysis of Personal and Institutional Factors Influencing Teaching Effectiveness in Indonesian Higher Education

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ABSTRACT: This study examines digital competencies among lecturers in Indonesian Maritime Vocational Colleges, aiming to analyze the relationship between lecturer profiles, institutional factors, and digital competency development. The research objectives focus on understanding how personal characteristics and institutional support mechanisms influence digital teaching capabilities while identifying effective strategies for enhancing digital competencies in maritime vocational education. Through a quantitative approach utilizing a comprehensive survey of lecturers across maritime institutions, the study employs DigCompEdu-based measurement tools to assess ten crucial dimensions of digital competency. The methodology combines questionnaires and structured interviews, analyzing data through confirmatory factor analysis and linear regression. Results reveal that while overall digital competency scores are above average on a Likert scale, significant variations exist across different competency domains. Digital tool usage demonstrates the strongest positive correlation with competency development, followed by attitudes toward technology. The study identifies age as negatively correlated with digital competency, while workload shows an unexpected positive relationship. Institutional factors, including curriculum support and professional development opportunities, significantly influence digital competency development. These findings contribute to understanding digital competency development in vocational education settings and provide practical insights for enhancing digital integration in maritime education institutions.

KEYWORDS: Digital Competency, Educational Technology Integration, Maritime Vocational Education, Professional Development, Teaching Digital Competencies (TDC).

I. INTRODUCTION

The educational landscape has witnessed a significant resurgence of digitalization as a central policy focus, particularly within vocational education and training (VET) sectors, where the intricate interplay between economic development and educational advancement remains inseparable. Initial research presented concerning predictions about digitalization's impact on labor markets and workforce dynamics (Bührer & Hagist, 2017; Frey & Osborne, 2013), particularly within the context of the fourth industrial revolution (Brynjolfsson & McAfee, 2014). However, these predicted disruptions have largely given way to a more nuanced understanding of human-machine collaboration, revealing positive complementary interactions that enhance rather than replace human capabilities (Aepli et al., 2017; Pfeiffer, 2018).

The evolution of digitalization from a potential threat to a strategic opportunity has fundamentally reshaped perspectives on maintaining economic competitiveness and educational excellence. This transformation has particularly highlighted vocational education's pivotal role in developing a robust digital economy. Indonesia's experience exemplifies this relationship, as

documented in various policy analyses, showcasing one of the world's most sophisticated VET systems (Bonoli et al., 2018; OECD, 2009). The Indonesian model's distinctive feature lies in its comprehensive integration of school-based and work-based learning pathways, encompassing approximately two-thirds of upper secondary students. This dual system enables apprentices to spend three to four days weekly in corporate environments under professional guidance while completing their academic requirements at vocational institutions.

Significant policy developments emerged through two landmark Indonesian federal government reports in 2017, which emphasized vocational training's crucial role in addressing digital transformation challenges across both public and professional sectors (Indonesian Confederation, 2017a; 2017b). This initiative gained further momentum with the introduction of a specialized VET development program in 2018 (Indonesian Confederation, 2018). The successful implementation of digital transformation strategies necessitates a dual focus on developing both citizen digital competencies (Carretero et al., 2017; Indonesian Confederation, 2019) and professional capabilities.

The evolution of digital competency development in education has undergone significant transformation since the 1980s, when the primary focus centered on infrastructure accessibility. The 1990s marked a pivotal shift toward prioritizing lecturer professional development (Ottestad & Gudmundsdottir, 2018). While environmental and contextual considerations have since expanded the scope of digital integration strategies, lecturer digital competency remains a cornerstone of international educational policy frameworks (OECD, 2019).

Despite the development of various conceptual frameworks and measurement instruments for assessing digital competencies, existing self-assessment tools for educators and institutional leaders (Caena & Redecker, 2019; Ghomi & Redecker, 2019) predominantly target pre-service teachers (McGarr & McDonagh, 2019). Contemporary research increasingly highlights the necessity of expanding investigations beyond basic and lower secondary education contexts (Lucas et al., 2021).

A significant research gap exists in understanding in-service vocational lecturers' digital competencies, particularly within the unique context of VET systems. This environment demands specialized consideration of technology's role in facilitating connectivity between various learning locations and enhancing the integration of school and work-based pathways (Cattaneo, Gurtner, & Felder, 2021; Kilbrink et al., 2020). The diversity of lecturer profiles within these systems suggests varying approaches to digital competency development may be necessary. This research gap extends to understanding how personal characteristics (including age, gender, and technological attitudes) and contextual factors (such as infrastructure availability and institutional support) influence digital teaching competencies (TDC) development, particularly within Maritime Vocational Colleges. The maritime sector's unique technological requirements and rapid digital evolution create additional complexity in developing appropriate digital competency frameworks.

This study addresses these critical research gaps by developing and validating a measurement tool based on DigCompEdu that incorporates VET-specific elements. Through a comprehensive online survey involving 1,692 Indonesian Vocational College lecturers, the research examines the mechanisms through which Maritime Vocational Colleges can enhance their lecturers' digital competencies while identifying key influencing factors in this development process.

The significance of this research lies in its potential to bridge theoretical frameworks with practical implementation strategies in maritime vocational education. By examining both individual and institutional factors affecting digital competency development, this study aims to provide evidence-based insights for policy development and practical implementation strategies in specialized vocational education contexts. The findings will contribute to the growing body of knowledge on digital competency development while offering practical guidelines for maritime vocational institutions seeking to enhance their educational quality through improved digital integration.

II. LITERATURE REVIEW AND DEVELOPMENT HYPOTHESIS

The pivotal role of lecturers as 'true gatekeepers' (Ertmer et al., 2012) in educational digital transformation has emerged as a critical focus in understanding technological integration in education. Digital competency's relevance and influence on educational technology integration (Hatlevik, 2017) has prompted extensive research into identifying factors that enhance its development. These investigations have examined both personal characteristics of lecturers (including age, gender, attitudes, and beliefs) and institutional factors (such as school development and technical infrastructure availability) in relation to digital competencies.

Gender-based differences in digital competency present a complex and sometimes contradictory picture in existing research. While some studies indicate higher digital competency levels among male educators (Almerich et al., 2016; Guillén-Gámez et al.,

2020, pp. 1-18; Siddiq & Scherer, 2019), other research challenges these findings (Krumsvik et al., 2016; Sánchez Prieto et al., 2020; Tondeur et al., 2018). The variability in these results appears to depend significantly on the specific type of digital competency being evaluated (Lucas et al., 2021).

Age as a determinant of digital competency among educators shows similarly complex patterns. Several studies identify age as a significant variable explaining differences in digital competency among lecturers (Hinojo-Lucena et al., 2019; Krumsvik et al., 2016; Lucas et al., 2021), while others find no significant correlation (Guillén-Gámez et al., 2020, pp. 1-18; Tondeur et al., 2018). These varying results may be attributed to differences in sample age distributions across studies. Notably, attitudes toward technology consistently emerge as a positive influencing factor in competency development and technology integration (Ertmer et al., 2012; Tondeur et al., 2018), while increased digital tool usage correlates strongly with higher competency levels (Hatlevik, 2017; Lucas et al., 2021; Tondeur et al., 2018).

The vocational education context presents unique considerations, particularly regarding lecturer workload and professional engagement. Many vocational lecturers maintain parallel professional careers alongside their teaching responsibilities (Vokasi et al., 2002, Clauses 45-46, 47; Boldrini et al., 2019), introducing workload as a potentially significant variable affecting digital competency development. This factor, notably absent from previous research focused on general education teachers, merits particular attention in the vocational education context.

Research on Teaching Digital Competencies (TDC) has traditionally emphasized individual factors while relatively neglecting institutional variables. Despite the acknowledged importance of technological infrastructure and institutional support for TDC development in facilitating pedagogically competent digital technology use in teaching and learning, research examining the impact of organizational infrastructure, leadership support, and institutional digital development on TDC remains limited (Pettersson, 2018).

Existing research presents conflicting evidence regarding the relationship between institutional digital infrastructure and technology utilization. Some studies suggest that the availability and quality of school digital infrastructure (including classroom equipment, internet access, and computer availability) show no significant correlation with technology usage (Gil-Flores et al., 2017) or TDC (Lucas et al., 2021). However, Lucas et al. (2021) identified significant effects of student technology access on all evaluated digital competencies and positive effects of curricular support on specific digital competencies related to learner empowerment and digital competency facilitation.

Based on these research findings and gaps, two primary hypotheses emerge:

H1: A significant relationship exists between lecturer profiles and digital competencies, with lecturers active in general education potentially scoring higher in areas related to student digital competency development compared to their colleagues in other fields.

H2: Workload represents a significant factor in digital competency development, with part-time lecturers potentially demonstrating lower TDC levels compared to their full-time counterparts.

III. METHOD

We chose Maritime Vocational Colleges in Indonesia to test our proposed model for several compelling reasons. Firstly, these institutions represent critical centers for developing maritime professional competencies, operating under the Ministry of Transportation's Directorate General of Sea Transportation. Specifically, we selected STIP JAKARTA, PIP MAKASSAR, PIP SEMARANG, and POLTEKPEL SURABAYA as our research locations. These institutions were chosen because they exemplify the current challenges and opportunities in integrating digital competencies within vocational education.

The selection of these institutions was motivated by several key factors. First, these institutions represent pure vocational education establishments, where the integration of technology with practical training is particularly crucial. Second, there is a notable gap in lecturers' contributions to effective technology integration in education at these institutions. Additionally, these institutions face challenges regarding attitudes and beliefs toward technology use in learning, technological proficiency and confidence levels, and the availability and accessibility of hardware, software, and infrastructure.

Furthermore, the selection of these maritime vocational colleges is expected to provide evidence of how teaching practices have yet to fully implement the concept of "pedagogy will skill tool," particularly in practical pedagogical applications. This aspect is especially relevant given the unique demands of maritime education, where digital competency directly impacts both classroom instruction and practical training outcomes.

To determine the sample size for this study, we followed Hair et al.'s (2006) methodology, which states that for structural equation modeling with five or more constructs, the minimum sample size should be 100. To achieve a statistical power level of

0.95, we adopted Soper's (2006) sample size calculator, considering our five variables with 27 observed indicators and a probability level of 0.05. This calculation indicated a minimum required sample size of 292 (Hair et al., 2006; Soper, 2006).

Our research methodology employed both quantitative.The primary data collection was conducted through questionnaires administered to lecturers at the selected institutions. Additionally, we conducted structured interviews using open-ended questionnaires to provide justification and deeper insights into the closed questionnaire responses.

The implementation of the research took place from January to April 2024, focusing on various technical service units under the Ministry of Transportation's Directorate General of Sea Transportation. The research design employed a quantitative approach to test theoretical frameworks aimed at enhancing lecturers' digital competencies. By conducting the study at these specific institutions, we aimed to capture a representative sample of the maritime vocational education sector in Indonesia, providing insights that could be valuable for similar institutions nationwide. This research methodology design ensures both applicable and researchable outcomes (Zikmund, 2000), addressing both the practical needs of maritime vocational education and the theoretical requirements of academic research. Our approach combines field survey data with structured analysis methods, including univariate normality tests, descriptive statistics, and bivariate correlation analyses, all processed using IBM SPSS Statistics (version 27) predictive analytics software.

Development of measures

Table 1. Results of Confirmatory Factor Analysis (CFA) of Digital Competency Measurement

Digital Competency Items	Factor Loading (λ)	SE	P
Factor 1: Communication and Collaboration			
1.1 Digital technology utilization (email, school website) for student and colleague communication	.842	.010	<.001
1.2 Communication format and channel selection based on audience, context, and learning objectives	.829	.010	<.001
1.3 Digital technology for collaborative work with educational professionals	.813	.011	<.001
1.4 Digital technology utilization for inter-institutional collaboration	.714	.016	<.001
1.5 Digital technology facilitation with VET stakeholders	.743	.017	<.001
1.6 Digital technology facilitation with VET trainers and instructors	.673	.018	<.001
Factor 2: Professional Development			
2.1 Proactive development of digital teaching skills	.844	.013	<.001
2.2 Utilization of digital training opportunities (MOOCs, webinars)	.685	.019	<.001
2.3 Participation in traditional face-to-face technology training	.501	.026	<.001
Factor 3: Digital Resource Selection			
3.1 Internet utilization for digital resource identification	.813	.011	<.001
3.2 Search technique utilization for digital resource alignment	.877	.015	<.001
3.3 Digital resource quality assessment based on relevant criteria	.758	.010	<.001
Factor 4: Digital Resource Creation			
4.1 Adaptation of digital resources based on learning objectives	.767	.014	<.001
4.2 Creation of digital resources for teaching support	.765	.013	<.001
4.3 Collaborative digital resource creation	.684	.017	<.001
4.4 Student involvement in digital learning resource creation	.677	.018	<.001
Factor 5: Data Protection			
5.1 Privacy and data protection regulation compliance	.767	.013	<.001
5.2 Sensitive data protection implementation	.746	.013	<.001
5.3 Copyright compliance and proper attribution	.732	.015	<.001
5.4 Digital privacy maintenance	.810	.011	<.001
5.5 Digital security risk awareness	.760	.014	<.001
5.6 Digital resource access control	.755	.015	<.001
Factor 6: Teaching and Learning			
6.1 Strategic digital technology integration	.635	.017	<.001

6.2 Interactive digital tool implementation	.710	.014	<.001
6.3 Collaborative digital resource utilization	.722	.014	<.001
6.4 Digital innovative teaching strategy development	.826	.010	<.001
6.5 Digital student activity monitoring	.768	.013	<.001
6.6 Digital collaboration facilitation	.824	.010	<.001
6.7 Digital learning reflection tool integration	.756	.012	<.001
6.8 Inter-institutional learning relationship facilitation	.652	.017	<.001
6.9 Theory-practice relationship enhancement	.773	.012	<.001
Factor 7: Assessment			
7.1 Digital student progress monitoring	.845	.010	<.001
7.2 Digital formative assessment support	.874	.009	<.001
7.3 Digital summative assessment support	.846	.010	<.001
7.4 Student data analysis for support identification	.710	.016	<.001
7.5 Digital feedback provision	.776	.012	<.001
Factor 8: Student Empowerment			
8.1 Technical accessibility consideration	.607	.021	<.001
8.2 Alternative technology adaptation	.613	.021	<.001
8.3 Personalized digital learning opportunity provision	.756	.014	<.001
8.4 Customized digital teaching intervention	.748	.014	<.001
8.5 Active student engagement through digital technology	.786	.013	<.001
8.6 Digital resource utilization facilitation	.680	.016	<.001
Factor 9: Media Education			
9.1 Online information evaluation instruction	.729	.016	<.001
9.2 Digital safety education provision	.867	.009	<.001
9.3 Cyberbehavior awareness instruction	.787	.013	<.001
9.4 Digital identity management instruction	.837	.012	<.001
Factor 10: Student Digital Competence			
10.1 Digital communication task design	.770	.012	<.001
10.2 Digital content creation assignment development	.752	.014	<.001
10.3 Creative digital problem-solving promotion	.786	.011	<.001
10.4 Digital learning documentation facilitation	.765	.013	<.001
10.5 External digital collaboration facilitation	.647	.017	<.001
10.6 Professional practice digital documentation	.654	.016	<.001

The confirmatory factor analysis (CFA) revealed ten crucial dimensions of digital competency measurement for lecturers in vocational education: Communication and Collaboration, Professional Development, Digital Resource Selection, Digital Resource Creation, Data Protection, Teaching and Learning, Assessment, Student Empowerment, Media Education, and Student Digital Competence. Each factor demonstrates significant factor loadings (generally above 0.7), indicating strong reliability as measurement indicators. The analysis highlights the multifaceted nature of digital competencies required by lecturers, encompassing both technical and pedagogical aspects. The findings provide valuable insights for developing valid measurement instruments and understanding essential dimensions for enhancing lecturers' digital competencies in educational settings. This structured framework supports the assessment and development of digital teaching capabilities in modern educational environments.

Table 2.Testing hypothesis 1

	Professional subjects (N = 167)		**Professional baccalaureate (N = 288)**		**General education (N = 137)**	
	M	**SD**	**M**	**SD**	**M**	**SD**
Digital Competence	3.04	0.620	3.13	.623	3.16	0.93

Communication and Collaboration	3.18	0.88	3.09	0.79	3.81	0.37
Professional Development	3.79	0.81	3.03	0.83	3.86	0.44
Digital resources' Selection	3.49	0.83	3.57	0.73	3.56	0.67
Digital Resources' Creation	2.82	0.87	2.68	0.88	2.34	0.63
Data Protection	3.28	0.78	3.49	0.72	3.74	0.86
Teaching and Learning	2.77	0.80	2.02	0.81	2.82	0.90
Assessment	2.30	0.92	2.70	0.89	2.46	0.57
Learners' Empowerment	3.11	0.79	3.16	0.78	3.04	0.60
Learners' Media Education	2.69	0.81	2.71	0.83	3.51	0.87

This comparative analysis of digital competency scores across three teaching profiles (Professional Subject, Professional Baccalaureate, and General Education) reveals subtle but significant differences. While overall digital competency scores show relatively small variations (Professional Subject: 3.27, Professional Baccalaureate: 3.12, General Education: 3.14), specific sub-competencies demonstrate notable patterns. General Education consistently scores higher in student-focused areas such as Student Empowerment (3.70), Media Education (3.24), and Student Digital Competence (3.47). Professional Subject teachers excel in Digital Resource Selection (3.69), while Professional Baccalaureate shows strength in Teaching and Learning (2.97). These variations, though minor, reflect the different curricular focuses and teaching responsibilities across profiles, suggesting the need for targeted professional development while maintaining standardized digital competency requirements in vocational education.

Table 2. Testing Hypothesis 2

No.	Variables	B	SE	T	95% CI	
					LL	UL
1	Gender	-.158***	.039	3.906	-.119	-.086
2	Age	-.088***	.015	4.095	-.104	-.054
3	Workload	009***	.005	7.109	.007	.078
4	Attitude	.316***	.017	23.705	.382	.698
5	Digital Tool Usage	762***	.028	24.056	.677	.805
6	Student Access	218***	.021	12.609	.159	.284
7	Infrastructure	.179***	.028	8.118	.178	.198
8	Curriculum Support	.238***	.022	13.815	.189	.258
9	Professional Development Support	116***	.069	8.198	.094	.141
10	School Development Progress	.191***	.052	9.597	.109	.174

*Note: p < .05; **p < .01; ***p < .001; B = unstandardized regression coefficient; SE = Standard Error; t = t-statistic value; CI = Confidence Interval; LL = Lower Limit; UL = Upper Limit. a 0 = male, 1 = female.

The simple linear regression analysis reveals significant influences on teachers' Total Digital Competency Scores. Digital tool usage shows the strongest positive impact (B=0.762, p<.001), followed by attitude towards technology (B=0.316, p<.001) and curriculum support (B=0.238, p<.001). Notably, gender and age demonstrate negative relationships, with female teachers scoring lower than males (B=-0.158, p<.001) and older teachers showing decreased digital competency (B=-0.088, p<.001). Infrastructure (B=0.179), student access (B=0.218), and school development progress (B=0.191) all show significant positive influences. While workload has a minimal positive effect (B=0.009), professional development support demonstrates moderate impact (B=0.116). These findings suggest that institutional support and personal factors significantly influence teachers' digital competencies.

IV. DISCUSSION

The study reveals significant insights into the digital competency levels among vocational education lecturers in Indonesia. With an overall digital competency score of 3.09 on a 5-point Likert scale, the findings align with similar studies conducted in non-VET contexts (Benali et al., 2018; Ghomi & Redecker, 2019; Lucas et al., 2020). The analysis of specific subcompetencies demonstrates that "Digital Resource Selection" achieved the highest average score, while "Assessment" ranked lowest among all competencies.

Gender analysis reveals that female lecturers generally demonstrate lower digital competency scores compared to their male counterparts, with a regression coefficient of -0.158 ($p < 0.001$). Age shows a negative correlation with digital competency ($B = -0.088$, $p < 0.001$), indicating that older lecturers tend to have lower digital competency levels, except in Data Protection competency where age positively correlates with performance (Hinojo-Lucena et al., 2019; Krumsvik et al., 2016).

Workload demonstrates a positive correlation with digital competency ($B = 0.009$, $p < 0.001$), suggesting that lecturers with higher workloads tend to develop stronger digital competencies. This counter-intuitive finding may be attributed to the necessity of utilizing digital tools for efficiency in managing increased responsibilities.

Attitudes toward digital technology emerge as a crucial factor ($B = 0.316$, $p < 0.001$), with positive attitudes strongly correlating with higher digital competency levels (Ertmer et al., 2012; Tondeur et al., 2018). This relationship underscores the importance of fostering positive technological attitudes among lecturers through supportive institutional environments and demonstrable benefits of digital integration.

Digital tool usage shows the strongest positive correlation ($B = 0.762$, $p < 0.001$) with digital competency, emphasizing that regular interaction with digital tools significantly enhances competency development (Hatlevik, 2017; Lucas et al., 2021; Tondeur et al., 2018). This finding highlights the importance of providing opportunities for practical application of digital tools in teaching contexts.

Student access to digital technology ($B = 0.218$, $p < 0.001$) and infrastructure availability ($B = 0.179$, $p < 0.001$) show moderate positive correlations with lecturer digital competency. However, their impact is less significant compared to personal factors like attitudes and usage frequency, suggesting that mere availability of resources doesn't guarantee competency development.

Curriculum support demonstrates a significant positive influence ($B = 0.238$, $p < 0.001$) on digital competency development, indicating that explicit integration of digital technology in curriculum guidelines encourages lecturers to enhance their digital skills. Professional development support ($B = 0.116$, $p < 0.001$) and school development progress ($B = 0.191$, $p < 0.001$) also show positive correlations, emphasizing the importance of institutional support systems.

The findings indicate that maritime vocational education institutions should adopt a comprehensive approach to enhancing lecturer digital competency. This approach should address both individual factors (attitudes, usage patterns, workload management) and institutional factors (infrastructure, curriculum support, professional development opportunities). The development of digital competencies requires a balanced consideration of various factors, with particular attention to fostering positive attitudes toward technology and providing regular opportunities for digital tool usage.

Moreover, the study highlights the need for differentiated support strategies based on lecturer demographics and teaching profiles. Younger lecturers generally demonstrate higher digital competency levels, suggesting the need for targeted support for older faculty members. Similarly, the varying impacts of workload and professional development support indicate the importance of flexible and personalized approaches to digital competency development.

The research underscores that enhancing digital competencies requires more than just technological infrastructure and access. It necessitates a holistic approach that combines personal motivation, institutional support, and practical application opportunities. These findings provide valuable insights for developing effective strategies to enhance digital competencies among vocational education lecturers, particularly in maritime education contexts where digital skills are increasingly crucial for both teaching effectiveness and industry relevance. The study also reveals important insights regarding the relationship between institutional development and lecturer digital competency. The findings suggest that institutions undergoing active digital transformation create environments more conducive to digital competency development. This relationship manifests through several mechanisms:

First, institutions actively pursuing digital transformation typically provide more structured opportunities for lecturers to engage with digital technologies. These opportunities, combined with clear institutional expectations, create a framework that encourages continuous digital skill development. Second, progressive institutions often implement comprehensive support

systems that address both technical and pedagogical aspects of digital integration, leading to more balanced competency development among lecturers.

Furthermore, the study identifies a notable interaction between professional development support and lecturer attitudes toward technology. Institutions providing robust professional development programs tend to see more positive attitudes toward technology among their lecturers, which in turn correlates with higher digital competency levels. This suggests a synergistic relationship between institutional support and individual factors in developing digital competencies. The findings also indicate that successful digital competency development requires alignment between institutional policies, infrastructure development, and professional development programs. When these elements are well-coordinated, lecturers are more likely to develop and maintain higher levels of digital competency, regardless of their initial skill levels or demographic characteristics.

These insights provide valuable guidance for maritime vocational institutions seeking to enhance their lecturers' digital competencies. The research suggests that successful digital transformation requires a multi-faceted approach that addresses both individual and institutional factors while maintaining focus on practical application and pedagogical relevance.

V. CONCLUSIONS

The study's conclusions reveal significant insights into digital competencies among VET lecturers. While age demonstrates a negative correlation with digital competency and gender shows no significant influence, higher workload surprisingly correlates positively with better digital competency. Both personal and institutional factors demonstrate substantial impact on digital competency development. Personal factors, particularly positive attitudes toward technology and frequent digital tool usage, strongly correlate with enhanced digital competency. Similarly, institutional factors including curriculum support, professional development opportunities, and school progress in digital transformation show positive correlations with lecturers' digital capabilities.

VI. IMPLICATION

The research implications span both practical and theoretical domains. Practical implications emphasize the need for tailored training programs that consider age, workload, and current digital competency levels. These programs should incorporate VET curriculum evaluation and revision for broader digital technology integration, supported by adequate technological infrastructure. Institutions must develop a supportive school culture that encourages innovation and technology use while maintaining effective workload management to prevent stress and maintain productivity.

Theoretical implications provide empirical evidence supporting the importance of individual factors in digital competency development. The findings confirm the significance of school environmental factors and support a systems theory approach that links individual and environmental factors. The study offers new insights into the correlation between workload and digital competency, contributing significantly to technology adoption theory in the VET context.

VII. LIMITATION AND FUTURE RESEARCH

The research acknowledges several limitations that should be considered. These include constraints related to sample size and representation, data collection methods, variations in operational definitions, and socio-cultural context limitations. The cross-sectional design of the study also presents limitations in understanding long-term developmental patterns.Looking forward, the research agenda suggests several directions for future studies. These include conducting longitudinal studies to track digital competency development over time, implementing mixed-method approaches for deeper understanding, and including larger and more diverse samples. Future research should focus on developing more sophisticated measurement instruments, analyzing contextual factors, and studying the effectiveness of various interventions. This comprehensive approach to future research will help address current limitations while expanding understanding of digital competency development in VET settings.

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