JOURNAL OF TECHNICAL EDUCATION AND TRAINING
ISSN: 2229-8932 e-ISSN: 2600-7932

JTET

Vol. 17 No. 4 (2025) 32-41
https://publisher.uthm.edu.my/ojs/index.php/jtet

Analysis of Developing Digital Education Competence Standards for Technical and Vocational Teachers

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DOI: https://doi.org/10.30880/jtet.2025.17.04.003

Article Info

Received: 5th May 2025
Accepted: 18th October 2025
Available online: 30th December 2025

Keywords

Digital competency, technical vocational teacher, digital education, TVET

Abstract

This study aims to formulate digital education competency standards for technical and vocational education and training (TVET) teachers in Indonesia by adapting frameworks from the Australian Qualifications Framework (AQF). As digital transformation accelerates across education sectors, Indonesian TVET teachers must enhance their capabilities to meet the demands of Industry 4.0. A mixed-method approach was employed, involving a quantitative survey of 209 vocational high school teachers across West Java and qualitative focus group discussions (FGDs) with policymakers, practitioners, and digital education experts. The findings indicate that more than 70% of productive subject teachers lack sufficient digital competencies, particularly in integrating information and communication technology (ICT) into classroom practices. Teachers reported low familiarity with digital platforms, e-learning pedagogy, and assessment systems aligned with digital teaching standards. Based on these findings, the study recommends the adoption of AQF-based competency units such as TAEDEL801, TAEDEL802, and TAELED801 within Indonesia's National Work Competency Standards (SKKNI). Additionally, a flexible certification pathway is proposed through Recognition of Prior Learning (RPL), allowing teachers to gain certification based on existing experience and skillsets. These recommendations support the development of a nationally recognized and internationally aligned digital competency model. Strengthening teacher digital literacy is essential for preparing students for the digital economy and promoting cross-border professional collaboration within global TVET systems.

1. Introduction

Amidst the era of the Industrial Revolution 4.0, which brings a wave of technological change, the term "Industrie 4.0" was reintroduced at the Hannover Fair in 2011 (Rupp et al., 2021). The Working Group on Industry 4.0 recommended the implementation of Industry 4.0 to the German federal government (Lu, 2017). Through the Making Indonesia 4.0 program, the government has developed a roadmap and strategy for Indonesia to enter the digital era . This policy needs to be promoted to enhance the digital skills of the Indonesian population, as reflected in the level of Information and Communication Technology (ICT) literacy among Indonesians. According to the *Digital Literacy Status of Indonesia 2020* survey conducted across 34 provinces, the overall digital literacy level of

Indonesian society remains at a moderate level, indicating the need for systematic and sustained policy interventions to strengthen digital competencies nationwide (Ministry of Communication and Information Technology of the Republic of Indonesia (MCI). In this context, teachers, as one of the most important stakeholders in the education system, are required to be competent and adaptive to rapid technological changes in order to effectively support digital transformation in learning and teaching practices (MCI, 2020). Teachers in Indonesia must possess four competencies: (1) pedagogical competence, which primarily involves the ability to educate and develop students' potential, (2) professional competence, focusing on mastery of teaching materials and their support, (3) personal competence, which includes the ability to act according to prevailing norms and values, and (4) social competence, which involves the ability to interact with the community (Ministry of Education and Culture, 2005; Tias, 2021). One of the references and standards of competence that can be adopted is from Australia, namely the Australian Professional Standards for Teachers, which emphasize professional knowledge, professional practice, and professional engagement (AITSL, 2011; NSW Government, 2023). [3]. The teacher competence standards in Australia, as outlined in The National Professional Standards for Teachers, state that teachers must have: (1) professional knowledge, professional practice, which includes: a) planning and implementing effective teaching and learning, b) creating and maintaining supportive and safe learning environments, and c) assessing, providing feedback, and reporting on student learning, and (2) professional engagement, which includes: a) engaging in professional learning, and b) engaging professionally with colleagues and the community (Lee et al., 2014; Lucas et al., 2021; Australian Industry Group, 2022).

The development of digital technology has impacted the competency demands on teachers in enhancing the quality of digital-based learning (Bekri et al., 2015). Technical and vocational teachers play a crucial role in preparing graduates to become skilled workers relevant to industry needs (Barthel, 2021). Digital competency includes the ability to use information and communication technology (ICT) in the learning process, develop digital-based teaching materials, and integrate technology into teaching and learning activities to improve the effectiveness and efficiency of education (Cattaneo et al., 2022; Hinojo-Lucena et al., 2019). However, the rapid technological changes in the industry often outpace the competencies of teachers who can respond to their students' needs in entering the workforce and industry. Teachers in Indonesia must possess four competencies: (1) pedagogical competence, which primarily involves the ability to educate and develop students' potential, (2) professional competence, with the main focus on mastery of the subject matter and its supporting materials, (3) personal competence, which includes the ability to act according to prevailing norms and values, and (4) social competence, which involves the ability to interact with the community (MCI, 2020). One reference and standard of competence that can be adopted is from Australia. The competency standards for teachers in Australia, as stipulated in The National Professional Standards for Teachers, state that teachers must possess: (1) professional knowledge and professional practice, which include: a) planning and implementing effective teaching and learning, b) creating and maintaining a supportive and safe learning environment, and c) assessing, providing feedback, and reporting on student learning, and (2) professional engagement, which includes: a) engaging in professional learning, and b) engaging professionally with colleagues and the community (Rupp et al., 2021).

The development of digital education competency standards for vocational teachers and lecturers based on the Australian Qualification Framework (AQF) needs to be enhanced. The AQF, which serves as a reference for the Indonesian National Qualifications Framework (KKNI), has evolved to meet the demands of the Industrial Revolution 4.0 era. In mid-2020, Australia officially released the draft of foundation skills for your future skills (Hart et al., 2018). Based on this data, it can be seen that the Australian government, through the AQF, has standardized digital literacy as one of the foundational skills that teachers must possess. This study aims to (1) analyze the digital education competency framework from AQF, (2) assess the current competency level of vocational teachers in Indonesia, and (3) propose a model for adaptation and implementation in the Indonesian context. This will ensure that teachers in Indonesia are better prepared to face the changes and shifts brought about by Industry 4.0.

2. Method

A mixed-method design was chosen to capture both the breadth and depth of teacher digital competency. Survey was used to depict the trend and distribution of Teachers' digital competency and Focus Group Discussion (FGD) was used to delve deeper into the aspects of digital competency in detail.

2.1 Survey

The quantitative descriptive approach utilizes data collection techniques through surveys with questionnaires distributed to SMK teachers in West Java. Participants were selected using purposive sampling, targeting teachers from diverse vocational backgrounds to ensure representativeness. A total of 209 productive teachers from various fields of expertise responded, with the respondent demographics provided in Table 1. Table 1 provides information on the respondent limits taken. Data collection was conducted using questionnaires that respondents had to fill out using a Likert scale of 1-5. There are 24 items in the questionnaire which then tested for its validity

using Pearson's Product Moment using SPSS 25.0. Based on the validity test there are 75 questionnaire items out of 89 that are valid. Additionally, one indicator stated which is direct ICT procurement was considered irrelevant to teachers' competency as it was usually connected to the role of school deputy principal or school management and do not fall under teachers' responsibility. Although there are some items excluded, the remaining items still represent the indicators used in the study and replacement was not needed. The result of validity test can be seen in Table 1.

Table 1 *Instrument validity result*

Variable	Indicators (based on AQF's Digital Ed. Competency Qualification Units)	Number of Items before validity test	Number of items after validity test
Digital Education Competency for TVET Teachers	Use e-learning with social media	13	13
	Direct ICT procurement	Not applicable as it was the school management's responsibility	
	Review enterprise e-learning systems and solutions implementation	8	8
	Initiate and lead applied research	15	15
	Implement improved learning practice	10	9
	Design pedagogy for e-learning	9	7
	Analyse, implement and evaluate e-assessment	17	17
	Evaluate, implement and use ICT-based educational platforms	8	7

The reliability test used Cronbach's Alpha formula. The reliability test resulted in 0.98, which makes the instrument considered reliable. The purpose of the questionnaire is to assess the digital capabilities of productive teachers in school learning. A literature review was conducted to determine the indicators of digital education competency based on the Australian Qualification Framework to develop the instrument. The results from the questionnaire are used to draft the digital education competency standards.

2.2 Focus Group Discussion

The qualitative approach involved Focus Group Discussions (FGDs). FGD was attended by 1 training provider, 1 expert in digital education in TVET, 4 teachers from Vocational High Schools, 2 representatives from government and private institutions, and 4 researchers.. This effort is aimed at designing a digital competency model for vocational education teachers, along with its stages. The FGD was facilitated by a moderator and involved contributions from various stakeholders. Digital education experts provided theoretical perspectives on global frameworks for teacher digital competencies, training institution representatives discussed their experience in designing and evaluating professional development programs, while vocational ICT teachers shared practical insights on school-level challenges such as infrastructure constraints, student readiness, and individual barriers to digital mastery. The analysis of data from the focus group discussions (FGDs) indicated a substantial gap between the existing digital skills of vocational school teachers and the demands of contemporary learning. This gap highlights the need for clear, progressive, and adaptive digital competency standards that can accommodate diverse contextual conditions in the field. These findings informed the development of a digital competency standard model for vocational educators, aligned with the Australian Qualifications Framework (AQF).

3. Result and Discussion

3.1 Demographics

This aligns with findings by Cattaneo et al. (Cattaneo et al., 2022), who reported similar digital gaps among vocational educators in Europe. This study involved 210 respondents with various categories determined by the researcher. The respondent categories include sex (man or woman), age (<25, 26-30, 31-35, 36-40, >40), education degree (Diploma, Bachelor, Master, Doctor), teaching duration in years (0-5, 6-10, 11-15, 16-20, >20), and field of expertise (Technology and Engineering, Energy and Mining, Information and Communication Technology, Agribusiness and Agrobiotechnology, Maritime, Business and Management, Tourism, Arts, and Creative Industries). Detailed information regarding the respondents involved in the study can be found in Table 2.

Table 2 *Research respondents*

Description	Frequency	Percentage (%)
Sex		
Man	124	59,05
Woman	86	40,95
Age		
< 25	7	3,33
26-30	58	27,62
31-35	34	16,19
36-60	32	15,24
>40	79	37,62
Education Degree		
Diploma	7	3,33
Bachelor	171	81,43
Master	32	15,24
Doctor	0	0,00
Teaching Duration (years)		
0-5	69	32,56
6-10	43	20,48
11-15	44	20,95
16-20	29	13.81
>20	21	10,00
Field of Expertise		
Technology and Engineering	137	65,24
Energy and Mining	1	0,48
Information and Communication	15	7,14
Technology	4	1,90
Agribusiness and Agrobiotechnology	7	3,33
Maritime	3	1,43
Business and Management Tourism	28	13,33
Arts and Creative Industries	3	1,43
Total Subject		
1 Subject	31	14,76
2 Subject	94	44,76
3 Subject	60	28,57
4 Subject	12	5,71
5 Subject	12	6,19
Lesson hours		
< 24	14	6,67
24-30	131	62,38
31-40	60	28,57
>40	5	2,38
Educator Certificate		
Yes	129	61,43
No	81	38,57

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3.2 Digital Skills Technical and Vocational Education Teachers

Technical and vocational education teachers are required to have digital skills to support optimal learning. According to the AQF standards, every teacher who will undertake certification in TAE80316 Graduate Certificate in Digital Education must take a package of units that will be assessed, consisting of 3 mandatory units: TAEDEL801 (Evaluate, implement, and use ICT-based educational platforms), TAEDEL802 (Use e-learning with social media), and TAELED801 (Design pedagogy for e-learning). In addition to the mandatory units, teachers are required to take elective unit packages, including: Group A with TAEASS801 (Analyse, implement, and evaluate e-assessment) and TAELED803 (Implement improved learning practice), and Group B with ICTICT805 (Direct ICT procurement) and TAELED804 (Review enterprise e-learning systems and solutions implementation) (Australian Industry Group, 2022). The survey results can be seen in Figure 1.

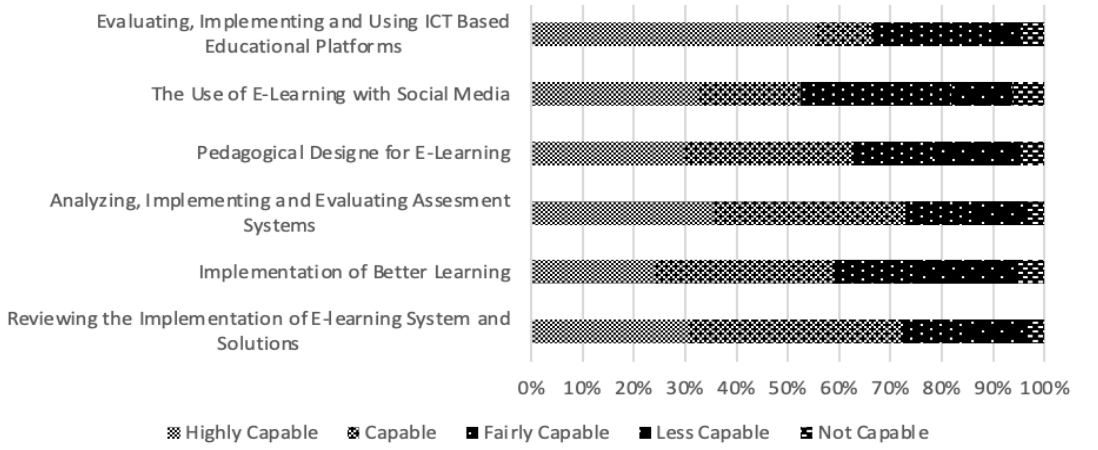

Fig. 1 *Survey results for TAE80316 graduate certificate in digital education*

Based on Figure 2, the majority of productive teachers possess highly varied digital skills, with a tendency towards insufficient mastery. This is a significant concern because Indonesia currently lacks clear regulations regarding the digital skills standards that teachers should possess (Alazam et al., 2013; Ana et al., 2020). On the other hand, these skills greatly support learning that can be tailored to the specific expertise of each field. The results of this survey serve as a reference for researchers to follow up in the form of a FGD with digital skills experts and certification providers in Australia. The FGD will feature speakers and discussants who are stakeholders related to digital education competence, including ICT experts, academic researchers, and vocational high school teachers from various study programs/spectrums. The discussion results can be presented in several aspects, including:

The condition of digital literacy among SMK teachers is very important for discussion as it involves information and a general overview of the digital literacy status of these teachers. Digital literacy in vocational education is not new (it has been around for a long time), but it has recently been revisited (Elmunsyah, 2014; Haryani et al., 2021). During the discussion, IT experts presented their research findings on the digital literacy of SMK teachers in West Java. It was found that many of the 209 SMK teachers surveyed still have issues related to digital literacy. Based on the theory developed by a researched in 2020 (Rupp et al., 2021), the digital literacy levels of SMK teachers in West Java were identified. The research results showed four levels of digital literacy: (1) Emerging, at this stage, the school/teachers are just beginning to explore digital tools (just purchasing equipment, hardware, and software, conducting training, etc. (Cahyadi et al., 2021; Dahalan et al., 2024); (2) Apply, at this stage, there is already an understanding of the contribution of ICT to school management, with schools starting to use or integrate ICT into school management and adopt ICT in the curriculum (Mantoro et al., 2017); (3) Infusing, at this level, ICT integration into the curriculum is present, and the use of technology is better (Rasman, 2018; Consoli et al., 2023); (4) Transforming, at this level, ICT becomes an integral part of both teachers' and students' personal lives (aiding the learning process), with integrated learning (student-centered learning and aligned with the real world) (Mhlongo et al., 2023).

An overview of AQF standard digital competencies compared to the current SKKNI. Last year, through collaboration and the AKSI ADB program, Universitas Pendidikan Indonesia conducted training and certification for several lecturers using AQF level 6 (Double Diploma) standards for learning development. AQF competency standards are highly dynamic and responsive to evolving needs, meaning that the standards for each level can change within a year. For example, a level 6 certification that was valid in 2020 might no longer exist or be downgraded to level 4 by 2023. AQF certification is very dynamic because it.

Similarly, the TAE80316 Graduate Certificate in Digital Education qualification under AQF also has the potential to be modified, including changes to the composition of competency units, the qualification level within the AQF, qualification requirements, and performance criteria as the basis for assessment. This flexibility must also be adopted for the TAE80316 Graduate Certificate in Digital Education qualification by the Indonesian National Work Competency Standards/Kerangka Kualifikasi Nasional Indonesia (KKNI) through periodic reviews. This ensures that digital education qualifications align with the conditions and needs of teachers in Indonesia (Mukminin et al., 2019). Within the AQF framework, there is a concept known as a cohort, which represents a group within the certification pathway. The cohort aims to accommodate the varying needs and abilities of qualification participants. Often, many qualification participants have experience and expertise in certain competency units but lack formal education or certification in those areas (Mutohhari et al., 2021; Nurjanah et al., 2022). To facilitate the certification process for participants, Recognition of Prior Learning (RPL) is applied to certain units. This allows participants to provide evidence documents for RPL and thus bypass the need to undergo training for all competency units to achieve specific certification, making the certification process shorter and more straightforward. SKKNI, which have been in place for some time, largely adopt standards from the AQF. Therefore, it is very feasible for digital education competencies to be adopted again or used as a reference in setting standards within the SKKNI.

Recommendations for Digital Competency Standards for Vocational High School Teachers: the stages or levels of digital literacy can be adopted from various sources. In addition to focusing on digital competencies themselves, we must also emphasize the development of attitudes or values and open mindsets and mental blocks that recognize the importance of digital literacy. Therefore, standards related to character quality must also be included. We can adopt these from certifications provided by BNSP, professional organizations, and institutions (such as UPI).

The development of ICT is closely related to literacy. IT developments will always be paired with literacy, such as Smart Campus, Smart Learning, Smart Class (Hidayat & Sensuse, 2022). Then paired with Smart Teacher, Smart User, which means smart in terms of the human aspect. This is referred to as smart literacy. Designing a standard requires extensive references to formulate digital standards. The standards are created by combining basic theory proposed by prominent figures with research in the field, which is then developed into a standard. This research can come from ICT organizations or international organizations (UNESCO, ILO, etc.), and it should refer to regulations like SKKNI to ensure the formulation is accurate. Based on survey results via questionnaires and FGDs, a draft model for digital education competency standards for vocational teachers based on the AQF is presented in Figure 2.

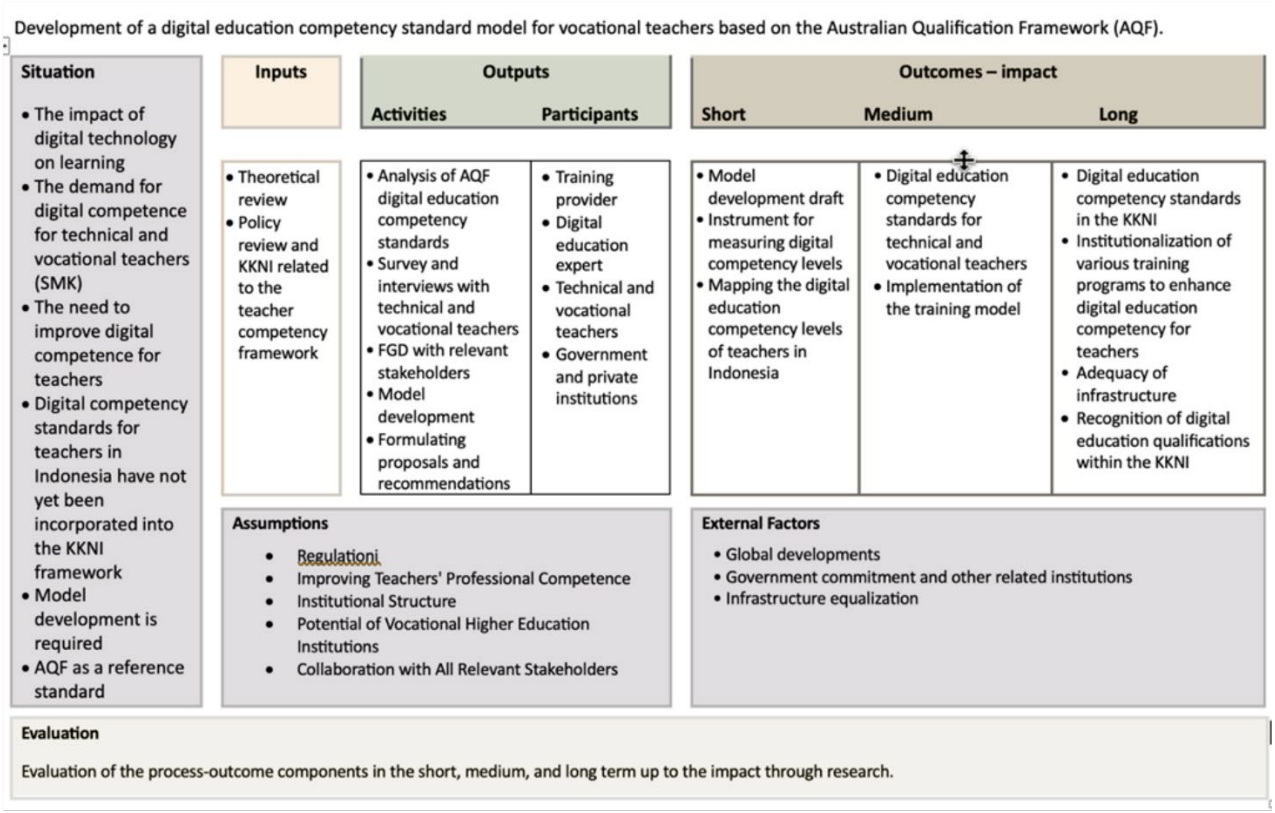

Fig. 2 *Design of a standard model for digital education competencies for vocational teachers based on the AQF*

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The causes of differences in digital competency and implementation in the classroom are varied, including factors such as gender, age (Lucas et al., 2021; Hinojo-Lucena et al., 2019), attitude towards technology (Lucas et al; Cattaneo et al., 2022), experience (Hinojo-Lucena et al., 2019), education level (Hinojo-Lucena et al., 2019), facilities (Lucas et al., 2021; Hinojo-Lucena et al., 2019), and environment (Hinojo-Lucena et al., 2019). Despite this, digital competency is a skill that teachers must master in the era of the Industry 4.0 revolution, requiring a scheme tailored to teachers' needs (Sousa & Rocha, 2019; Kanwar et al., 2019). This diversity has led to the creation of various qualification cohorts/groups. The design of the educational qualification cohort model can be seen in Figure 3.

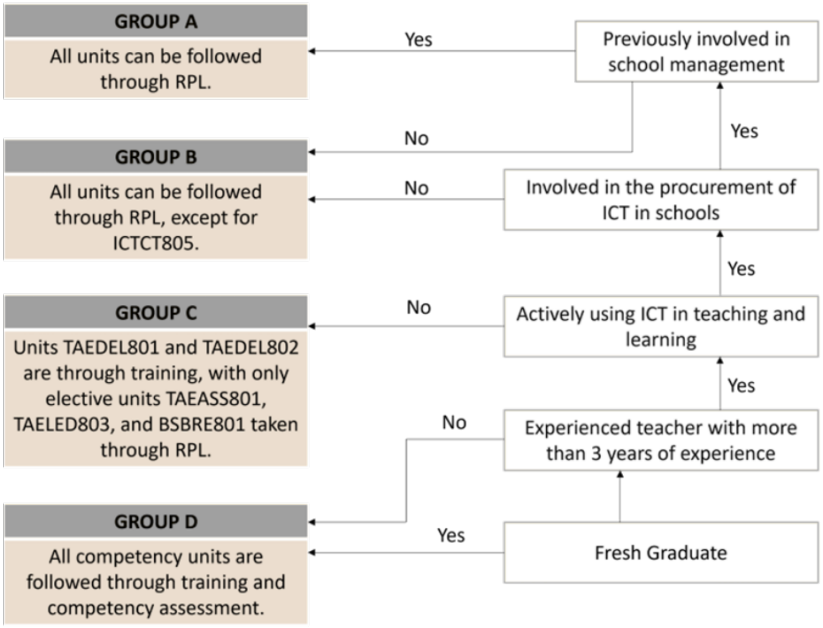

Fig. 3 Design model flow of digital competency standards for vocational teachers based on AQF standards

The cohort outlined in Figure 3 provides opportunities for each productive teacher to participate in training and certification according to their abilities and experience. Similar to the digital education qualifications in the Australian Qualification Framework, the competency units that prospective qualification candidates need to fulfill are as follows in Table 3.

Table 3 Code unit

Code	Title
TAE	Training and Education Training Package
TADEL 802	Use e-learning with social media
ICTICT805	Direct ICT procurement
TAELED804	Review enterprise e-learning systems and solutions implementation
BSBRES801	Initiate and lead applied research
TAELED803	Implement improved learning practice
TAELED801	Design pedagogy for e-learning
TAEASS801	Analyse, implement and evaluate e-assessment
TAEDEL801	Evaluate, implement and use ICT-based educational platforms

Mandatory units: TAEDEL801 Evaluate, implement, and use ICT-based educational platforms, TAEDEL802 Use e-learning with social media, TAELED801 Design pedagogy for e-learning. Elective Units: Group A: TAEASS801 Analyze, implement, and evaluate e-assessment, TAELED803 Implement improvements in teaching practices. Group B: BSBRES801 Initiate and lead applied research, ICTICT805 Direct ICT procurement, TAELED804 Review e-learning systems and implement organizational solutions.

In adapting this qualification, the qualification rules remain the same since the applied standard is the Australian qualification standard. However, the scheme and instruments used must be flexible to meet the needs of teachers and educators in Indonesia. Each prospective qualification candidate is still required to complete three core units and choose two elective units from two groups of elective units. This adaptation is necessary to accommodate the conditions, experience, and qualifications of the prospective qualification candidates as depicted in Figure 3. Efforts to recognize the skills possessed by productive teachers, especially in digital skills, are then translated into a digital skills certification model, which can be seen in Figure 4.

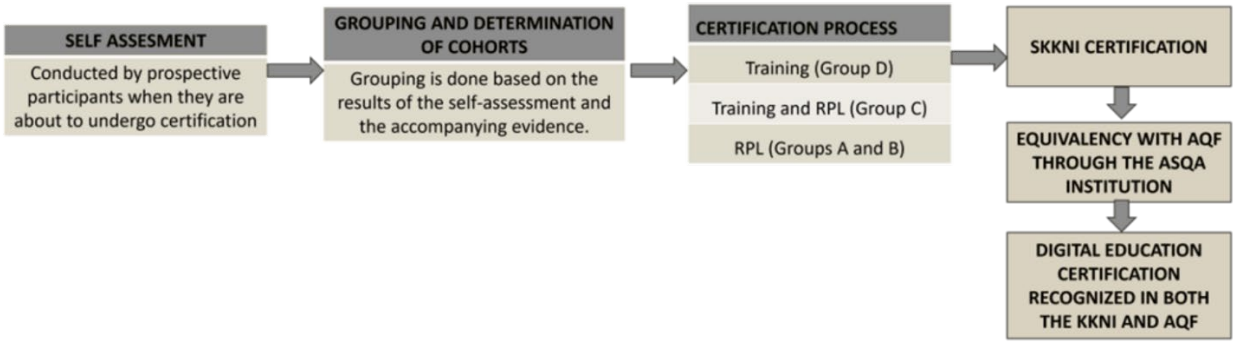

Fig. 4 *Digital education certification model adopted from AQF*

The digital education certification model in Figure 4 provides opportunities for technical and vocational education teachers, especially those teaching productive subjects, to be certified and recognized nationally and internationally. After participants undergo the certification process, they are considered as teachers with digital education qualifications within the KKNI. Since these qualification standards have been aligned with the AQF standards, there is an opportunity for certification equivalence by institutions licensed under the Australian Skills Quality Framework (ASQA). Consequently, participants recognized with these qualifications within the KKNI can also be acknowledged within the AQF. This widens the collaboration opportunities for teachers, with a strong foundation in digital skills and certification. It requires cooperation from various stakeholders to realize and implement this effectively.

4. Conclusion

This research analyzed digital education competency standards with reference to the Australian Qualifications Framework (AQF), aiming to identify adaptable elements for developing standards in Indonesia. The findings highlight a critical need to strengthen the digital competencies of Indonesian vocational teachers to meet the demands of the evolving educational landscape. To address this, the study recommends the integration of AQF-aligned certification schemes into Indonesia's National Work Competency Standards (SKKNI), the provision of targeted training programs aligned with industry needs, and the formalization of Recognition of Prior Learning (RPL) mechanisms. These measures can support a more flexible and inclusive approach to teacher certification. Future research should focus on evaluating the implementation of these standards and exploring their applicability across diverse regions and educational levels. Overall, the study contributes to national efforts to align with international competency frameworks and enhance teacher preparedness in the digital era.

5. Implication

The implications of this research on digital education based on AQF standards include improving the competence of vocational school (SMK) teachers, enabling them to better understand and adapt more structured teaching methods. The proposed model has several practical and policy implications. In practice, the research supports the development of structured training and certification pathways for vocational teachers with institutions such as Universitas Pendidikan Indonesia (UPI) could initiate pilot programs aligned with AQF standards to improve teacher readiness. From a policy and research perspective, the model provides a foundation for revising the Indonesian National Work Competency Standards (SKKNI) to incorporate digital skill frameworks, while also guiding future research to assess the model's scalability and its impact on student learning outcomes. However, this study is limited to vocational teachers in West Java. Therefore, broader regional sampling and longitudinal studies are recommended to validate and refine the model for long-term implementation across diverse educational contexts.

Acknowledgement

The authors would like to express their sincere gratitude to all parties who have contributed to the completion of this research. We extend our appreciation to Universitas Pendidikan Indonesia for providing institutional support and facilitating this research initiative. We are deeply grateful to the 209 vocational high school teachers in West Java who participated in the survey, generously sharing their time and insights regarding digital education competencies. Special thanks are also due to the participants of the Focus Group Discussion, including the training providers, digital education experts, government and private institution representatives, and fellow researchers, whose valuable perspectives enriched this study. We acknowledge the collaboration facilitated through the AKSI ADB program, which enabled the training and certification activities referenced in this research. Our gratitude extends to the institutions and experts in Australia who provided guidance on the Australian Qualification Framework (AQF) standards, which served as a critical reference for this study. Finally, we thank the reviewers and editors of the Journal of Technical Education and Training for their constructive feedback, which greatly improved the quality of this manuscript.

Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

Author Contribution

The authors confirm contribution to the paper as follows: ***study conception and design:*** *L. Widaningsih, J. Maknun & V. Dwiyanti;* ***data collection:*** *L. Widaningsih, A. Ramdanisari & M. Muktiarni;* ***analysis and interpretation of results:*** *L. Widaningsih, J. Maknun & V. Dwiyanti;* ***draft manuscript preparation:*** *L. Widaningsih, V. Dwiyanti & A. Ramdanisari;* ***review and editing:*** *J. Maknun & M. Muktiarni. All authors reviewed the results and approved the final version of the manuscript.*

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