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Prioritizing vocational teacher adaptive capability for industry 4.0: An analytic hierarchy process

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ABSTRACT

Digital transformation and the Industrial Revolution 4.0 require vocational teachers to adapt comprehensively. However, previous studies have generally examined teacher competency only partially and have not identified the dimensions of adaptation that should be prioritized. This study determines the priority of five dimensions of vocational teacher adaptation: Technology Adaptation (AT), Pedagogical Adaptation (AP), Vocational Content Adaptation (AKK), Teacher Role Adaptation (APG), and Sociocultural Adaptation (ASK). Using the Analytic Hierarchy Process (AHP) method, data were collected from 36 vocational teachers via a paired-comparison questionnaire on a Saaty scale of 1-9. After a consistency test, the responses of three respondents were eliminated, and then the remaining 33 assessments were aggregated using the geometric mean and weighted using the eigenvector method. The results showed that AP received the highest priority (23.2%), followed by APG (22.0%), AT (21.0%), AKK (18.6%), and ASK (15.3%). The Consistency Ratio of 0.063 indicates that the assessments are consistent. These findings imply that vocational teacher development policies should prioritize strengthening pedagogical competence and teachers' professional roles, with technology positioned as a pedagogically integrated learning tool within the Technological Pedagogical Content Knowledge (TPACK) framework.

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ABSTRAK

Transformasi digital dan Revolusi Industri 4.0 menuntut guru vokasi untuk beradaptasi secara menyeluruh. Namun, penelitian terdahulu umumnya mengkaji kompetensi guru secara parsial dan belum menetapkan dimensi adaptasi yang perlu diprioritaskan. Penelitian ini menentukan prioritas lima dimensi adaptasi guru vokasi, yaitu Adaptasi Teknologi (AT), Adaptasi Pedagogik (AP), Adaptasi Konten Kejuruan (AKK), Adaptasi Peran Guru (APG), dan Adaptasi Sosial Kultural (ASK). Melalui metode Analytic Hierarchy Process (AHP), data dikumpulkan dari 36 guru vokasi menggunakan angket perbandingan berpasangan berskala Saaty 1-9. Setelah uji konsistensi, tanggapan tiga responden dieliminasi, kemudian 33 penilaian yang tersisa diagregasi menggunakan rata-rata geometrik dan dibobot menggunakan metode eigenvector. Hasil menunjukkan bahwa AP memperoleh prioritas tertinggi (23,2%), diikuti oleh APG (22,0%), AT (21,0%), AKK (18,6%), dan ASK (15,3%). Consistency Ratio sebesar 0,063 menunjukkan bahwa penilaian dinyatakan konsisten. Temuan ini mengimplikasikan bahwa kebijakan pengembangan guru vokasi perlu memprioritaskan penguatan kompetensi pedagogik dan peran profesional guru, dengan teknologi diposisikan sebagai sarana pembelajaran yang terintegrasi secara pedagogis dalam kerangka Technological Pedagogical Content Knowledge (TPACK).

Kata Kunci: *adaptasi pedagogik; analytic hierarchy process; guru vokasi; kemampuan adaptif guru*

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INTRODUCTION

The dynamics of the Industrial Revolution 4.0 demand that vocational education continuously adapt to meet the changing competencies and needs of the workforce (Aruani & Susanti, 2025; Kamaludin et al., 2022; Suwandi & Alfat, 2022). Teachers, as the frontline in implementing learning, face increasingly complex demands for adaptation amid accelerating digital transformation, technological development, and evolving 21st-century competency needs (Malik et al., 2019). That adaptation is not only related to the mastery of Information and Communication Technology (ICT) but also to the integration of pedagogical knowledge, mastery of curriculum content, the ability to design innovative learning, and the strengthening of professional and social competencies to respond to societal dynamics. From the perspective of Technological Pedagogical Content Knowledge (TPACK), teachers' adaptive abilities are developed through the synergistic interaction among technology, pedagogy, and content, enabling effective learning in the era of the Fourth Industrial Revolution (Hermansah et al., 2025; Malik et al., 2019).

Various studies show that digital transformation has changed the demands on teacher competencies from mere technological mastery to the ability to integrate technology, pedagogy, and learning culture as part of teacher professionalism. The success of educational transformation depends on teachers' ability to adapt to change, which is influenced by knowledge, pedagogical beliefs, self-efficacy, and school-environment support (Ertmer & Ottenbreit-Leftwich, 2010; Kim et al., 2017). In vocational education, these demands become even more complex, as teachers are required to possess digital competencies that connect learning to the development of industrial technology (Rahmawati et al., 2025). However, various studies indicate that teachers' digital literacy and competencies remain predominantly at the intermediate level. In contrast, those with advanced digital competencies still require strengthening in several dimensions to meet the ever-evolving industrial needs (Rahmawati et al., 2022).

The development of Artificial Intelligence (AI) and Augmented Reality (AR) increasingly emphasizes that teacher adaptation is determined not only by technological mastery but also by pedagogical readiness and institutional support for integrating innovations into learning (Gupta & Bhaskar, 2020; Kamaludin et al., 2022). The technology has proven to enhance the quality and learning experience, although its implementation still faces challenges related to teacher readiness and the educational ecosystem (Al Husaeni et al., 2025; Putra et al., 2025). Nevertheless, previous research generally still examines teacher competencies in a partial manner, such as digital literacy, TPACK, or AI adoption. There has not been much research that comprehensively identifies and prioritizes the dimensions of vocational teacher adaptation as a construct integrating aspects of technology, pedagogy, curriculum, professionalism, and industry connectivity. This gap is the basis for this research to formulate the priorities of vocational teacher adaptation dimensions in the era of the Fourth Industrial Revolution (Altamimi, 2025; Malik et al., 2019).

Several researchers developed vocational teacher competency standards using the Analytic Hierarchy Process (AHP). The results showed four main dimensions: pedagogical, professional, vocational, and technological, with pedagogical competence as the highest priority. This study demonstrates that AHP is effective for prioritizing teacher competencies

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aligned with vocational education and industry needs (Wahyuni et al., 2022). In addition, AHP can be integrated with Fuzzy logic, as evidenced by research showing that mapping the green curriculum using 20 criteria successfully identified the integration of sustainability principles. The competencies developed encompass cognitive, affective, and psychomotor dimensions, thereby encouraging students to have concern and the ability to contribute to solving environmental issues through collaborative learning. Furthermore, these findings serve as a foundation in formulating a blue curriculum that focuses on strengthening marine literacy as a strategy for the sustainable utilization of marine resources to support community welfare (Widiaty, 2024).

Furthermore, research on secondary schools in Hanoi, Vietnam, involving 133 school teachers, shows that the application of AHP is effective in identifying the priority of teachers' digital skills. The research results reveal that skills directly related to implementing learning, particularly the use of learning software, are the top priority. In addition, classroom management, mastery of learning software, and professional data management are the three competencies that received the highest weight. These findings indicate that teachers prioritize digital skills that directly contribute to the effectiveness of the learning process over technical or administrative digital competencies (Son & Thuan, 2026). Nevertheless, most previous research still focuses on the use of AHP in digital competencies, technology-based learning, or administrative decision support systems (Tsani & Salomo, 2025; Wahyuni et al., 2022; Widiaty, 2024). Research on teacher adaptation, as a broader construct, remains relatively limited.

However, various bodies of literature emphasize that teacher adaptation is not only related to the ability to use technology but also to integrating technology with pedagogy, content mastery, changes in professional roles, and responding to social and cultural changes. Education emphasizes that the success of educational change depends on the interaction between knowledge, pedagogical beliefs, self-efficacy, and school culture, not solely on technological mastery. It explains that educational change is an adaptive process involving the transformation of both individual and organizational capacities (Ertmer & Ottenbreit-Leftwich, 2010; Karaman & Şahin, 2017). This perspective emphasizes that 21st-century teachers must integrate pedagogical, professional, collaborative, and lifelong learning competencies to adapt to changes in the educational environment (Aas, 2023).

Based on the study, three research gaps underpin the novelty of this research. First, previous research generally examines teacher competence in a partial manner, such as digital literacy, ICT competence, or technology adoption, without integrating the dimensions of technology, pedagogy, vocational content, teacher roles, and socio-cultural aspects into a comprehensive conceptual framework. Second, the use of AHP has been more directed toward evaluating digital competence or decision support systems. At the same time, its application to prioritizing the adaptation dimensions of vocational teachers remains very limited. Third, no research has been found in Indonesia that specifically prioritizes the dimensions of vocational teacher adaptation, based on the perceptions of vocational education practitioners, using the AHP approach to develop a teacher competency development model in the era of the Fourth Industrial Revolution. Therefore, this research offers a novelty in the form of prioritizing the dimensions of vocational teacher adaptation by integrating five main dimensions technology, pedagogy, vocational content, teacher roles, and socio-cultural into a single AHP-based analytical framework.

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Based on these gaps, the novelty of this research lies in the development of a multidimensional teacher adaptation priority model that integrates five critical dimensions, Technological Adaptation (TA), Pedagogical Adaptation (PA), Vocational Content Adaptation (VCA), Teacher Role Adaptation (TRA), and Socio-cultural Adaptation (SCA), within a structured AHP analysis framework. The use of classical AHP with active teacher respondents to capture in-depth perceptions of adaptation priorities differs from previous AHP research (Latif et al., 2024). Comparative analysis of perceptions across dimensions has not been widely conducted in the context of teacher adaptation in Indonesia, particularly in comparing the relative priorities among pedagogy, technology, teacher roles, content, and socio-cultural aspects. This research contributes to the development of evidence-based policies for teacher development that consider multi-dimensional adaptation simultaneously, rather than technology or pedagogical aspects in isolation (Wild et al., 2018).

This research aims to: (1) determine the priority weights of the five dimensions of teacher adaptation based on respondents' perceptions using the AHP method; (2) test the consistency of respondents' assessments in making pairwise comparisons; (3) analyze the variability and patterns of respondents' answers to understand perception differences; and (4) provide evidence-based policy recommendations for teacher development that consider multi-dimensional adaptation simultaneously. To achieve these objectives, this study is built on the following framework: (1) digital transformation and social change occurring simultaneously (Du et al., 2019); (2) the five identified dimensions of adaptation (TA, PA, VCA, TRA, and SCA) are interrelated and require different priorities (Koehler et al., 2013); (3) the AHP method can be used to determine the priority of adaptation dimensions based on teachers' perceptions as the main stakeholders; and (4) the priority results can be used as a basis for formulating effective and efficient teacher development policies (Balbağ et al., 2017). This framework positions the five dimensions as a single multidimensional construct in which the relative weight of each dimension, rather than its existence, constitutes the object of inquiry.

LITERATURE REVIEW

Teacher Adaptive Capability

Teacher Adaptive Capability refers to teachers' professional capacity to adjust their knowledge, skills, and teaching practices in response to changes in the educational environment (Dewi et al., 2023; Wahyuni, 2022). These changes include technological advancements, curriculum updates, student characteristics, and labor market dynamics. Unlike the concept of competence, which emphasizes mastery of specific skills, adaptability emphasizes the teacher's capacity to respond flexibly to change, develop innovative solutions, and continuously improve professional practices through ongoing learning (Teece et al., 2016). Various studies show that teachers' adaptability is a multidimensional construct. Adaptation is not only related to the use of digital technology but also includes the ability to adjust teaching strategies, update professional competencies, perform various educational roles, and build collaboration with the educational environment and the workforce.

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Therefore, the ability to adapt is viewed as a dynamic process that enables teachers to maintain the quality of learning while responding effectively to change (Husna et al., 2023; Yanti & Fernandes, 2021). In vocational education, adaptability has more complex characteristics than in general education because teachers must keep pace with technological developments, changes in competency standards, and the ever-evolving needs of the job market. These conditions require teachers not only to master pedagogical and vocational competencies but also to integrate technology, learning innovations, and industry partnerships into their learning practice. Thus, it can be understood as a multidimensional capability that serves as the foundation for the development of vocational teachers in facing the transformation of education and the workforce.

Analytic Hierarchy Process (AHP)

The Analytic Hierarchy Process (AHP) is a multi-criteria decision-making (MCDM) method developed to prioritize decisions based on several interrelated criteria. AHP organizes problems into a hierarchical structure consisting of goals, criteria, sub-criteria, and alternatives, and then performs pairwise comparisons using a fundamental scale of 1-9 to obtain the priority weights of each criterion, in line with Saaty in "*The Analytic Hierarchy Process: Planning, Priority Setting, Resource Allocation*." The priority weights are calculated using the eigenvector method, and the consistency of the assessments is assessed using the Consistency Ratio (CR). A CR value of ≤ 0.10 indicates that the respondents' assessments are consistent and the weighting results are acceptable, in line with Saaty's "*Decision Making with The Analytic Hierarchy Process*." It can integrate experts' subjective judgments into a systematic decision-making process.

AHP has been widely applied in the fields of education, management, and public policy. AHP is a systematic decision-making framework for determining the level of intervention and prioritizing the development of vocational education (Thammaboribal et al., 2025). By establishing a hierarchy of criteria and weights based on expert assessments, AHP helps identify aspects that require primary attention, ensuring that the implementation of vocational education increasingly aligns with the needs of the Business and Industrial World (DUDI). The analysis results show that strengthening collaboration through the High Intervention model is the most effective strategy for enhancing the connection between vocational education institutions and industry.

The implementation of this model requires more intensive involvement from the business and industrial world (*Dunia Usaha dan Dunia Industri*/DUDI), especially in developing a curriculum responsive to labor market needs, conducting training to support students' job readiness, and providing learning facilities and infrastructure that meet industry standards (Tsani & Salomo, 2025). In this study, AHP is used to determine the priority of the dimensions of Vocational Teacher Adaptive Capability (VTAC), namely TA, PA, VCA, TRA, and SCA, thereby obtaining priority weights as the basis for formulating recommendations for the development of vocational teacher competencies in the era of the Industrial Revolution 4.0.

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METHODS

This research uses a quantitative approach with the AHP method. This approach was chosen because of its ability to systematically process subjective assessments and produce measurable priorities in line with Saaty's "*Decision Making with The Analytic Hierarchy Process*." The research instrument is an AHP questionnaire consisting of: (1) respondent identity (optional) including name/initials, gender, years of service, and education level; and (2) a pairwise comparison questionnaire among the five dimensions of adaptation using the Saaty scale 1-9. The scale includes: 1 (equally important), 3 (slightly more important), 5 (more important), 7 (very important), 9 (absolutely more important), and midpoints 2, 4, 6, 8 for compromise.

The instrument grid includes 10 comparison pairs: TA-PA, TA-VCA, TA-TRA, TA-SCA, PA-VCA, PA-TRA, PA-SCA, VCA-TRA, VCA-SCA, and TRA-SCA. There are three stages in data collection, namely: the preparation stage, which includes the development of the AHP questionnaire, instrument validation through expert judgment, and a pilot test of the instrument on five teachers to ensure the clarity of instructions. The implementation stage includes distributing the questionnaire both directly and online (Google Form), assisting respondents who need guidance in completing it, and collecting the questionnaires within two weeks. The verification stage includes checking the completeness of the answers, identifying respondents with extreme inconsistencies, and validating the raw data.

Data Analysis

The pairwise judgments were analyzed using the standard AHP computational procedure (see **Figure 1**).

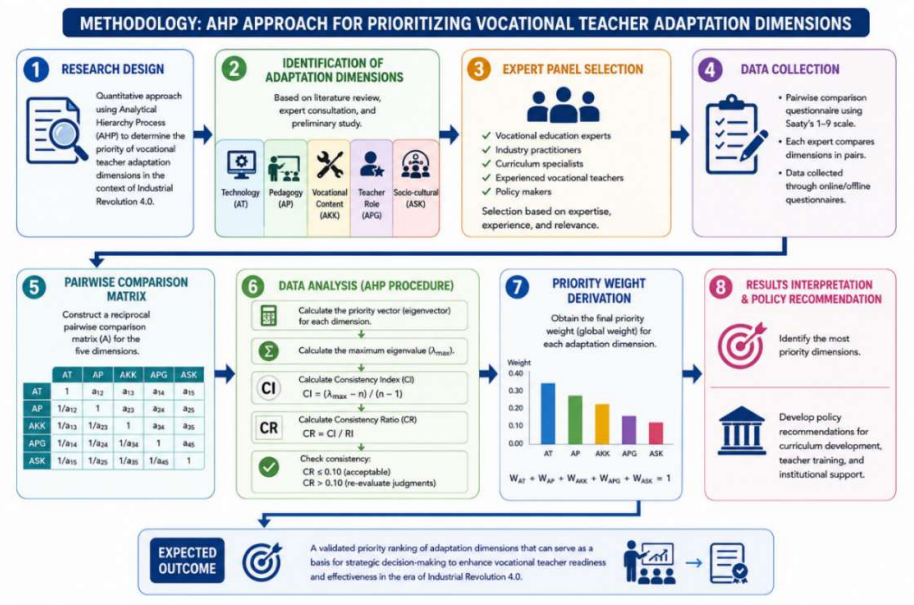

Figure 1. Research Procedure
Source: Research, 2026

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First, the individual judgments for each of the ten comparison pairs were aggregated using the geometric mean, which is the recommended aggregation technique for group AHP because it preserves the reciprocal property of the judgment matrix. The aggregated values were then arranged into a 5 × 5 reciprocal pairwise comparison matrix, in which element aij represents the relative importance of dimension i over dimension j, and aji = 1/aij. Second, the matrix was normalized by dividing each element by the sum of its column, and the priority weight of each dimension was derived from the average of the normalized rows using the eigenvector method.

The resulting weights were then expressed as percentages to indicate the relative priority of each adaptation dimension. Third, the consistency of the judgments was examined. The maximum eigenvalue (λmax) was obtained by multiplying the comparison matrix by the priority vector and dividing the result by the corresponding weight. The Consistency Index (CI) was calculated as $CI = (\lambda max - n)/(n - 1)$, where n is the number of dimensions, and the Consistency Ratio (CR) was obtained as CR = CI/RI, using RI = 1.12 as the random index for n = 5. A CR value of ≤ 0.10 was adopted as the threshold for acceptable consistency.

Respondents whose individual CR exceeded this threshold were excluded from the final analysis, eliminating three of the 36 respondents and leaving 33 sets of judgments for the aggregate computation. Finally, descriptive statistics-minimum, maximum, mean, median, standard deviation, coefficient of variation (CV), and geometric mean-were computed for each comparison pair in order to examine the distribution and variability of respondents' perceptions. The CV was used to assess the degree of consensus among respondents, with a higher CV indicating greater divergence of judgment across the sample.

RESULTS AND DISCUSSION

Data were collected with the following criteria: 1) Respondents completed the questionnaire in full; 2) The respondents' eligibility was appropriately assessed. Here are the statistical descriptions of the paired data for each dimension.

Table 1. Descriptive data of the five Dimensions of Vocational Teacher Adaptation

Pair	Min	Max	Mean	Median	Std.Dev	CV	Geo
TA-PA	0.125	9.000	1.570	1.000	1.630	104%	1,185
TA-VCA	0.111	9.000	1.710	1.000	1.960	115%	1,162
TA-TRA	0.111	5.000	1.200	1.000	1.090	91%	0,961
TA-SCA	0.125	6.000	1.240	1.000	1.190	96%	0,997
PA-VCA	0.111	9.000	2.310	1.000	2.250	97%	1,198
PA-TRA	0.111	7.000	1.830	1.000	1.710	93%	1.192
PA-SCA	0.125	8.000	2.050	1.000	1.850	90%	1,448
VCA-TRA	0.111	6.000	1.470	1.000	1.340	91%	0,982
VCA-SCA	0.111	7.000	2.020	1.000	1.770	88%	1,356
TRA-SCA	0.125	8.000	2.610	1.000	2.210	85%	1,9213

Source: processed, July 2026

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Based on **Table 1**, the median is 1.000 across all pairs, indicating that more than 50% of respondents consider all dimensions equally important. The highest coefficient of variation (CV) is found in the TA-VCA pair (115%), indicating a lack of consensus on the priority between TA and VCA. Conversely, the lowest CV is observed in the TRA-SCA pair (85%), indicating that respondents are more unanimous in agreeing that TRA is more important than SCA. The highest mean is found in the TRA-SCA pair (2.61), indicating that respondents tend to rate TRA as more important than SCA, while the lowest mean is in the TA-TRA pair (1.20), indicating that TA and TRA are rated as almost equally important.

Table 2. Pairwise Comparison Matrix

Dimension	TA	PA	VCA	TRA	SCA
TA	1	1,185	1,162	0,961	0,99
PA	0,844	1	1,530	1,198	1,448
VCA	0,861	0,654	1	0,982	1,356
TRA	1,041	0,835	1,018	1	1,921
SCA	1,003	0,691	0,737	0,521	1

Source: Research 2026

Based on the aggregate value in **Table 2**. The 5X5 comparison matrix shows that a value >1 indicates the row dimension is more important than the column dimension, while a value <1 indicates the opposite. Example: TA-PA = 1.185 means TA is 1.185 times more important than PA. The next step, after normalizing the matrix, is to calculate and weight the priorities and compute the maximum λ, resulting in the following values:

Table 3. Priority Weights, Eigenvalues, and Maximum λ

No	Adaptation Dimension	Weight	Percentage	V = M × W	λ = V / W
1	PA	0,232	23,2%	1,229	5,297
2	TRA	0,220	22,0%	1,190	5,409
3	TA	0,210	21,0%	1,095	5,214
4	VCA	0,186	18,6%	0,989	5,317
5	SCA	0,153	15,3%	0,791	5,170

Source: processed, July 2026

Based on **Table 3**, PA is the highest-priority dimension (23.2%), followed by TRA (22.0%), TA (21.0%), VCA (18.6%), and SCA (15.3%). The CR value = 0.063 is less than 0.10, indicating that the respondents' assessments are consistent. This shows that the obtained data is valid and suitable for further analysis.

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Discussion

Priority of the Teacher Adaptation Dimension

The research results show that PA is the highest-priority dimension (23.2%) among the five dimensions of teacher adaptation. These findings align with Darling-Hammond's research in "Effective Teacher Professional Development," which emphasizes that teacher effectiveness is determined more by pedagogical skills than by mere mastery of technology or content. Research also found that institutional support, in the form of training and professional development, is an important factor in the adoption of learning technology, underscoring the importance of pedagogy as a foundation (Gupta & Bhaskar, 2020).

This result converges with the AHP-based study reviewed earlier, which evaluated vocational teacher competency standards and likewise identified pedagogical competence as the highest priority among the pedagogical, professional, vocational, and technological dimensions (Wahyuni et al., 2022). The convergence of the two studies-conducted with different respondent groups and different dimension structures- strengthens the argument that pedagogy constitutes the stable core of vocational teacher professionalism. The finding is equally consistent with previous research, which demonstrated that the success of technology-supported educational change depends more on teachers' pedagogical knowledge, beliefs, and self-efficacy than on the availability of technology (Ertmer & Ottenbreit-Leftwich, 2010).

Several factors that explain the dominance of PA include: 1) Pedagogy is the core of the learning process and an irreplaceable foundation over technology or other aspects (Demirtaş & Arslan, 2018); 2) The implementation of the Merdeka Curriculum in Indonesia requires teachers to be more flexible and adaptive in their pedagogical approaches; and (3) each generation of students has different characteristics that require different pedagogical approaches. Recent curriculum initiatives in Indonesia, including deep-learning-oriented curriculum design, place comparable demands on teachers to reorganize instructional approaches around meaningful and contextual learning (Kamil et al., 2026). TRA ranks second with a weight of 22.0%, only 1.2 percentage points behind PA. This finding indicates that respondents are aware of the importance of transforming the teacher's role in the modern era. Research emphasizes that the role of teachers has shifted from merely being instructors to becoming agents of change and learning leaders (Larsson & Olin-Scheller, 2020; Liljenberg & Blossing, 2021).

This pattern extends the literature reviewed earlier and shows that adaptive and inclusive practice develops when teachers act as agents of their own professional learning (Aas, 2023). The high weight assigned to TRA in the present study provides quantitative support for both claims, indicating that role transformation is not a by-product of adaptation but one of its principal drivers. Technology Adaptation (TA) ranks third with a weight of 21.0%. This finding is interesting because, in the discourse of digital transformation, technology is often considered a top priority, aligning with Schwab's "*The Fourth Industrial Revolution*." However, respondents in this study placed it below AP and APG. This aligns with findings emphasizing that effective technology integration must be pedagogically grounded (the TPACK concept). Research on interactive learning media design similarly indicates that the

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effect of technology on students' learning interest is determined by the instructional design and pedagogical arrangement of the media rather than by the sophistication of the tool itself (Rosyiddin et al., 2023).

Research also shows that although the Technological Pedagogical Knowledge (TPK), Technological Content Knowledge (TCK), and TPACK abilities of geography teachers are already very good, their implementation in lesson plan documents is still suboptimal, indicating that technology is not the only determining factor for the success of learning (Malik et al., 2019; Rahmawati et al., 2024). This ordering diverges from the AHP study of 133 secondary school teachers in Hanoi, which placed digital skills related to instructional delivery at the top of the priority hierarchy (Son & Thuan, 2026). The difference lies in the frame of comparison: the study compared sub-skills within the digital domain, whereas the present study compared TA against four non-technological dimensions (Son & Thuan, 2026). Read together, the two studies suggest that technology ranks highest when the frame of reference is confined to digital competence, but recedes behind pedagogy and professional role when placed within a broader adaptation construct.

VCA ranks fourth with a weight of 18.6%. This lower position can be explained by: 1) The specificity of vocational content that not all teachers encounter; 2) The dependence of content changes on industry developments that are beyond the teacher's control, in line with Billett in "*Vocational Education: Purposes, Traditions and Prospects*"; and (3) the effectiveness of the content highly depends on the way it is delivered (pedagogy). A needs analysis of secondary-level teaching materials also found that teachers' perceptions of content relevance are shaped by the availability of contextual materials aligned with learners' needs, indicating that content adaptation depends on institutional and material support rather than on teachers' initiative alone (Khaira et al., 2023).

This can be explained by: 1) Respondents may perceive that SCA is already functioning well; 2) SCA often occurs implicitly and is less consciously recognized (Chung et al., 2019); and 3) Compared to pedagogy, the role of teachers, and technology, the socio-cultural aspect is considered less critical. This position is also consistent with research, whose AHP analysis showed that aligning vocational education with industry requires high-intensity institutional intervention, that is, collaboration largely beyond the individual teacher's control (Tsani & Salomo, 2025). A similar structural dependence appears, in which curriculum-level competencies could be mapped and weighted only once institutional and industry actors were involved (Latif et al., 2024; Widiaty, 2024). Regarding the lowest-ranked dimension, school culture is a decisive moderator of whether new professional practices are sustained, suggesting that the low weight assigned to SCA reflects its low visibility to teachers rather than its low importance in practice (Karaman & Şahin, 2017).

Implications for Teacher Development Policy

Based on the research findings, several policy implications can be formulated. First, strengthening pedagogical competence (PA) becomes the main priority. Sustainable professional development programs in pedagogy need to be intensified, including training in active learning methods, differentiation, and formative assessment. Learning communities to share good pedagogical practices also need to be developed. This is in line with findings

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that emphasize the importance of continuous professional development for teachers (Karaman & Şahin, 2017). Secondly, strengthening the role of teachers (TRA) becomes the second priority. The program for developing teacher leadership, creating spaces for teacher innovation and creativity, and strengthening collaboration among teachers needs enhancement.

Research emphasizes the importance of institutional support in the form of recognition and rewards for teachers who adopt learning innovations (Gupta & Bhaskar, 2020; Shinno & Mizoguchi, 2021). Third, the integration of technology based on pedagogy (TA) becomes the third priority. TPACK training and the development of infrastructure that supports technology integration need to be carried out in a coordinated manner through the ACTA (Activity, Content, Technology, and Assignment) approach, which can help teachers harmonize the three components of TPACK in learning (Rahmawati et al., 2025; Rahmawati et al., 2022). Fourth, vocational content adjustment (VCA) is carried out gradually through collaboration with industry and the workforce, in line with Billett in "*Vocational Education: Purposes, Traditions and Prospects*." Fifth, the strengthening of socio-cultural aspects (SCA) remains a focus through raising awareness about the importance of socio-cultural contexts and culturally responsive learning training (Ladson-Billings, 1995).

Comparison with Previous Research

The results of this study reinforce and expand upon the findings of previous research. Earlier studies show that the advanced digital competence of vocational high school teachers remains unevenly distributed and requires strengthening across several dimensions, and that digital literacy at the secondary level remains predominantly at the intermediate level (Rahmawati et al., 2022, 2024). This study complements those findings by showing that pedagogy remains the top priority, even above technology, which indicates that the development of teachers' digital competence cannot be separated from the strengthening of pedagogical capacity.

A similar pattern appears in previous AHP-based studies. Pedagogical competence has been placed as the highest priority among the pedagogical, professional, vocational, and technological dimensions of vocational teacher competency standards (Wahyuni et al., 2022), while the highest weight is assigned to digital skills that directly support instructional delivery when the comparison is confined to the digital domain (Son & Thuan, 2026). A comparable finding shows that institutional support through training and professional development outweighs purely technical factors in the adoption of technology-based learning (Gupta & Bhaskar, 2020). The findings of this study indicate that pedagogy (23.2%) and teacher role (22.0%) are the main priorities for adaptation, suggesting that pedagogical and professional aspects remain the primary focus in teacher development.

Limitations of the Study

Several limitations should be taken into account when interpreting these findings. First, the study involved 36 vocational teachers, of whom 33 were retained after the consistency screening. Although this number is adequate for AHP, which relies on the quality and consistency of expert judgment rather than on statistical representativeness, the sample size

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limits the generalisability of the priority weights to the wider population of vocational teachers.

Second, the respondents were drawn from a limited geographical area and from a restricted range of vocational expertise programs, so the results may not capture variation across regions, school types, or industry sectors. Third, the study applied classical AHP, which assumes that the five adaptation dimensions are independent; in practice, these dimensions are interrelated, and methods such as the Analytic Network Process (ANP), Fuzzy AHP, or DEMATEL would be better suited to modeling interdependence and the vagueness inherent in subjective judgment.

Fourth, the data reflect teachers' perceptions of priority rather than observed adaptive performance; the resulting weights therefore indicate perceived importance and not demonstrated capability. Fifth, demographic attributes such as length of service, education level, gender, and school type were collected on an optional basis and therefore not analyzed as moderating variables. Finally, the weights were derived at a single point in time. Because adaptation demands shift with technological and industrial change, the resulting hierarchy should be read as contextual rather than fixed, and periodic re-assessment is advisable.

CONCLUSION

Based on the research results and discussion, it can be concluded that PA is the highest-priority dimension among the five dimensions of teacher adaptation, indicating that the teacher's ability to adapt teaching methods and strategies is the primary foundation in the learning adaptation process. TRA is in the second position, emphasizing the importance of transforming the teacher's role from instructor to facilitator, motivator, and innovator. TA is in the third position, indicating that technology is viewed as a supporting tool rather than the main goal of learning, in line with the framework. VCA and SCA are in the fourth and fifth positions, respectively.

The consistency test yielded a CR of 0.063 (≤ 0.10), indicating that the assessments of the 36 respondents are consistent and the data are suitable for use. Variability analysis shows that the highest coefficient of variation is in the TA-VCA pair and the lowest in the TRA-SCA pair, indicating greater perceptual diversity among respondents. Based on the findings, the researchers provided several recommendations, including: 1) Reflective pedagogical workshops and active learning method training; 2) Strengthening the role of teachers as facilitators and innovators; 3) Evaluation of technology infrastructure and integrated TPACK training; 4) Pedagogical mentoring programs between senior and junior teachers; 5) Development of teacher learning communities (professional learning community); 6) Collaboration with industry for vocational content adjustment; 7) Enhancement of socio-cultural awareness through culturally responsive training.

Ideally, for further research, it is expected to: 1) expand the respondents to 100+ teachers from various types of schools (elementary, middle, high/vocational) and regions for broader generalization; 2) add demographic variables (years of service, education level, gender, type of school) for group difference analysis and perception difference testing. (b) Compare with other methods such as ANP, Fuzzy AHP, and DEMATEL for validation and to enrich the analysis; 3) Conduct in-depth interviews with respondents from each cluster to qualitatively

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understand their reasons for preference; 4) Add other dimensions (emotional, leadership, collaboration, classroom management) to enrich the teacher adaptation model.

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