

INTEGRATING PEDAGOGICAL COMPETENCE AND INDUSTRIAL TRAINING TO IMPROVE GRADUATE QUALITY IN AVIATION VOCATIONAL EDUCATION

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Abstract: Vocational aviation education must deliver graduates whose competencies match strict regulatory and industry standards amid fast technological change. This study investigates how lecturer competence and industrial training jointly influence graduate quality in Indonesian state aviation polytechnics, and whether the learning process mediates these relationships. Using a quantitative ex-post facto design, we surveyed 274 final-year students from seven state aviation polytechnics selected through proportionate stratified random sampling. A structured questionnaire measured lecturer competence, industrial training, learning process, and perceived graduate quality. Data were analyzed with Partial Least Squares Structural Equation Modeling (PLS-SEM) in SmartPLS 4.0 to assess measurement validity and reliability, estimate direct and indirect effects, and evaluate model fit and predictive performance via path coefficients, R^2 , Q^2 , and the standardized root mean square residual (SRMR). The findings show that both lecturer competence and industrial training exert significant direct effects on graduate quality. The learning process is a strong predictor of graduate outcomes, while the indirect effects of lecturer competence and industrial training through the learning process are positive but statistically limited. In addition, the model demonstrated acceptable overall fit, with an SRMR value of 0.072, which is below the recommended threshold of 0.08. This confirms that the proposed model has an acceptable fit with the empirical data. These results support integrating pedagogical development with industry-based learning strategies to strengthen graduate quality in aviation vocational education. Policymakers should align curricula, assessment, and partnership governance.

Keywords: Vocational Education; Aviation polytechnic; Lecturer competence; Industrial training; Learning process; Graduate quality; Employability

Introduction

Vocational education (VE) plays a crucial role in preparing graduates for technology-driven and highly regulated sectors such as aviation. In the context of digitalization, automation, and stricter safety standards, vocational institutions are increasingly expected to produce graduates who possess not only technical competence but also adaptability and employability skills (Jiménez Ramírez et al., 2023; Puerta & García, 2024). To address this demand, dual vocational training models and stronger education–industry partnerships have been promoted to improve curriculum relevance, particularly through structured work-based learning (WBL) that gives students meaningful industrial exposure (Muravyeva & Oleynikova, 2024; Saryadi et al., 2024; Suyitno et al., 2025). This reflects a broader shift toward competence-based and outcome-oriented vocational education, where graduate quality is increasingly assessed through

employability, employer satisfaction, and alignment between training and job requirements (Ahmid et al., 2023; Jiménez Ramírez et al., 2023; Laundon et al., 2023; Saryadi et al., 2024).

Despite these developments, a persistent mismatch remains between graduates' competencies and labor market demands. Vocational curricula often fail to keep pace with technological change, while limited collaboration with employers weakens the integration of current industry knowledge into teaching and learning (Husain et al., 2022; Ibrahim & Nashir, 2022; Oshima et al., 2023). In developing and transitional contexts, this challenge is compounded by unequal access to facilities, limited instructional resources, and differing institutional capacities (Gul et al., 2025; Musyimi, 2021). The problem becomes more acute in the era of the Fourth Industrial Revolution, where vocational systems must continuously respond to emerging technologies and changing occupational standards in order to avoid producing graduates equipped for outdated practices rather than current and future roles (Kamaruzaman et al., 2025; Tremonte-Freydefont et al., 2024). Therefore, ongoing curriculum renewal, stronger industry engagement, and adaptive teaching strategies remain essential (Ibrahim & Nashir, 2022; Kamaruzaman et al., 2025).

Within this perspective, graduate quality is understood not only in terms of academic achievement but also through competence-based frameworks that combine technical expertise with broader employability attributes such as communication, teamwork, self-efficacy, and lifelong learning capacity (Ahmad et al., 2023; Hartini et al., 2025). It must also reflect practical experience gained through work-integrated learning and direct workplace exposure (Leadbeatter et al., 2023; Wagino et al., 2023). For this reason, vocational institutions commonly use tracer studies, employer feedback, and competency assessments to evaluate graduate readiness in a more comprehensive and multidimensional way (Alvunger, 2024; Husain et al., 2022).

Lecturer competence and instructional quality are widely recognized as important factors in shaping graduate outcomes. Instruction that links theory with practice, promotes critical thinking, and introduces workplace-like problem solving can strengthen employability readiness, especially when lecturers continuously update their pedagogical and professional expertise (Chen, 2025; Hashim et al., 2025; Nopas, 2025; Zhang, 2025). In vocational education, this makes alignment between lecturer competence and current industry standards particularly important (Kamaruzaman et al., 2025; Романова, 2022). At the same time, industry also plays a crucial role in maintaining curriculum relevance and preparing students for employment. Dual VET partnerships, apprenticeships, internships, and structured work-based learning help align training with labor market demands while strengthening both technical competence and professional socialization (Ahmid et al., 2023; Jiménez Ramírez et al., 2023; Laundon et al., 2023; Saryadi et al., 2024).

However, important gaps remain in connecting pedagogical competence with industry-based learning. Misalignment between educator preparation and changing industry standards can weaken instructional effectiveness, while resource and infrastructure limitations often reduce opportunities to provide authentic industrial learning environments (Chukwuedo et al., 2024; Musyimi, 2021; Oshima et al., 2023; W. Wei, 2024). Rapid technological change adds further pressure for institutions to continuously adjust their teaching approaches and industry linkages (Tremonte-Freydefont et al., 2024; Zheng, 2025). These conditions reveal a key research gap: although lecturer competence and industry-based learning are both recognized as important for graduate quality, they are often examined separately rather than as interconnected elements within an integrated vocational education system. Empirical evidence remains limited on how pedagogical competence and industrial training jointly influence graduate outcomes through the learning process, including both direct and mediated effects (Hsu, 2025; Muchira et al., 2022). In aviation higher education, the learning process is a critical mediator because it translates

pedagogical and industrial inputs into safety-oriented, practice-based, and industry-relevant competencies required in high-risk professional settings. Therefore, this study investigates the combined effects of lecturer competence and industrial training on graduate quality, with particular attention to the mediating role of the learning process in aviation vocational education.

To strengthen the conceptual basis of this study, the following discussion elaborates the key constructs underlying the proposed model, namely lecturer competence, industrial training, learning process, and graduate quality. Lecturer competence in vocational education is widely viewed as a multidimensional construct that includes subject expertise, pedagogical skill, technological literacy, and interpersonal ability. Competent lecturers are therefore expected not only to master technical content, but also to design responsive and student-centered learning experiences that connect theory with practice (Bangayan et al., 2025). In this context, technology has become an essential part of lecturer competence, as vocational learning increasingly relies on digital tools, simulations, and collaborative platforms. Digital competence is now considered a core component of professional teaching practice, with the potential to make learning more interactive, engaging, and relevant to employability development (Akmal et al., 2025).

Industrial training, including internships, apprenticeships, and workplace placements, is also central to vocational education because it links classroom learning to professional practice. Its role is supported by experiential learning theory, which suggests that students learn more effectively through direct experience, reflection, and application in authentic work settings (Zhang, 2025). The theory of planned behavior further explains that industrial training can influence employability by shaping attitudes, self-efficacy, confidence, and career motivation, especially when internship experiences are positive and well supervised (Hermansyah et al., 2025; Hong, 2025). Similarly, experiential and situated learning theories show that vocational skills are strengthened through reflection, practical activity, and participation in real communities of practice, making internships and work placements especially valuable for developing job-relevant competencies and employability outcomes (Chukwuedo & Ementa, 2022; Nikoloudakis & Rangoussi, 2024; Zhang, 2025).

Beyond lecturer competence and industrial training, the learning process itself is an important factor in graduate quality. Student engagement, interaction, feedback, practice, and task relevance all contribute to competence development and employability. Evidence shows that active and immersive learning environments, including work-based learning, teaching factory models, and project-based or collaborative approaches, help strengthen both technical and soft skills while improving graduate quality (Akmal et al., 2025; Saryadi et al., 2024; Tanjung et al., 2025; Zhang, 2025). Overall, the literature suggests that lecturer competence, industrial training, and learning processes are core elements of effective vocational education. However, these components are still often studied separately rather than within an integrated framework. Empirical research that jointly examines pedagogical competence and industry-based learning while also testing the mediating role of the learning process remains limited, particularly in high-risk and technology-intensive fields such as aviation vocational education. This gap highlights the need for integrated models that link lecturer competence and industrial training to graduate quality through the learning process. Therefore, this study investigates the combined effects of lecturer competence and industrial training on graduate quality, with particular attention to the mediating role of the learning process in aviation vocational education.

Method

This study employed a quantitative, non-experimental ex-post facto design to investigate the relationships among lecturer competence, industrial training, learning processes, and graduate quality in vocational education. The use of this design was appropriate because the variables

occurred naturally and were not manipulated, making it possible to examine their associations in authentic educational settings with relevance to policy and practice. To assess the conceptual model and estimate both direct and indirect relationships, the study used Partial Least Squares Structural Equation Modeling (PLS-SEM). This analytical approach is appropriate for predictive and exploratory research involving multiple latent constructs and mediation effects. Previous studies in vocational education have also utilized PLS-SEM to examine the links among pedagogical competence, work-based learning, engagement, and employability, which supports its relevance for analyzing complex educational issues (Mardi et al., 2025; Suyitno et al., 2025). In addition, PLS-SEM is suitable for data that may not follow a normal distribution and for moderate sample sizes, conditions that are common in multi-institutional vocational education research (Abdullah et al., 2022; Ahmad et al., 2023).

The population in this study included all final-year students enrolled in Indonesian state aviation vocational institutions at the time of data collection, totaling 869 students across seven state aviation polytechnics. To ensure that each institution was adequately represented, proportionate stratified random sampling was applied, with each polytechnic serving as a stratum and the number of selected respondents adjusted according to the size of its population (Nugroho et al., 2023). Based on the Slovin formula with a 5% margin of error, the required sample size was determined to be 274 students. The distribution of the population and the sample for each institution is presented in Table 3.2.1.

Table 3.2.1. Population and Sample Distribution by Institution

No	Institution	Population	Sample
1	Medan Aviation Polytechnic	95	30
2	Palembang Aviation Polytechnic	112	36
3	Indonesia Aviation Polytechnic (Curug)	118	37
4	Surabaya Aviation Polytechnic	289	91
5	Indonesia Pilot Academy (Banyuwangi)	28	9
6	Makassar Aviation Polytechnic	159	50
7	Jayapura Aviation Polytechnic	68	21
	Total	869	274

In addition to institutional representation, the sample also covered various aviation-related study programs. The largest proportion of respondents came from Airport Electrical Engineering (71 students; 25.91%), followed by Air Transportation Management (50 students; 18.25%), Airport Management (33 students; 12.04%), Building and Runway Engineering (32 students; 11.68%), Aircraft Engineering (30 students; 10.95%), Airport Technology (27 students; 9.85%), Air Navigation Engineering (21 students; 7.66%), and several smaller groups, including Aircraft Operation, Air Traffic, and other or unidentified programs. This composition strengthens the generalizability of the findings because the sample represents both technical and managerial-operational orientations in aviation vocational education.

This sampling approach is consistent with recommended practices in multi-institutional vocational education research and helps strengthen the generalizability of the findings within the context of Indonesian aviation vocational education. Alternative approaches such as cluster sampling or convenience sampling were not used because they carry a greater risk of bias and may weaken representativeness in quantitative modeling studies (Akmal et al., 2025; Bangayan et al., 2025).

Data were gathered using a structured self-administered questionnaire designed to measure four latent constructs: lecturer competence, industrial training, learning process, and graduate quality. The instrument was adapted from previously validated measures in vocational education and then translated and adjusted to fit the aviation education context. All items were rated on a four-point Likert scale ranging from 1 (strongly disagree) to 4 (strongly agree). Items written in a negative form were reverse-coded to reduce response bias, while the exclusion of a neutral response option was intended to encourage more definite answers. Lecturer competence was measured through six indicators, namely pedagogical competence, communication, assessment, technological competence, interpersonal skills, and classroom management. Industrial training was represented by four indicators: student satisfaction, supervisor evaluation, skill improvement, and relevance to employment. The learning process construct included indicators related to active student-centered learning, clarity of understanding, practical application, student–lecturer interaction, and instructional structure. Meanwhile, graduate quality was reflected through industry alignment, comparative advantage, competency mastery, orientation toward further education, and alignment with employment.

The data were analyzed using SmartPLS 4.0 through the PLS-SEM approach by following two main stages, namely measurement model evaluation and structural model assessment, in line with recommended procedures in PLS-SEM-based educational research (Bangayan et al., 2025; Hu et al., 2025). The reflective measurement model was first evaluated in terms of reliability and validity using Cronbach's alpha (≥ 0.60), composite reliability (≥ 0.70), outer loadings (≥ 0.70), and average variance extracted (AVE ≥ 0.50). Discriminant validity was then assessed using the Fornell–Larcker criterion and the HTMT ratio (Hu et al., 2025; W. Wei, 2024). After the measurement model met the required criteria, the structural model was tested using a bootstrapping procedure with 5,000 resamples to estimate the significance of the path coefficients based on t-values and p-values. In addition, the explanatory power of the model was evaluated using R^2 , its predictive relevance was assessed through Stone–Geisser's Q^2 , and overall model fit was examined using the SRMR.

Ensuring the validity and reliability of the instrument was a major concern in this study. Content validity was established through expert judgment involving specialists in vocational education and practitioners in aviation training, who evaluated the relevance and clarity of each item. Construct validity was then supported through psychometric testing within the PLS-SEM framework, in line with current recommendations in vocational education research (Husain et al., 2022; Y. Wei, 2019).

The study was conducted in accordance with established academic ethical standards. Participation was entirely voluntary, and all respondents were informed about the purpose of the study, their right to withdraw at any time, and the confidentiality of the information they provided. No personal identifiers were collected, and the data were used exclusively for academic purposes. These procedures were applied to ensure informed consent, protect participant anonymity, and support responsible data management.

Discussion

The measurement model was first evaluated to assess the reliability and validity of the four reflective constructs: Lecturer Competence, Industrial Training, Learning Process, and Graduate Quality. Three indicators with outer loadings below 0.70 were removed, including two from Learning Process (experience-based learning and ease of understanding) and one from Graduate Quality. After refinement, all remaining indicators exceeded the 0.70 threshold. Convergent validity was confirmed by AVE values above 0.50, while internal consistency was supported by composite reliability values above 0.70 and Cronbach's alpha values above 0.60.

Discriminant validity was also established, as the square roots of AVE exceeded inter-construct correlations and all HTMT values were below 0.85. Overall, the measurement model satisfied the required psychometric criteria and was considered suitable for structural model testing. As shown in Figure 4.1.1, lecturer competence and industrial training influence graduate quality both directly and through the learning process.

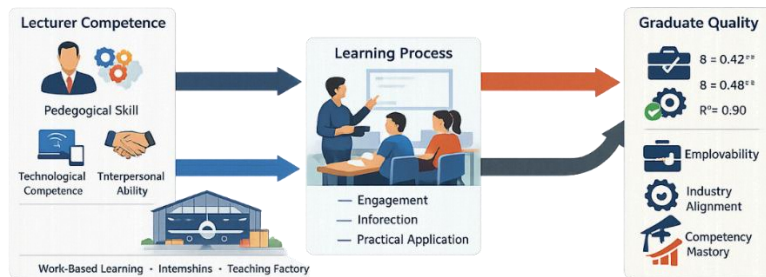


Figure 4.1.1. Measurement Model Results

After the measurement model was confirmed, the structural model was tested using bootstrapping with 5,000 resamples. The results showed that lecturer competence had a positive and significant direct effect on graduate quality ($\beta = 0.239$, $p = 0.010$), indicating that stronger pedagogical, technological, and interpersonal competence contributes to better graduate quality and employability alignment, in line with previous findings (Ahmad et al., 2023; Kamaruzaman et al., 2025). Industrial training also had a significant direct effect on graduate quality ($\beta = 0.190$, $p = 0.003$), confirming the importance of structured internships and WBL in improving workplace-relevant competence and job readiness (Tanjung et al., 2025; Saryadi et al., 2024). In addition, the learning process emerged as a strong predictor of graduate quality ($\beta = 0.307$, $p = 0.009$). Lecturer competence significantly influenced the learning process ($\beta = 0.372$, $p < 0.001$), while industrial training also showed a smaller but still significant effect ($\beta = 0.176$, $p = 0.005$), suggesting that pedagogical quality and experiential learning jointly support students' learning dynamics. Table 4.2.1 presents the direct effects of the structural model, showing that lecturer competence, industrial training, and the learning process have significant effects on graduate quality.

Table 4.2.1. Direct Effects of the Structural Model

Path	Standardized Coefficient (β)	p-value
Lecturer Competence \rightarrow Graduate Quality	0.239	0.010
Industrial Training \rightarrow Graduate Quality	0.190	0.003
Learning Process \rightarrow Graduate Quality	0.307	0.009
Lecturer Competence \rightarrow Learning Process	0.372	0.000
Industrial Training \rightarrow Learning Process	0.176	0.005

Bootstrapping results showed that the indirect effect of lecturer competence on graduate quality through the learning process was positive but not statistically significant ($\beta = 0.114$, $p = 0.051$). Similarly, the indirect effect of industrial training on graduate quality through the learning process was also non-significant ($\beta = 0.054$, $p = 0.095$). These findings indicate that the learning process, although important for graduate quality, does not fully mediate the effects of lecturer competence and industrial training, as their direct effects remain stronger. Overall, the results suggest partial

or limited mediation rather than full mediation, implying that improvements in lecturer competence and industrial training can enhance graduate quality directly even when changes in the learning process are relatively limited, consistent with previous studies (Ghosh et al., 2022; Rodzalan et al., 2022). Table 4.3.1 presents the indirect effects and mediation results, showing that the learning process did not significantly mediate the effects of lecturer competence and industrial training on graduate quality.

Table 4.3.1. Indirect Effects and Mediation Results

Indirect Path	Coefficient (β)	p-value
Lecturer Competence \rightarrow Learning Process \rightarrow Graduate Quality	0.114	0.051
Industrial Training \rightarrow Learning Process \rightarrow Graduate Quality	0.054	0.095

Model explanatory power was assessed using R^2 . The learning process produced $R^2 = 0.591$, indicating that lecturer competence and industrial training explained 59.1% of its variance, while graduate quality showed $R^2 = 0.500$, meaning that lecturer competence, industrial training, and the learning process jointly explained 50.0% of the variance. These values indicate meaningful to strong explanatory power in the aviation vocational context (Chen, 2025; Husain et al., 2022). Predictive relevance was also supported, as all endogenous constructs had Q^2 values above 0. In addition, the model demonstrated acceptable overall fit, with an SRMR value of 0.072, which is below the recommended threshold of 0.08. Figure 4.4.1 illustrates the structural model with path coefficients and R^2 values, indicating the direct relationships among lecturer competence, industrial training, learning process, and graduate quality.

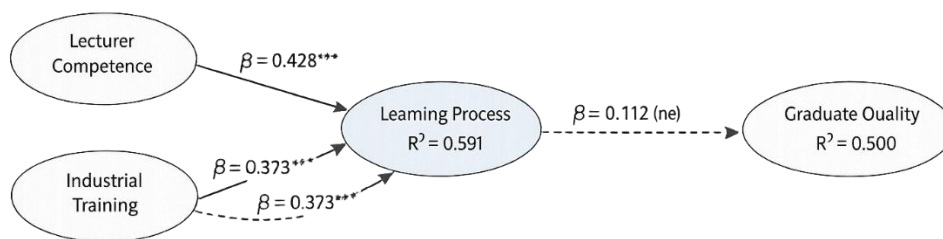


Figure 4.4.1. Structural Model with Path Coefficients and R^2 Values

The findings confirm that lecturer competence and industrial training are important determinants of graduate quality in vocational education, especially in high-risk and technology-intensive sectors such as aviation. The significant direct effect of lecturer competence indicates that pedagogical effectiveness, professional expertise, and instructional adaptability play an important role in improving employability outcomes (Ahmad et al., 2023; Kamaruzaman et al., 2025). Likewise, the direct effect of industrial training supports previous studies showing that authentic industry exposure through internships, dVET, and structured work-based learning helps strengthen both technical and soft skills required by the labor market (Saryadi et al., 2024; Tanjung et al., 2025). The results also show that industrial training contributes to graduate quality independently, even after the learning process is considered.

In addition, the learning process had a strong direct effect on graduate quality, indicating that engagement, interaction, and practical application are important mechanisms through which

educational experiences contribute to employability. This finding is consistent with previous studies showing that active, structured, and collaborative learning environments support competence development and professional identity formation (Omar & Abdullah, 2025; Rodzalan et al., 2022). However, the mediation results should be interpreted with caution. Although the indirect effects of lecturer competence and industrial training through the learning process were positive, they did not reach the conventional level of statistical significance. This indicates that the direct effects of lecturer competence and industrial training on graduate quality are more dominant than their indirect effects through the learning process. Therefore, in this model, the learning process should be understood primarily as an important direct predictor of graduate quality rather than as a strong mediating mechanism. This suggests that graduate quality may also be shaped by other factors, such as labor market conditions, individual motivation, and institutional support (Idkhan, 2025).

These findings are consistent with previous studies showing that experiential learning can improve employability, although its mediating effect may be weakened by personal and contextual factors such as self-efficacy and institutional conditions (Chukwuedo & Ementa, 2022). In this study, the partial mediation results suggest that lecturer competence and industrial training influence graduate quality not only through learning processes but also through direct pathways that are not fully captured by the measured learning variables. This indicates that employability is shaped by both educational processes and wider systemic conditions.

The study also contributes theoretically by validating an integrated model that links pedagogical competence, industrial training, and learning processes to graduate quality. This supports vocational education frameworks that emphasize synergy between education and industry to align learning outcomes with labor market needs (Puerta & García, 2024). At the same time, the findings refine existing assumptions by showing that learning processes do not always function as dominant mediators, pointing instead to the importance of models that consider both direct and indirect effects. This is further supported by evidence that industry-based training embedded in educational systems can strengthen curriculum responsiveness to changing workforce demands (Димитрова et al., 2025).

In practical terms, the results suggest several implications for policy and institutional practice. The strong direct effect of lecturer competence highlights the need for continuous professional development, particularly in pedagogical innovation, industry collaboration, and technological updating, all of which are closely related to graduate employability (Huang, 2025; Husain et al., 2022). The significant role of industrial training also indicates the importance of strengthening industry partnerships to provide structured and high-quality training experiences. Embedding mandatory industrial training within vocational curricula may help reduce skills gaps and improve employment readiness, although this requires coordinated policy support and institutional capacity aligned with industry expectations (Ibrahim & Nashir, 2022; Putra et al., 2022). Operationally, curriculum–industry alignment can be strengthened by recognizing relevant industry certifications, competency tests, and workplace-based training outcomes within the academic credit system. This should be supported by joint curriculum review with industry partners, shared assessment rubrics based on occupational standards, and formal agreements on supervision, evaluation, and feedback during industrial training. More broadly, the findings reinforce the need for integrated curriculum design in which pedagogical strategies and industrial training are developed in a connected manner, especially in aviation and other safety-sensitive sectors where graduate quality directly affects operational performance and public safety.

Several limitations should also be acknowledged. The use of cross-sectional and self-reported data limits causal interpretation and may introduce response bias, so longitudinal tracer studies would be useful to examine the long-term effects of lecturer competence and industrial

training on graduate careers (Musyimi, 2021). In addition, the focus on state aviation vocational institutions within one national context may limit the generalizability of the findings to other sectors or countries, indicating the need for broader institutional and sectoral coverage in future studies (Syukhri et al., 2024). Future research should also expand the model by including additional mediating and moderating variables, such as learner characteristics, institutional culture, supervision quality during industrial training, and digital pedagogical innovation. Exploring technological change and hybrid learning environments may further strengthen explanations of employability development in vocational education (Ahmad et al., 2023).

Conclusion

This study investigated the combined effects of lecturer competence and industrial training on graduate quality in aviation vocational education, with the learning process treated as a mediating variable. The results indicate that lecturer competence and industrial training both have significant direct effects on graduate quality, highlighting their importance in preparing graduates for technology-intensive and safety-critical sectors. The learning process also significantly predicts graduate quality, although its mediating role is only partial, suggesting that graduate outcomes are influenced by factors beyond classroom learning alone. The study contributes theoretically by validating an integrated model that connects pedagogical competence and industry-based training within a single framework. In doing so, it challenges the assumption that learning processes fully mediate educational inputs and points to the need for more nuanced explanations of employability development. Practically, improving graduate quality requires not only instructional innovation, but also sustained lecturer professional development and stronger, more structured industrial training partnerships. For policymakers and institutional leaders, these findings emphasize the importance of coordinated strategies that align curriculum, teaching competence, and industry collaboration to improve the relevance and effectiveness of aviation vocational education in meeting labor market needs.

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