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Enhancing the Quality of Aviation Graduates Through Integrated Teaching Competence and Industrial Training

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ABSTRACT

In the context of the aviation vocational education system in Indonesia, the alignment between instructional quality and industry readiness remains a persistent concern. This study investigates the integrated effects of lecturer competency and industrial training on graduate quality, with the learning process examined as a mediating construct. Utilizing a quantitative ex-post facto design, data were collected from 274 students across four state aviation polytechnics. Partial Least Squares Structural Equation Modelling (PLS-SEM) was employed to explore both direct and indirect causal pathways. Results revealed that both lecturer competency and industrial training significantly impact the learning process, which in turn strongly influences graduate quality. While direct effects of both independent variables on graduate quality were confirmed, indirect effects through the learning process showed mixed results. This study introduces a novel integrated model combining lecturer competency and industrial training with a mediating learning process, which has been underexplored in aviation-focused vocational education research. The findings emphasize the strategic need to synchronize pedagogical and experiential learning to produce industry-ready graduates.

Keywords: Vocational Education, Lecturer Competency, Industrial Training, Graduate Quality, Learning Process, PLS-SEM

INTRODUCTION

The rapidly evolving demands of the global aviation industry require a transformative shift in how vocational institutions prepare their graduates (Yiu et al., 2022); (Halawi et al., 2024); (Miani et al., 2021). In Indonesia, aviation polytechnics are critical in producing technically proficient human resources capable of meeting the stringent operational and safety standards of this highly regulated field. Despite ongoing systemic reforms, a persistent gap remains between the competencies of vocational graduates and the evolving needs of industry stakeholders (Chowdhury & Habib, 2024); (Quang et al., 2020; (Wagiran et al., 2023a). Recent studies have shown that vocational education graduates in Indonesia tend to experience higher unemployment rates than their counterparts from general education programs, underscoring a significant mismatch between educational output and labor market demands (Wagiran et al., 2023b); (Suryadi et al., 2020). This misalignment is particularly acute in specialized sectors such as aviation, where training programs frequently fall short of industry expectations.

Contemporary literature underscores the dual significance of pedagogical quality and industry-based learning in vocational education (Yoto et al., 2024); (Rodliyah et al., 2024). Research demonstrates that aligning teaching

practices with real-world industry contexts significantly enhances students' professional competence, creativity, and vocational identity, thereby improving overall pedagogical effectiveness (Meltzer & Schwencke, 2020). Similarly, project-based learning and structured internships aligned with industry practices have been shown to support skill acquisition and workforce readiness (M. Li & Rohayati, 2024). However, pedagogical competence alone is insufficient for ensuring employability, highlighting the necessity of meaningful workplace exposure (Billett, 2019a); (Kyndt et al., 2021); (Schröder & Dehnbostel, 2021a). Nevertheless, current scholarship often treats these two dimensions—lecturer competence and industrial training—as isolated variables, overlooking their potential interplay and mediating mechanisms (Wesselink et al., 2020a).

Lecturer competence is widely acknowledged as a critical determinant of instructional effectiveness and student achievement, especially in vocational and professional education settings (Zen et al., 2022a); (Dang et al., 2024a); (Zvyagin, 2016). Within aviation polytechnics—where precision, safety, and regulatory compliance are paramount—the role of lecturers extends beyond knowledge transmission to include curriculum mediation, instructional facilitation, assessment literacy, and alignment with real-world practices (Pisitkasem, 2021). Theoretical models such as Pedagogical Content Knowledge (PCK) and Technological Pedagogical Content Knowledge (TPACK) posit that teaching competence is inherently multidimensional, encompassing pedagogical, technological, and interpersonal skills to foster deep learning and knowledge transfer (Abubakir & Alshaboul, 2023); (Mohammadpour & Maroofi, 2023); (Zen et al., 2022b); (Dang et al., 2024b).

In practice, competent vocational lecturers are expected not only to master subject content but also to engage learners through clear communication, formative assessments, and adaptive teaching strategies (Le & Pham, 2016). Evidence confirms that pedagogical competence—such as lesson planning, classroom management, instructional design, and performance assessment—is central to teaching quality in vocational settings (Komaro et al., 2022). Effective pedagogical practice in vocational education requires not only mastery of subject content but also the ability to manage instructional time efficiently (Zhou, 2023a); (Abdul-Raof & Hatib, 2022); (Parker & Roumell, 2020). Time management is a pivotal cognitive-behavioural strategy that directly influences teaching productivity and learner engagement, particularly in complex instructional environments (Pettersen et al., 2024); (Vattøy & Gamlem, 2019). In developing instructional competencies, educators must also be adept at utilizing valid and reliable measurement instruments to assess learning outcomes and refine teaching strategies (Kritkharuehart et al., 2024); (Adom et al., 2020); (Laohajaratsang et al., 2023); (Meskhi et al., 2021); (Magdalena et al., 2023). Rigorously developed questionnaires are essential for capturing nuanced aspects of pedagogical effectiveness, such as instructional clarity, assessment literacy, and responsiveness to learner needs. Additionally, managerial competencies, including time management and classroom leadership, are vital for effective instructional delivery, particularly in competency-based educational models (Chaula, 2024). Consequently, lecturer competence is best understood as a composite construct that integrates pedagogical expertise, communication ability, assessment proficiency, technological literacy, interpersonal engagement, and organizational acumen—all of which are essential for delivering learner-centered and industry-relevant instruction (Battista et al., 2022); (Oanh et al., 2023); (Dang et al., 2024c).

Industrial training in vocational education serves as a pivotal pedagogical strategy to bridge the divide between theoretical learning and real-world application (Xue & Keat, 2024); (Schneider et al., 2022); (Turchyn et al., 2022); (Suyitno et al., 2022). Rooted in the principles of experiential learning (Tarnopolsky et al., 2021) and situated learning theory (Chen et al., 2020), industrial training enables students to internalize knowledge by participating in authentic workplace environments. Such training strengthens technical skills, fosters soft skills such as teamwork and communication, and cultivates professional behaviors consistent with industry standards (Kyndt et al., 2021); (Billett, 2019b).

Empirical evidence indicates that student satisfaction with industrial placements, supervisor evaluations, and employment outcomes following training are key indicators of program effectiveness (Hains-Wesson & Ji, 2024). When effectively structured and embedded within the curriculum, industrial training not only develops job-specific skills but also boosts students' self-efficacy and career orientation (Chen et al., 2020); (Hains-Wesson & Ji, 2024); (Muhammad et al., 2022), thereby enhancing their transition to the labor market. Therefore, this variable encompasses diverse dimensions including training quality, skill acquisition, behavioral development, and overall employability.

The learning process in vocational education involves both cognitive engagement and interactive dynamics between students and instructors (Zhou, 2023b); (Ayu et al., 2024). Grounded in constructivist learning theory and student-centered pedagogical frameworks, this process reflects how effectively students absorb, apply, and extend knowledge in both classroom and practical settings (Huang et al., 2023); (Dewsnap & Konatham, 2025). High-quality learning experiences are characterized not only by active participation and clarity of instruction but also by hands-on skill development and meaningful instructor-learner interaction (Bazán-Ramírez et al., 2022); (Nuankaew et al., 2020); (Boateng, 2020).

Research indicates that well-designed vocational learning environments—featuring dialogic teaching, problem-based instruction, and real-world application have a substantial impact on student achievement and satisfaction (Schröder & Dehnbostel, 2021b); (Wesselink et al., 2020b). As such, the learning process functions as a mediating factor through which lecturer competence and industrial training shape educational outcomes (Zhang, 2022); (Impola, 2023); (Klotz et al., 2014); (Christiansen et al., 2022). Core indicators include active learning strategies, conceptual clarity, relevance to practical applications, and perceived instructional effectiveness.

Graduate quality refers to the extent to which vocational education equips students with the competencies necessary to meet industry expectations, particularly in high-stakes sectors such as aviation (Hamdani & Suherman, 2021); (S. Li et al., 2024); (Saputro et al., 2021). This concept aligns with the principles of employability and Competency-Based Education (CBE), which emphasize measurable learning outcomes over traditional time-based credentials (Padilla-Delgado et al., 2024); (Seyoum et al., 2024); (Caleb, 2024). High-quality graduates are characterized not only by their technical expertise but also by their adaptability, communication skills, and capacity for lifelong learning (Gao & Huber, 2024); (Lundberg et al., 2021).

Common indicators of graduate quality include employer satisfaction, job-placement accuracy, comparative academic achievement, and pursuit of further education (Ramasamy et al., 2021); (Inceoglu et al., 2019). In aviation polytechnics, this quality is assessed based on graduates' ability to comply with safety regulations, demonstrate operational readiness, and meet certification standards (International Civil Aviation Organization, 2023a); (International Civil Aviation Organization, 2023b); (International Civil Aviation Organization, 2022); (International Civil Aviation Organization, 2014); (International Civil Aviation Organization, 2018); (International Civil Aviation Organization, 2023c); (International Civil Aviation Organization, 2020); (Spayne et al., 2024); (Puspita et al., 2020). Therefore, graduate quality is a multidimensional construct encompassing cognitive, technical, and affective readiness for industry integration.

To address the gap in existing literature, the present study proposes an integrated analytical model that explores the combined impact of lecturer competence and industrial training on graduate quality, with the learning process positioned as a mediating variable. This framework draws upon PCK and situated learning theory, advocating for a holistic and synergistic approach to vocational education that bridges the academic-industry divide. The objectives of this study are twofold: (1) to analyze the direct and indirect effects of lecturer competence and industrial training on graduate quality, and (2) to examine the mediating role of the learning process within this framework. Using Partial Least Squares Structural Equation Modeling (PLS-SEM), the research contributes a novel empirical model tailored to the aviation polytechnic context. It is among the first efforts to investigate these interactions comprehensively within Indonesia's aviation education landscape, offering both theoretical contributions and practical implications for policy and institutional improvement.

METHOD

Research Design and Participants

The conceptual framework of this study, illustrated in Figure 1, outlines the hypothesized structural relationships among key variables influencing the quality of graduates in aviation polytechnics. The model proposes that *lecturer competence* and *industrial training* function as exogenous variables that directly affect the *learning process*. In turn, the learning process serves as a mediating construct that influences *graduate quality*. This framework represents a multidimensional perspective on the effectiveness of vocational education, where pedagogical proficiency and practical industrial exposure are considered interrelated factors rather than isolated components. By positioning the learning process as the central mediating element, the model seeks to capture the dynamic interaction between instructional inputs and the competencies demonstrated by graduates. The hypothesized relationships among *lecturer competence*, *industrial training*, *learning process*, and *graduate quality* are conceptualized in Figure 1, which visually presents the proposed structural model underpinning this study.

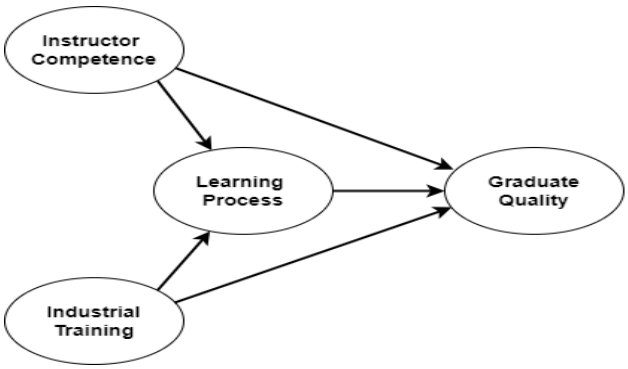

Figure 2.1.1. Conceptual Framework Illustrating the Hypothesized Relationships

This study adopted a quantitative, non-experimental ex-post facto design to examine both the direct and mediated effects of *lecturer competency* and *industrial training* on *graduate quality* in Indonesian aviation polytechnics. The study population comprised 869 students enrolled across four state-owned aviation polytechnics. To obtain a representative sample, a proportionate stratified random sampling technique was employed, resulting in 274 respondents. The Slovin formula was applied to determine the sample size, while proportional allocation ensured an equitable distribution of participants across the selected institutions.

$$n = \frac{N}{1 + N(e)^2} \quad (1)$$

Where:
n: required sample size
N: total population
e: margin of error (set at 5% or 0.05)

$$n = \frac{N}{1 + (N \times e^2)} = \frac{869}{1 + (869 \times 0{,}05^2)} = \frac{869}{1 + (869 \times 0{,}0025)}$$

$$n = \frac{869}{1 + 2{,}1725} = \frac{869}{3{,}1725} \approx 274$$

This formula was chosen for its practicality in calculating sample sizes from finite populations where the level of precision is known. Using purposive sampling, a total of 274 final-year students were selected across several campuses, ensuring they had experienced both the academic and industrial components of the curriculum.

Sampling technique used in this study was proportionate stratified random sampling. This is a method where the population is divided into several subgroups or strata based on certain characteristics, and the number of samples taken from each stratum is proportional to the size of that stratum in the population. This technique ensures that the sample represents the overall population according to the distribution of each stratum. To calculate the number of samples for each institution using this method, the following formula is used:

$$n_i = \left(\frac{N_i}{N}\right) \times n \quad (2)$$

Where:
ni: sample size from stratum i
Ni: population size of stratum i
N: total population
n: total sample size

As an example, at Medan Aviation Polytechnic (Politeknik Penerbangan Medan), with a total student population of 95, the proportionate stratified random sampling method was used to determine that 30 students should be selected as the research sample. This was calculated using the formula:

$$n_i = \left(\frac{N_i}{N}\right) \times n$$

$$n_i = \left(\frac{95}{869}\right) \times 274 = 0{,}11 \times 274 \approx 30 \text{ of respondence}$$

The sample distribution across institutions was based on the proportion of their student populations. For example, Medan Aviation Polytechnic (95 students) contributed 30 samples. Palembang Aviation Polytechnic (112 students) contributed 36 samples. Curug Civil Aviation Institute (118 students) contributed 37 samples.

Surabaya Aviation Polytechnic, which had the largest population of 289 students, contributed 91 samples. Banyuwangi Aviation Academy, with the smallest population of 28 students, contributed 9 samples. Makassar Aviation Polytechnic (159 students) contributed 50 samples, and Jayapura Aviation Polytechnic (68 students) contributed 21 samples.

This method ensures that each institution is proportionally represented according to its population, providing more accurate results in reflecting the overall population—as shown in Table 3.1.

Table 2.1.1 Details of Population and Sample Distribution by Institution

No	Institution Name	Number of students	
		Population	Sample
1	Medan Aviation of Polytechnic	95	30
2	Palembang Aviation of Polytechnic	112	36
3	Indonesia Aviation of Polytechnic	118	37
4	Surabaya Aviation of Polytechnic	289	91
5	Indonesia Pilot Academy	28	9
5	Makasar Aviation of Polytechnic	159	50
6	Jayapura Aviation of Polytechnic	68	21
Total		869	274

Following the determination of proportional sample sizes, the respondents within each institution were selected using simple random sampling. This method involves selecting participants at random from the strata without considering subgroup characteristics. For instance, from the 95 students at Medan Aviation Polytechnic, 30 were randomly selected without considering their subgroup (e.g., class or department). This same process was applied to all participating institutions.

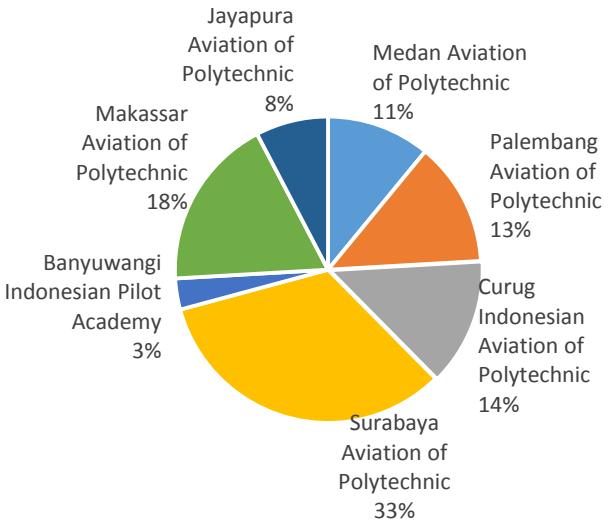

Figure 2.1.2. Proportional Distribution of Respondents

Figure 2.1.2. illustrates the proportional distribution of respondents based on their institutional affiliation within Indonesian state aviation polytechnics. The largest share of participants was drawn from Surabaya Aviation Polytechnic (33%), followed by Makassar (18%), Curug (14%), and Palembang (13%). Smaller proportions were reported from Medan (11%), Jayapura (8%), and the Banyuwangi Indonesian Pilot Academy (3%). This distribution reflects the implementation of a proportionate stratified random sampling technique, designed to ensure equitable institutional representation across the sample and enhance the generalizability of the study's findings.

Instrumentation

The research instrument was constructed based on the operational definitions of each variable to ensure conceptual clarity and consistency in measurement. The study incorporates three exogenous variables, one intervening variable, and one endogenous variable. The exogenous variables include *lecturer competence* and *industrial training*, while the *learning process* functions as the intervening variable. The *quality of graduates* is identified

as the endogenous outcome variable. The primary tool for data collection was a structured questionnaire, which was adapted and modified from previously validated instruments. A closed-ended format was used to guide respondents in selecting from a predefined set of answers, thus ensuring response consistency and facilitating quantitative analysis. The questionnaire employed a Likert scale to measure respondents' level of agreement with various statements. The development process involved decomposing each primary research variable into sub-variables, which were subsequently delineated into measurable components. These components provided the foundation for generating specific and targeted questionnaire items.

Table 2.2.1 Likert Scale Interpretation Table

Statement Type	Strongly Agree (SA)	Agree (A)	Disagree (D)	Strongly Disagree (SD)
Positive	4	3	2	1
Negative	1	2	3	4

Each item in the questionnaire was scored according to the respondent's selected response. The study employed a five-point Likert scale. For positively worded statements, the scale ranged from *Strongly Agree* (4) to *Strongly Disagree* (1). In contrast, for negatively worded statements, the scoring was reversed, with *Strongly Agree* receiving a score of 1 and *Strongly Disagree* receiving a score of 4. The complete scoring scheme is presented in Table 3.2. To ensure a shared conceptual framework and enhance measurement precision, operational definitions for each variable are described below:

Lecturer Competence

Lecturer competence is operationally defined as a multidimensional construct encompassing pedagogical expertise, content mastery, instructional design, assessment literacy, classroom management, communication skills, and alignment with industry practices. In the context of aviation polytechnics, this variable measures the instructors' capability to facilitate industry-relevant, learner-centered education, and is assessed through validated indicators reflecting teaching clarity, instructional planning, adaptability, and the integration of workplace scenarios into academic delivery.

Industrial Training

Industrial training refers to structured, curriculum-integrated work placement programs in certified aviation industries, designed to provide students with hands-on technical experience and soft skill development. Operationally, this variable includes dimensions such as the relevance of industrial tasks to academic content, mentorship quality during training, and the acquisition of professional competencies. It is measured based on student feedback, supervisor evaluations, and alignment with aviation industry standards and regulatory frameworks

Learning Process

The learning process is defined as the mediating cognitive and interactive engagement that occurs between students and instructors during instructional delivery. It encapsulates active learning strategies, instructional coherence, skill application, and collaborative practices, both in theoretical and practical settings. Operationally, this construct is assessed by students' perceptions of instructional effectiveness, relevance to real-world contexts, engagement levels, and the clarity of pedagogical communication.

Graduate Quality

Graduate quality represents the degree to which aviation polytechnic graduates demonstrate readiness for employment in aviation-related fields, meeting technical, regulatory, and soft-skill standards demanded by the industry. This variable is operationalized through indicators such as employer satisfaction, job placement accuracy, regulatory certification achievement, and graduates' perceived self-efficacy. It integrates constructs of employability, competency-based education, and professional preparedness aligned with international benchmarks.

Table 2.2.2 presents the four main latent constructs utilized in this study along with the total number of indicators assigned to measure each construct. Lecturer Competence (LC) was represented by six indicators reflecting various dimensions of pedagogical, technological, and professional teaching capabilities. Industrial Training (IT) consisted of four indicators, capturing students' practical experience, industry exposure, and job relevance. Learning Process (LP) was measured using five indicators emphasizing student engagement, understanding, and instructional coherence. Lastly, Graduate Quality (GQ) was also assessed through five indicators focusing on employability, adaptability, and alignment with industry standards. These indicators were

developed and validated through expert review and pilot testing to ensure their relevance and accuracy in capturing the intended constructs.

Table 2.2.2. Summary of Constructs and the Number of Indicators

Construct	Indicators
Lecturer Competence (LC)	6 indicators
Industrial Training (IT)	4 indicators
Learning Process (LP)	5 indicators
Graduate Quality (GQ)	5 indicators

To ensure construct validity, a comprehensive instrument blueprint was developed. This blueprint systematically maps questionnaire items to each research variable and its indicators. Each variable was deconstructed into conceptually grounded indicators, which formed the basis for generating targeted items. The number of items per indicator was determined by its theoretical importance and the need to maintain balance between clarity and measurement reliability.

The overall instrument design was intended to ensure thorough coverage of all conceptual dimensions while maintaining clarity, coherence, and ease of comprehension for respondents. A detailed presentation of the questionnaire blueprint, including the distribution of items across variables, indicators, item counts, and associated item numbers, is provided in Table 3.3.

Tabel 2.2.1 *Questionnaire Items*

Variable	Indicators	No. of Items	Items Numbers
Lecturer competence	Pedagogical skills	3	1, 2, 3
	Communication skills	3	4, 5, 6
	Assessment skills	3	7, 8, 9
	Technological proficiency	3	10, 11, 12
	Interpersonal skills	2	13, 14
	Classroom management skills	2	15, 16
Industrial Training	Student satisfaction with training experiences	2	1, 2
	Positive evaluation of student performance	2	3, 4
	Improvement in technical and soft skills	2	5, 6
	Success in obtaining relevant employment	2	7, 8
Learning Process	Active student-centered learning process	2	1, 2
	Helps students understand the material	2	3, 4
	Ability to apply practical skills	2	5, 6
	Positive interaction between students and lecturers	2	7, 8
	Well-structured instructional content	2	9, 10
Graduate Quality	Meets industry needs and expectations	2	1, 2
	Graduates are superior compared to others	2	3, 4
	Possesses relevant knowledge, insight, and skills	2	5, 6
	Pursues further higher education	2	7, 8
	Secures jobs aligned with competencies	2	9, 10

Validity and Reliability

The measurement model was rigorously assessed following established procedures for Partial Least Squares Structural Equation Modeling (PLS-SEM) using SmartPLS version 4.0. Convergent validity was evaluated based on four primary criteria: outer loadings, Average Variance Extracted (AVE), Composite Reliability (CR), and Cronbach's Alpha. All indicator loadings exceeded the recommended threshold of 0.70, indicating strong indicator reliability. Additionally, AVE values for all latent constructs surpassed the 0.50 benchmark, signifying that each construct captured more variance from its indicators than from measurement error. Composite Reliability values exceeded 0.70 across all constructs, demonstrating strong internal consistency. Meanwhile,

Cronbach's Alpha coefficients were consistently above 0.60, which meets the minimum standard for acceptable reliability. Collectively, these results confirm that the measurement model meets the criteria for convergent validity and aligns with the theoretical constructs underpinning the research.

Discriminant validity was verified using both the Fornell-Larcker criterion and the Heterotrait-Monotrait ratio (HTMT). Under the Fornell-Larcker criterion, the square root of each construct's AVE exceeded its correlations with other constructs, confirming adequate discriminant validity. In parallel, HTMT values for all construct pairs remained well below the conservative threshold of 0.85, further supporting empirical distinctiveness among constructs. The structural model was then assessed using several key metrics. The coefficient of determination (R^2) was 0.591 for the *learning process* and 0.500 for *graduate quality*, suggesting that the exogenous variables provide moderate to substantial explanatory power for the endogenous constructs, in accordance with the interpretation guidelines by Hair et al. (2019). Predictive relevance was further validated through Stone-Geisser's Q^2 values, calculated using the blindfolding procedure. All Q^2 values were positive, indicating satisfactory predictive capability of the model. Model fit was additionally confirmed by the Standardized Root Mean Square Residual (SRMR), which was below the recommended threshold of 0.08. This suggests a satisfactory overall fit between the observed data and the hypothesized model structure.

Data Collection Procedure

The data collection process in this study adhered to rigorous methodological protocols to ensure the validity and reliability of the empirical findings. A structured questionnaire was employed as the primary instrument, developed based on existing validated scales from prior research in vocational and aviation education. The instrument underwent a comprehensive content validation process, including expert judgment and pilot testing, to ensure construct clarity and contextual relevance.

The population consisted of final-year students enrolled in seven Indonesian state aviation polytechnics. Utilizing a proportionate stratified random sampling technique, the total sample size was determined using the Slovin formula with a 5% margin of error, yielding 274 respondents from a population of 869 students. Each institution's sample allocation was calculated proportionally based on its respective student population to ensure representative distribution.

The data collection was executed over a period of four weeks through both online and face-to-face administration modes, depending on institutional accessibility and regional health protocols. Respondents were given clear instructions regarding confidentiality and the academic purpose of the study. Participation was voluntary, and informed consent was obtained prior to the completion of the questionnaire.

This procedure ensured a high response rate and minimized non-response bias, thereby enhancing the overall quality and generalizability of the data.

Structural Model Evaluation Procedure

To evaluate the proposed hypotheses and examine the relationships among the latent constructs, the structural model was analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM). This approach is well-suited for studies involving complex models with both formative and reflective constructs, particularly when sample sizes are moderate and distributional assumptions may not be fully met. The analysis was conducted using SmartPLS version 4.0, which allows for simultaneous estimation of the measurement and structural models. Path coefficients and the significance of hypothesized relationships were assessed using the bootstrapping resampling method with 5,000 iterations. This technique enhances the robustness of parameter estimation, providing confidence intervals and t-statistics that are not dependent on data normality. Statistical significance was determined using standard criteria: t-values greater than 1.96 and p-values below 0.05, indicating significance at the 95% confidence level.

The assessment of the structural model in this study was centered on three critical dimensions. First, the analysis examined the direct effects of lecturer competence, industrial training, and the learning process on graduate quality. This aimed to identify the magnitude and significance of the causal relationships among the core variables. Second, the study explored the indirect effects, particularly the mediating role of the learning process, which functioned as an intermediary mechanism linking the exogenous constructs (lecturer competence and industrial training) to the endogenous outcome (graduate quality). Third, the overall explanatory power of the model was assessed using the R^2 values for the learning process and graduate quality constructs, reflecting the model's capacity to account for variance within these latent variables and thus supporting the model's predictive relevance.

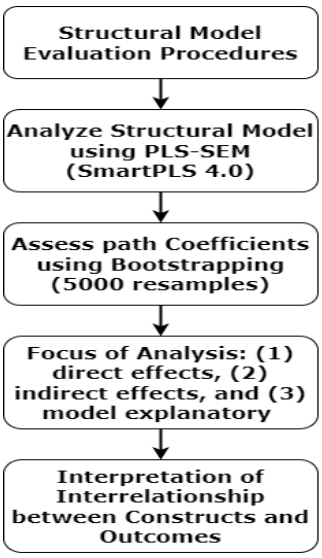

Figure 2.5.1 Conceptual Flowchart

This analytical procedure facilitated a comprehensive interpretation of the structural relationships among key constructs in vocational aviation education. The findings provide empirical support for how lecturer competency and industrial training—representing core pedagogical and experiential inputs contribute to the enhancement of graduate quality, both directly and through the mediating role of the learning process. These results highlight the strategic importance of aligning instructional practices with structured industry engagement to optimize graduate outcomes in Indonesian aviation polytechnics. The sequential steps undertaken in the structural model evaluation using PLS-SEM are depicted in Figure 2.5.1. outlining the conceptual flow from model specification through to the interpretation of structural relationships.

SEM consists of two primary components: the measurement model, which specifies how latent variables are operationalized through observable indicators and the nature of these measurements; and the structural model, which outlines the hypothesized relationships among latent constructs.

There are two main approaches within SEM: Covariance-Based SEM (CB-SEM) and Variance-Based SEM (PLS-SEM). The selection of the appropriate method is contingent upon data characteristics, particularly the assumption of multivariate normality. When the data meet the normality assumption, CB-SEM is considered appropriate. However, in cases where normality is not observed, PLS-SEM is preferred due to its flexibility and suitability for non-parametric conditions, as was the case in this study.

The normality test results revealed that the significance probability values for all observed variables were less than 0.05, indicating a rejection of the null hypothesis and suggesting that the data were not normally distributed. In response to these findings, further verification of the data distribution was conducted using the Lilliefors test, which provided a more robust assessment of normality, particularly in small to medium-sized samples. The non-normal distribution pattern confirmed the appropriateness of applying Partial Least Squares Structural Equation Modeling (PLS-SEM), which does not require multivariate normality and is particularly well-suited for exploratory models and predictive research in social and behavioral sciences.

The results of the Lilliefors test further confirmed the outcomes of the initial normality assessment, showing that the significance probability values for all variables were below 0.05. This outcome indicates a rejection of the null hypothesis for each variable, thereby confirming that none of the variables followed a normal distribution. Given these distributional characteristics, the study adopted Partial Least Squares Structural Equation Modeling (PLS-SEM) as the primary analytical technique for hypothesis testing. This approach is particularly advantageous in cases involving non-normal data, complex models with multiple latent constructs, and relatively moderate sample sizes, as it prioritizes prediction-oriented analysis over strict distributional assumptions.

Statistical Analysis

The statistical analysis in this study was conducted using a combination of descriptive statistics and inferential analysis, employing the Partial Least Squares Structural Equation Modeling (PLS-SEM) approach. PLS-SEM was selected due to its suitability for complex models with multiple constructs and its ability to handle formative and reflective measurement models in small to medium sample sizes. The analysis was carried out using SmartPLS version 3.0.

Descriptive statistics were used to summarize the demographic characteristics of respondents and to describe the central tendencies and dispersion of each variable. Prior to hypothesis testing, a series of preliminary

analyses was conducted, including tests for normality, convergent validity, discriminant validity, reliability (Cronbach's alpha and composite reliability), and multicollinearity (VIF values).

The measurement model evaluation involved assessing factor loadings, Average Variance Extracted (AVE), Composite Reliability (CR), and the Fornell-Larcker criterion to ensure construct validity. Discriminant validity was further verified through Heterotrait-Monotrait ratio (HTMT) analysis.

The structural model was evaluated using R-square (R^2) values to determine the explanatory power of endogenous constructs, path coefficients (β) to assess the strength and significance of relationships among variables, and the predictive relevance (Q^2) of the model using blindfolding techniques. Additionally, model fit was evaluated using Standardized Root Mean Square Residual (SRMR) and Normed Fit Index (NFI).

To examine the significance of the hypothesized relationships, a bootstrapping procedure with 5,000 resamples was applied. Direct, indirect, and total effects were analysed to understand the mediating role of the learning process between lecturer competence, industrial training, and graduate quality. This comprehensive approach ensures both the robustness and generalizability of the findings.

RESULTS AND DISCUSSIONS

Measurement Model

The subsequent phase of data analysis employed Structural Equation Modeling (SEM), a robust multivariate analytical technique that integrates factor analysis and path analysis. SEM facilitates the examination of both direct and indirect relationships among one or more latent independent variables and one or more latent dependent variables. It allows for a comprehensive analysis of the structural relationships between exogenous and endogenous constructs, making it particularly suitable for complex theoretical models.

Within the measurement model evaluation, two indicator items under the Learning Process (LP) construct—PB-1.1 and PB-2.1—were identified as having outer loading values below the recommended threshold of 0.70, indicating insufficient contribution to the latent construct. Similarly, under the Graduate Quality (GQ) construct, one indicator—KL-1.1—also exhibited an outer loading value below 0.70. To enhance the reliability and convergent validity of the measurement model, these items were excluded from further analysis. Following the removal of the low-loading indicators, the updated construct relationships are presented in Figure 4.13. As shown in the revised model, all remaining items demonstrated strong convergent validity, with factor loading values exceeding 0.70, thereby confirming the adequacy of the measurement model for subsequent structural analysis.

To satisfy the requirements of convergent validity, each construct must demonstrate outer loading values greater than 0.70 and an Average Variance Extracted (AVE) value exceeding 0.50 (Hair et al., 2019). The analysis results showed that most indicators had outer loading values above the 0.70 threshold, except for two indicators under the Learning Process (LP) construct—PB-1 (Experience) and PB-2 (Ease of Understanding)—which exhibited values below 0.70. These lower values suggest that the respective indicators did not sufficiently correlate with their latent construct and were thus excluded from the final model. The retained indicators, all with outer loadings above 0.70, are considered valid and reliable measures, exhibiting a high correlation with their corresponding constructs. Furthermore, the AVE values for all constructs exceeded 0.50, confirming that the model demonstrates adequate convergent validity across its latent variables.

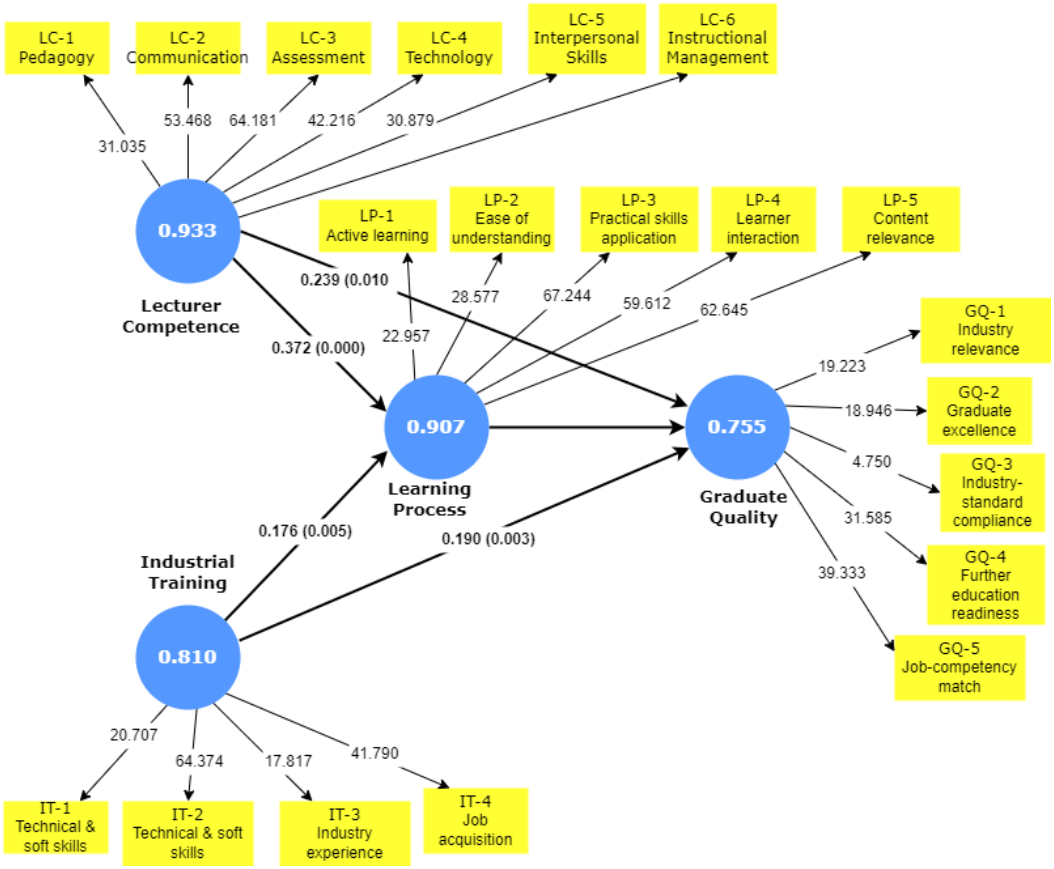

Figure 3.1.1. Measurement and Structural Model Results

The results of the cross-loading analysis demonstrated that each item exhibited a stronger correlation with its designated construct than with any other construct, thereby supporting discriminant validity. For instance, in the Lecturer Competence (LC) construct, the item KD-1.2 under the pedagogical indicator recorded a cross-loading value of 0.890, which was higher than its cross-loadings on all other indicators across different constructs. This pattern was consistently observed across all items and indicators in the model. These findings confirm that each indicator uniquely reflects its corresponding latent variable and does not overlap in measurement with other constructs. As such, the model meets the criteria for discriminant validity, ensuring that each construct is empirically distinct and captures a unique dimension of the theoretical framework.

Item reliability was assessed through outer loading values, as part of the convergent validity evaluation. According to the reliability criteria, each item must exhibit an outer loading greater than 0.70 to be considered reliable. As shown in Figure 4.13, the retained items met this requirement, indicating that all items demonstrate acceptable reliability in measuring their respective constructs.

In addition, Composite Reliability (CR) values were evaluated to assess the internal consistency of each indicator set. The analysis revealed that all constructs achieved CR values above the 0.70 threshold, except for two indicators under the Learning Process (LP) variable: PB-1 (Experience) and PB-2 (Ease of Understanding), which recorded CR values of 0.675 and 0.656, respectively. These values fall slightly below the recommended threshold, suggesting marginal reliability concerns for these specific indicators. However, after their exclusion, the remaining indicators demonstrated strong internal consistency, thus fulfilling the requirements for construct reliability.

Structural Model

The primary objective of this study was to investigate the extent to which lecturer competence and industrial training influence graduate quality in Indonesian aviation polytechnics, both directly and indirectly through the mediating role of the learning process. Structural Equation Modeling using Partial Least Squares (PLS-SEM) was employed to evaluate the hypothesized relationships. The analysis revealed several statistically significant direct effects. The results of the hypothesis testing for the structural model indicated that all direct effect hypotheses were statistically significant, as evidenced by p-values less than 0.05. These findings confirm the presence of meaningful relationships between the exogenous and endogenous variables within the model. The results are visually summarized in Figure 3.1.1 and Tabel 3.2.1, which illustrates the path coefficients and significance levels

among the constructs. This outcome supports the theoretical assumptions of the study and affirms the validity of the proposed structural relationships.

Table 3.2.1 Results of Direct and Indirect Effects Testing

Hypotesis	**Path Coeff.**	**P values**
Lecturer competence -> Graduate Quality	0,239	0,010
Industrial Training -> Graduate Quality	0,190	0,003
Learning Process -> Graduate Quality	0,307	0,009
Lecturer competence -> Learning Process	0,372	0,000
Industrial training -> Learning Process	0,176	0,005
Lecturer competence -> Learning Process -> Graduate Quality	0,114	0,051
Industrial Training -> Learning Process -> Graduate Quality	0,054	0,095

Lecturer competence had a positive and significant impact on graduate quality ($\beta = 0.239$, $p = 0.010$), as did industrial training ($\beta = 0.190$, $p = 0.003$). Furthermore, both lecturer competence and industrial training significantly affected the learning process. Lecturer competence showed a stronger association ($\beta = 0.372$, $p < 0.001$) compared to industrial training ($\beta = 0.176$, $p = 0.005$). The learning process itself had a notable positive effect on graduate quality ($\beta = 0.307$, $p = 0.009$), underscoring its importance as a mediating variable. However, the indirect effects mediated by the learning process were not statistically significant. The path from lecturer competence to graduate quality via the learning process produced a coefficient of $\beta = 0.114$ ($p = 0.051$), slightly exceeding the conventional significance threshold. Similarly, the indirect path from industrial training to graduate quality through the learning process yielded a coefficient of $\beta = 0.054$ ($p = 0.095$). These results imply that while the learning process is significantly associated with both the predictors and the outcome, it does not serve as a full mediator in these relationships. Methodologically, the model demonstrated acceptable predictive power. The coefficient of determination (R^2) was 0.591 for the learning process and 0.500 for graduate quality, indicating moderate to strong explanatory capabilities. Stone-Geisser's Q^2 values for all endogenous variables were above zero, confirming satisfactory predictive relevance. Additionally, the Standardized Root Mean Square Residual (SRMR) was 0.072, below the recommended threshold of 0.08, indicating a good model fit. In summary, the findings confirm that both pedagogical input (lecturer competence) and industry exposure (industrial training) significantly influence the perceived quality of aviation graduates. The limited mediating role of the learning process suggests that other contextual or instructional elements such as curriculum structure, instructor qualifications, or the broader institutional learning environment—may moderate how experiential learning contributes to educational outcomes. Future research should explore these potential moderating mechanisms in greater depth.

Theoretical Implications atau Interpretation of Findings

The findings of this study contribute significantly to the theoretical discourse surrounding vocational education in the aviation sector, particularly through the validation of a multidimensional model linking lecturer competence, industrial training, and the learning process to graduate quality. These results extend existing theories in teaching effectiveness and experiential learning by empirically demonstrating that both pedagogical attributes and workplace exposure exert substantial influence not only directly on graduate outcomes, but also indirectly through the internal mechanisms of student learning engagement.

The positive and significant relationship between lecturer competence and the learning process reinforces prior research emphasizing the role of pedagogical clarity, assessment literacy, technological integration, and interpersonal management in fostering student-centered learning environments. This supports the theoretical framework of Pedagogical Content Knowledge (PCK) and Technological Pedagogical Content Knowledge (TPACK), highlighting that lecturer quality is a core determinant in activating cognitive and applied learning processes in technical education.

In parallel, the strong direct and mediated influence of industrial training on graduate quality through the learning process substantiates the relevance of experiential learning theory and situated cognition, indicating that authentic industry-based experiences deepen learners' understanding and readiness for professional roles. This confirms the theoretical notion that real-world exposure functions as a contextual bridge between formal instruction and workplace performance.

Collectively, these results affirm that the integration of competent instruction and industry-based training creates a synergistic effect that enhances the overall quality of aviation graduates. The study advances vocational education literature by positioning the learning process as a central mediating variable that operationalizes the pathway from educational inputs to employability outcomes—thereby reinforcing the strategic value of internal instructional mechanisms in translating curriculum design into workforce readiness.

CONCLUSIONS

This study examined the structural relationships among lecturer competence, industrial training, the learning process, and graduate quality within the context of Indonesian aviation polytechnics. The findings empirically confirm that both lecturer competence and industrial training exert significant direct effects on graduate quality, while also influencing it indirectly through the learning process as a mediating variable. The learning process itself emerged as a critical pathway that translates instructional quality and experiential exposure into enhanced employability outcomes.

The results underscore the theoretical proposition that strengthening pedagogical capabilities and providing authentic industrial experiences contribute not only to improved instructional engagement but also to the production of graduates who are technically proficient, professionally adaptable, and aligned with the needs of the aviation industry. The validated model highlights the central role of the learning process as a conduit for educational effectiveness, bridging the gap between academic preparation and industry readiness.

These findings advance the discourse in vocational education by offering a comprehensive and evidence-based model that integrates teaching quality, industrial relevance, and student-centered learning. The study provides a foundation for further research and institutional practice aimed at optimizing graduate outcomes through systemic instructional and experiential enhancements. Future research could explore additional contextual factors or extend the model across different vocational domains.

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