

Digital Transformation and Cadet Engagement in Online General English Learning: A SEM-PLS Study

Meita Maharani Sukma*^{ORCID}, Lusiana Dewi Kusumayati^{ORCID}, Laila Rochmawati^{ORCID},
Fatmawati^{ORCID}, Dimas Arya Soeadyfa Fridyatama^{ORCID}, Lady Silk Moonlight^{ORCID}

Politeknik Penerbangan Surabaya, Jemur Andayani I St. No.73, Surabaya, East Java, 60236, Indonesia

*Corresponding author, email: mitamsukma@poltekbangsby.ac.id

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Abstract

This study was conducted to analyze the influence of digital transformation and cadet engagement on learning effectiveness in online General English learning at one of the university at Indonesia. The research focuses on understanding how technological and behavioral factors contribute to learning outcomes in a digital learning environment. A quantitative approach was employed using a survey design involving 40 cadets who participated in online General English courses. Data were collected through a structured questionnaire consisting of three constructs: digital transformation, cadet engagement, and learning effectiveness. The data were analyzed using Structural Equation Modeling–Partial Least Squares (SEM-PLS) with SmartPLS software. The measurement model evaluation showed that all indicators met the required thresholds, with outer loadings above 0.70, Average Variance Extracted (AVE) values ranging from 0.876 to 0.912, and composite reliability values exceeding 0.90, indicating strong validity and reliability. The structural model results revealed that cadet engagement has a significant positive effect on learning effectiveness ($\beta = 0.733$, $p < 0.05$), while digital transformation does not show a significant effect ($\beta = 0.174$, $p > 0.05$). The model explains 76.9% of the variance in learning effectiveness ($R^2 = 0.769$), indicating strong predictive power. These findings suggest that student engagement plays a more dominant role than technological factors in determining the effectiveness of online learning. Overall, the study highlights the importance of integrating digital transformation with active learning strategies to enhance learning outcomes.

1. Introduction

The rapid advancement of digital technology has fundamentally transformed the organization and operation of higher education systems globally. Institutions are increasingly adopting digital tools to enhance academic performance, improve educational quality, and meet the demands of a technology-dependent society (Nnaji et al., 2026). In this landscape, digital transformation extends beyond the mere adoption of new software; it necessitates profound shifts in institutional governance, instructional design, and student learning paradigms to foster greater flexibility and innovation (Carmo et al., 2025).

The rationale for prioritizing digital transformation is particularly evident in vocational education, such as aviation polytechnics, where skill-based learning must align strictly with industry requirements. Digital environments allow these institutions to create student-centered platforms that facilitate the active interaction and ongoing practice essential for language acquisition (Lambekova et al., 2025). In General English learning, online platforms serve as critical conduits for communication, ensuring that cadets remain engaged with educational resources despite the shift from traditional classrooms (Apridayani et al., 2023). In a similar aviation education context, a previous study on the development of a website for the D3 Aeronautical Communication Study Program showed that web-based digital platforms can support academic information services and institutional learning activities (Moonlight et al., 2022).

Thematic literature suggests that the efficacy of online environments is a product of interconnected dimensions, primarily digital transformation, student engagement, and learning behavior (Herzallah et al., 2025). Previous studies indicate that while digital transformation improves institutional accessibility, its ultimate success depends on how technology is integrated into the pedagogical process (Carmo et al., 2025). Furthermore, researchers have consistently found that individual characteristics such as digital literacy and learning habits often exert a more significant impact on learning outcomes than technological availability alone (Vaszkun & Mihalkov Szakács, 2025).

Current scholarship also underscores student engagement as a pivotal factor in academic achievement, integrating cognitive, emotional, and behavioral aspects (Chambers & Whitfield, 2025). In the context of

language learning, self-regulated learning and motivation are recognized as vital elements that enhance a student's capacity to attain superior outcomes (Apridayani et al., 2023). To analyze these complex relationships, recent educational research has increasingly utilized Partial Least Squares Structural Equation Modeling (PLS-SEM), which allows for the simultaneous evaluation of measurement and structural models (Hair & Alamer, 2022; (Sasongko et al., 2025).

Despite these developments, a significant gap remains in the existing literature. Most studies on digital transformation focus on general higher education contexts and rarely examine vocational institutions, particularly within the highly disciplined aviation sector (Carmo et al., 2025). Additionally, research in online English acquisition often emphasizes linguistic performance in isolation, failing to integrate broader structural variables like institutional digital transformation and multifaceted student engagement into a single, comprehensive model (Fageeh, 2024; Herzallah et al., 2025).

This lack of integration is especially critical given the unique nature of aviation education, which demands rigorous discipline and precise communication skills. The professional requirement for English proficiency in aviation necessitates a specialized look at how digital shifts and engagement levels interact to produce effective learning. To date, the specific synergy between digital transformation and cadet engagement within this specialized vocational framework has not been sufficiently explored, leaving a void in both theoretical understanding and practical application.

The objective of this study is to analyze the influence of digital transformation and cadet engagement on the effectiveness of online General English learning using the PLS-SEM approach. By examining the structural relationships between these variables, this research seeks to provide a comprehensive model of successful online learning. The findings are intended to offer theoretical contributions to educational technology frameworks and provide practical strategies for improving vocational training in the digital era.

2. Method

This study employed a quantitative research approach using a survey design to analyze the relationships between digital transformation, cadet engagement, and learning effectiveness in an online learning environment (Guo & Erdenebold, 2025). The use of a quantitative approach was considered appropriate because it allows researchers to examine causal relationships between variables and test hypotheses using statistical analysis (Hair & Alamer, 2022). In addition, the study utilized the Partial Least Squares Structural Equation Modeling (PLS-SEM) technique, which is widely used in educational research to analyze complex models involving multiple latent constructs (Sasongko et al., 2025).

2.1. Research Design

This research applied a correlational design to examine the relationships among variables without manipulating the research environment (Guenther et al., 2025). The design aimed to identify how digital transformation and cadet engagement influence learning effectiveness in online General English learning (Herzallah et al., 2025). The use of PLS-SEM was chosen because it is suitable for exploratory research and can handle complex relationships between variables even with relatively small sample sizes (Hair & Alamer, 2022).

Furthermore, PLS-SEM allows simultaneous evaluation of measurement and structural models, making it effective in assessing both validity and reliability while testing hypotheses (Guo & Erdenebold, 2025). This method has been widely applied in previous studies investigating technology adoption and online learning effectiveness in higher education (Sasongko et al., 2025).

2.2. Participants

The participants of this study consisted of 40 cadets enrolled in an online General English course at one of the university at Surabaya, Indonesia. The respondents were selected because they represent vocational students who are actively involved in online learning activities (Lambekova et al., 2025). All participants had prior experience using digital learning platforms, ensuring that they were familiar with online learning environments (Carmi, 2024).

The selection of participants was based on the assumption that cadets in aviation education require both technical and communication skills, particularly in English, which makes them relevant subjects for this study (Fageeh, 2024). In addition, the relatively homogeneous background of the participants helps ensure consistency in the analysis of the variables under study (Hair & Alamer, 2022).

2.3. Sampling Technique

This study used a purposive sampling technique to select respondents based on specific criteria relevant to the research objectives (Ali et al., 2025). The criteria included cadets who actively participated in online General English learning and had experience using digital learning platforms (Vaszkun & Mihalkov Szakács,

2025). This sampling method was chosen to ensure that the respondents had sufficient exposure to the variables being studied.

Purposive sampling is commonly used in educational research to obtain data from participants who are directly involved in the phenomenon under investigation (Herzallah et al., 2025). This approach allows researchers to focus on respondents who are most relevant to the research context, thereby improving the accuracy and validity of the findings (Hair et al., 2022).

2.4. Data Collection Technique

Data in this study were collected using an online questionnaire distributed through a digital platform such as Google Forms. The use of an online questionnaire was chosen because it allows efficient data collection, particularly in online learning environments where face-to-face interaction is limited (Carmi, 2024).

The questionnaire link was distributed to respondents through institutional communication channels, and participants were given sufficient time to complete the survey. Before filling out the questionnaire, respondents were informed about the purpose of the study and were assured that their responses would remain confidential and used only for academic purposes (Creswell, 2014).

The use of online surveys has been widely adopted in educational research due to its flexibility, accessibility, and ability to reach respondents in different locations (Guo & Erdenebold, 2025). In addition, online questionnaires reduce data entry errors and facilitate faster data processing compared to traditional paper-based methods (Hair et al., 2022).

2.5. Research Instrument

The measurement model comprised latent variables represented by multiple indicators. The evaluation of the model focused on assessing convergent validity, discriminant validity, and reliability. Convergent validity was examined using outer loadings and Average Variance Extracted (AVE), while reliability was assessed through composite reliability. Indicators that did not meet the recommended thresholds were removed to improve the overall quality of the model (Khasanah et al., 2026).

The research instrument used in this study was a structured questionnaire developed based on relevant literature related to digital transformation, student engagement, and learning effectiveness (Herzallah et al., 2025). The instrument consisted of three main constructs: digital transformation, cadet engagement, and learning effectiveness.

Each construct was measured using multiple indicators adapted from previous studies to ensure content validity (Hair & Alamer, 2022). A five-point Likert scale was used to measure respondents' perceptions, ranging from strongly disagree (1) to strongly agree (5) (Khasanah et al., 2026).

Example items included:

- a. "The online learning system is easy to use" (digital transformation)
- b. "I actively participate in online learning activities" (engagement)
- c. "Online learning improves my understanding of the material" (effectiveness)

Table 1. Research Instrument Grid

Variable	Indicator	Code
Digital Transformation (X1)	Ease of use	X1.1
	System accessibility	X1.2
	Technology support	X1.3
Cadet Engagement (X2)	Participation	X2.1
	Interaction	X2.2
	Motivation	X2.3
Learning Effectiveness (Y)	Understanding	Y1
	Learning outcomes	Y2

Each statement was evaluated on a five-point Likert scale, where 1 represented strongly disagree and 5 indicated strongly agree

2.6. Measurement Model

The measurement model in this study consisted of latent variables represented by multiple indicators. The evaluation focused on assessing convergent validity, discriminant validity, and reliability (Hair & Alamer, 2022). Convergent validity was assessed using outer loadings and Average Variance Extracted (AVE), where values above 0.70 for loadings and 0.50 for AVE indicate acceptable validity (Khasanah et al., 2026). Reliability was evaluated using composite reliability, with values above 0.70 indicating strong internal consistency (Guo & Erdenebold, 2025). Indicators that did not meet the required thresholds were considered for removal to improve the overall quality of the measurement model (Khasanah et al., 2026).

2.7. Data Analysis Technique

The data analysis was conducted using SmartPLS software to perform PLS-SEM analysis. The analysis consisted of two main stages: evaluation of the measurement model and evaluation of the structural model (Hair & Alamer, 2022). The structural model was assessed using path coefficients, t-statistics, p-values, and R-square values to determine the strength and significance of relationships between variables (Nurtanto et al., 2025). In addition, bootstrapping procedures were applied to test the significance of the hypotheses (Guo & Erdenebold, 2025).

3. Results and Discussion

3.1. Structural Model Evaluation

The structural model analysis was conducted to examine the relationships between digital transformation, cadet engagement, and learning effectiveness in the context of online General English learning. The model demonstrates strong predictive capability, with an R-square value of 0.769 (see Figure 1). This indicates that 76.9% of the variance in learning effectiveness is explained by the independent variables (Hair & Alamer, 2022). This suggests that the proposed model is robust in explaining learning outcomes in a specialized vocational online environment.

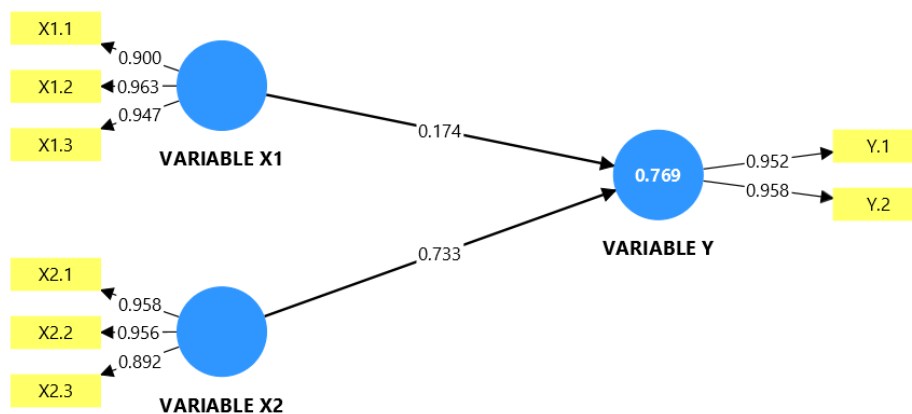


Figure 1. Structural Model of Digital Transformation, Cadet Engagement, and Learning Effectiveness

3.2. Measurement Model Evaluation

The evaluation of the measurement model indicates that all indicators meet the required validity thresholds. As shown in Table 2, the outer loading values for all indicators exceed 0.70, which confirms that each indicator adequately represents its corresponding latent construct (Hair & Alamer, 2022).

Table 2. Outer Loadings

Indicator	Loading
X1.1	0.900
X1.2	0.963
X1.3	0.947
X2.1	0.958
X2.2	0.956
X2.3	0.892
Y1	0.952
Y2	0.958

3.3. Reliability and Validity

To ensure the constructs are consistently measured, reliability and validity tests were conducted. The results, as summarized in Table 3, demonstrate high internal consistency with Cronbach’s alpha and Composite Reliability (CR) values exceeding 0.90. Furthermore, the Average Variance Extracted (AVE) values range from 0.876 to 0.912, significantly exceeding the 0.50 threshold, which confirms strong convergent validity (Hair & Alamer, 2022).

Table 3. Reliability and Validity

Variable	Cronbach's Alpha	Composite Reliability (CR)	AVE
X1	0.931	0.956	0.878
X2	0.929	0.955	0.876
Y	0.904	0.954	0.912

3.4. Discriminant Validity

Discriminant validity was assessed using the Heterotrait-Monotrait Ratio (HTMT). Most values are below the 0.90 threshold (see Table 4). However, the ratio between cadet engagement and learning effectiveness is 0.945. While high, this reflects a strong conceptual overlap in online learning environments where engagement is often inseparable from the learning process itself.

Table 4. HTMT Values

Variable	X1	X2	Y
X1	-		
X2	0.843	-	
Y	0.813	0.945	-

3.5. Hypothesis Testing (Bootstrapping Analysis)

The bootstrapping results reveal that Cadet Engagement (X2) has a significant positive effect on Learning Effectiveness (Y) ($\beta = 0.733, p < 0.05$) (Table 5, Table 6). Conversely, Digital Transformation (X1) does not show a statistically significant direct effect on learning effectiveness ($\beta = 0.174, p > 0.05$).

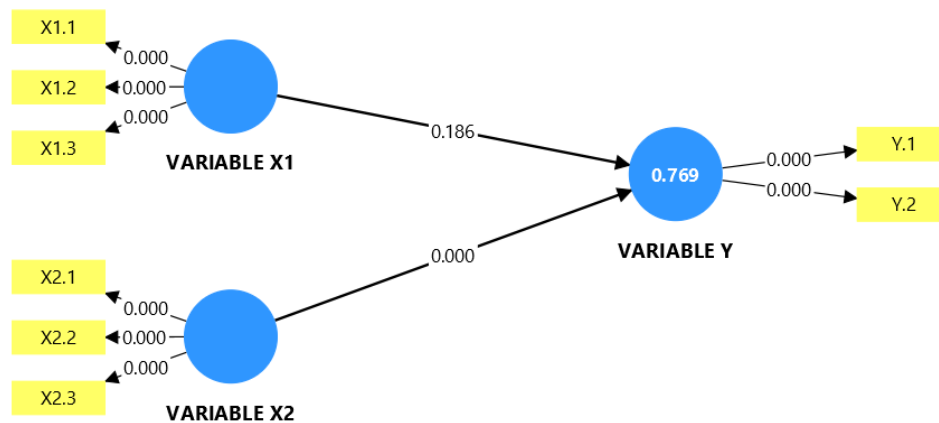


Figure 2. Bootstrapping Results of Structural Model

Table 5. Path Coefficients

Relationship	Coefficient
X1 → Y	0.174
X2 → Y	0.733

Table 6. Bootstrapping Results

Relationship	Coefficient	T-Statistics	P-Values
X1 → Y	0.174	1.323	0.186
X2 → Y	0.733	5.962	0.000

3.6. The Role of Digital Transformation

The findings indicate that digital transformation does not directly influence learning outcomes. Although the direction is positive, the statistical results suggest that technology alone is insufficient to improve learning quality. This may occur because cadets are already familiar with digital environments, making technology a "baseline" requirement rather than a primary differentiator for success. Its effectiveness depends on how it is meaningfully integrated into pedagogical practices.

3.7. The Role of Cadet Engagement

The results demonstrate that cadet engagement is the most significant and dominant driver of learning effectiveness. This finding implies that academic success in a digital environment is not determined by the tools themselves, but by the extent to which students actively immerse themselves in the learning process. Engagement in online General English learning encompasses behavioral, emotional, and cognitive dimensions such as consistent participation in virtual discussions, interaction with peers, and the intrinsic motivation to practice language skills. This finding is also supported by previous research showing that engagement plays an important role in strengthening the relationship between digital learning resources and learning-related outcomes (D'Ambra et al., 2022).

The dominance of this variable suggests that for cadets in a high-discipline vocational setting, engagement acts as the primary engine for knowledge retention. Cadets who are actively involved are better equipped to overcome the transactional distance inherent in online learning, turning passive digital consumption into active language acquisition.

3.8. Integration of Technology and Engagement

The effectiveness of digital transformation is inextricably linked to the level of student engagement. Technology functions optimally only when it serves as a catalyst for interaction, collaboration, and active participation. The success of digital learning systems is heavily influenced by user readiness and institutional support (Lambekova et al., 2025).

In this study, the insignificant direct effect of digital transformation (X1) suggests that without high engagement (X2), digital infrastructure remains a "passive shell." Technology provides the necessary platform, but engagement provides the energy required to achieve learning objectives. This synergy highlights that educational institutions must harmonize technological upgrades with pedagogical strategies that prioritize student involvement (Herzallah et al., 2025).

3.9. Practical Implications

The results of this study present meaningful implications for vocational higher education institutions, particularly aviation polytechnics. At the institutional level, management should go beyond the provision of digital equipment and place greater emphasis on cultivating a digital culture that supports cadet engagement. In the case of Politeknik Penerbangan Surabaya, the improvement of a website-based facility service system reinforces the importance of institutional digital readiness in supporting academic processes and learning activities (Moonlight et al., 2025). From the perspective of instructional design, instructors are expected to create more interactive online English learning modules by incorporating real-time feedback, collaborative problem-solving, and gamification to maintain cadets' interest and participation (Fageeh, 2024). Accordingly, educational institutions should not only offer digital learning platforms but also facilitate teachers in strengthening their digital competencies and adapting their teaching roles to preserve meaningful teacher-student relationships in online learning settings (Mitev et al., 2024). Regarding professional readiness, enhancing cadet engagement may also contribute to preparing students for the collaborative demands of the aviation industry, where active English communication plays a vital role in safety.

3.10. Comparison with Previous Studies

These findings are consistent with previous research which identifies engagement as a pivotal determinant of success in online education (Chambers & Whitfield, 2025). However, the lack of a significant direct effect from digital transformation contrasts with some earlier studies (Carmo et al., 2025). This discrepancy may be attributed to the specific context of this study, where cadets might view technology as a standard utility rather than a novel motivational factor, further reinforcing the idea that "how" technology is used (engagement) matters more than "what" technology is available.

3.11. Limitations and Future Research

Despite its contributions, this study has several limitations. **Generalizability:** The sample is limited to a specific vocational group. Future research should expand the population to diverse academic disciplines to validate the model's broader applicability. **Mediating Variables:** This study examined direct relationships. Future research should specifically test whether Cadet Engagement acts as a mediator between Digital

Transformation and Learning Effectiveness, as the current data suggests technology works primarily through the lens of engagement. **Variable Expansion:** Future models should incorporate additional constructs such as instructional design quality, psychological motivation, and digital literacy to capture more of the variance in learning effectiveness.

4. Conclusion

This study concludes that cadet engagement is the primary driver of learning effectiveness in online General English courses at the aviation polytechnic level. The findings reveal that while digital transformation provides the necessary infrastructure, it does not inherently guarantee improved learning outcomes. Instead, the effectiveness of online learning is more profoundly rooted in the students' active participation and cognitive involvement. This suggests that in a high-discipline vocational environment, technology serves as a facilitator, but the actual pedagogical value is realized only through well-designed instructional strategies that foster student engagement. The results imply that the mere presence of digital platforms is insufficient to achieve educational excellence. Therefore, institutions should shift their focus from purely technical upgrades to holistic approaches that prioritize cadet interaction, motivation, and collaboration. Future research should explore additional variables such as instructional design and the potential mediating role of engagement to provide a more nuanced understanding of how digital tools can be better leveraged to enhance vocational learning outcomes.

Author Contributions

All authors have equal contributions to the paper. All the authors have read and approved the final manuscript.

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Declaration of Conflicting Interests

The authors declare that there are no conflicts of interest related to this study.

Data Availability

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Declaration on AI Use

The authors confirm that no artificial intelligence (AI) tools were used to generate the content of this study. Any AI-assisted tools were limited to language refinement under human supervision.

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