

Development and evaluation of a competency-based Electronic ICAO English Language Proficiency (E-IELP) platform in aviation vocational education

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ABSTRACT

Aviation vocational education requires competency-based digital learning media that enable cadets to practice workplace communication tasks aligned with industry standards. This study developed and evaluated a web-based Electronic ICAO English Language Proficiency (E-IELP) platform to support aviation communication training for aeronautical communication cadets at an aviation vocational polytechnic in Indonesia. The platform provides ICAO-aligned learning activities, including radiotelephony read-back, situation analysis, emergency communication scenarios, and speaking tasks. This study employed a research and development (R&D) approach based on the ADDIE model, followed by a quasi-experimental pre-test-post-test control-group design to evaluate the platform's effectiveness. Forty-eight cadets participated in the study and were assigned to treatment and control groups. Data were collected through needs analysis questionnaires, curriculum analysis, expert validation forms, user response questionnaires, performance tests, and interviews. Quantitative data were analyzed using descriptive statistics, paired-samples t-tests, Welch's independent-samples t-test, and effect size estimates, while qualitative data were analyzed using thematic analysis. The platform was judged feasible by experts and received highly positive responses from users. The treatment group achieved significantly higher post-test performance than the control group, indicating that the platform effectively supports structured, repeated, and feedback-oriented aviation communication practice. However, because the study was conducted at a single institution over a four-week intervention and involved a relatively small sample using a five-point performance scale, the very large effect size should be interpreted with caution. Overall, the findings suggest that the E-IELP platform can serve as an effective supplementary competency-based digital learning platform for aviation vocational education.

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INTRODUCTION

Vocational education is expected to prepare graduates with competencies directly aligned with workplace demands (Andriansyah & Kamalia, 2021; Gilic & Inandi, 2026). In aviation vocational education, professional communication competence is essential for cadets to acquire because aviation operations require accurate, clear, and timely communication (Chatzi & Kourousis, 2024; Dum Dumaya, 2025; Kes et al., 2026; Lin et al., 2025). For aeronautical communication cadets, this competence includes the ability to use standardized phraseology, plain language, radiotelephony communication, and appropriate responses in routine and non-routine operational situations. Therefore, aviation vocational institutions need learning environments that enable cadets to practice

communication tasks reflecting real workplace contexts (Savchenko & Necheporuk, 2021; Suyatmo et al., 2026).

The International Civil Aviation Organization (ICAO) language proficiency requirements can be understood as industry standards that aviation vocational institutions need to translate into competency-based learning activities (International Civil Aviation Organization, 2016; Treadaway & Read, 2025). These standards require cadets to develop not only language knowledge but also practical communication performance relevant to future occupational roles (Borasheva, 2026; Hack et al., 2026). However, conventional instruction in ICAO English language proficiency preparation often provides limited opportunities for repeated speaking practice, authentic simulation, immediate feedback, and performance-based assessment. Classroom explanation, paper-based exercises, and online meetings may not fully represent the communication demands faced by future aviation communication officers (Dapica et al., 2022; Masiulionienė & Tupčiauskaitė, 2023; Treadaway & Read, 2024).

Technology integration in vocational education provides opportunities to create flexible, interactive, and competency-based learning environments. Web-based platforms can support autonomous learning, repeated practice, lecturer feedback, performance monitoring, and language-skill development when they are integrated with clear pedagogical tasks (Baziukė et al., 2025; Kravchenko et al., 2025; Zhang & Li, 2026). In aviation communication training, digital platforms can be designed to provide radiotelephony simulations, emergency communication scenarios, situation analysis, and speaking tasks that reflect workplace communication demands (Demirdöken, 2024; G. Wang & Zhao, 2020). The use of smart aviation technologies, mixed-reality applications, and natural language processing further indicates that aviation education increasingly requires digital media that can connect operational scenarios with communication performance (Jiang et al., 2023; Wild et al., 2025). Such platforms are relevant to vocational education because they connect theoretical knowledge, practical skill development, and professional competence assessment.

Although digital learning has been widely adopted in vocational and aviation training, limited empirical studies have developed and evaluated a competency-based platform that integrates ICAO-aligned aviation communication tasks, workplace simulation, lecturer feedback, and performance-based assessment for aeronautical communication cadets (Garcia, 2023; Ramanjaneyulu et al., 2026). Existing studies tend to focus separately on general aviation English instruction, aviation technical training, or technology-enhanced learning (Mahmood et al., 2025; Sheffield et al., 2025), rather than combining these elements into a structured vocational learning platform. This gap indicates the need for a digital platform that supports aviation communication competence in vocational education.

Unlike a general learning management system that mainly distributes materials or a generic speaking-practice tool that focuses on pronunciation and fluency without an aviation competency framework, E-IELP was designed around ICAO language proficiency descriptors and aeronautical communication tasks. Its novelty lies in integrating scenario-based task packages, spoken-response recording, lecturer feedback, and performance-based assessment in one workplace-oriented platform for aeronautical communication cadets. Therefore, the platform is not only a digital repository but also a competency-based practice environment that connects aviation English, radiotelephony scenarios, and vocational assessment.

In Indonesia, the development of such a platform is particularly relevant because aviation vocational institutions need accessible and scalable learning media that can support cadets' professional competence (Rochmawati & Rosyid, 2025; Sylvia et al., 2024). An aviation vocational polytechnic in Indonesia requires learning media that are aligned with the curriculum, institutional learning culture, and ICAO language proficiency standards (Pane et al., 2025). A web-based platform can provide cadets with flexible access to aviation communication materials and enable lecturers to supervise learning through structured tasks and feedback (Afonso et al., 2025; Fussell & Thomas, 2021).

To address this gap, the present study developed a web-based electronic ICAO English language proficiency (E-IELP) platform for aviation communication training. The platform provides interactive learning activities, including radiotelephony read-back, situation analysis, conversation-based questions, storytelling based on aviation illustrations, responses to communication problems,

emergency communication tasks, and speaking activities related to aviation operational scenarios. These activities were designed to help cadets practice aviation communication competence through authentic and structured digital learning. Accordingly, this study addresses the following research questions: (1) How can a competency-based E-IELP platform be developed to support aviation communication training in vocational education? (2) To what extent is the E-IELP platform feasible and practical based on expert judgment and cadet responses? and (3) To what extent does the E-IELP platform improve cadets' aviation communication performance compared with conventional online instruction?

This study aims to (1) develop a competency-based E-IELP platform for aviation communication training in vocational education, (2) validate the feasibility of the E-IELP platform through expert judgment and user responses, and (3) evaluate the effectiveness of the E-IELP platform in improving cadets' aviation communication performance. The findings are expected to contribute to digital vocational learning, particularly in aviation communication training. Practically, the E-IELP platform may support aviation polytechnics in providing flexible, authentic, and competency-oriented learning experiences. Theoretically, this study contributes to the discussion on technology integration, competency-based learning, performance-based assessment, and work readiness in vocational education. The results and conclusion are therefore organized around these three objectives: platform development, feasibility and practicality, and effectiveness.

METHOD

This study employed a research and development design based on the ADDIE model, followed by a quasi-experimental pre-test–post-test control-group evaluation to develop and examine a competency-based Electronic ICAO English Language Proficiency (E-IELP) platform for aviation communication training (Almelhi, 2021; N. Li et al., 2024; Lim, 2025; Pasupuleti, 2024). The development process followed the five stages of ADDIE—analysis, design, development, implementation, and evaluation—which provide a systematic framework for developing instructional products and aligning learning needs, instructional activities, assessment, and evaluation (Spatioti et al., 2022; Yu et al., 2021). The subsequent quasi-experimental evaluation was used to examine the effectiveness of the developed platform. Because the participants belonged to existing classes, individual random assignment was not feasible. The treatment group therefore used E-IELP as a supplementary digital learning platform, whereas the control group received conventional online instruction. Both groups completed a pre-test and post-test to assess changes in aviation communication performance.

The study was conducted at an aviation vocational polytechnic in Indonesia during a scheduled four-week IELP preparation program. The site was selected because its aeronautical communication program requires cadets to develop professional communication competence aligned with the ICAO Language Proficiency Requirements. Participants were 48 full-time aeronautical communication cadets from the same instructional program and academic cohort, comprising two intact classes of 24 cadets each. One class served as the treatment group and the other as the control group. The groups followed the same course sequence, IELP preparation schedule, syllabus, learning objectives, lecturer-guided schedule, and assessment preparation plan.

All participants had completed elementary and pre-intermediate English courses and had prior exposure to basic aeronautical communication and radiotelephony phraseology. The inclusion criteria were completion of these English courses, basic knowledge of grammar and sentence construction, and prior introduction to basic aeronautical communication and radiotelephony phraseology. These criteria ensured that participants had the prerequisite knowledge needed to engage in ICAO-aligned communication training. Individual age and gender data were not retained in the analytic dataset; consequently, participant characteristics could only be described at the program and cohort levels. Two lecturers with expertise in aviation English and aeronautical communication administered the learning activities, performance tests, and interviews to maintain alignment between the instructional and assessment procedures and the aviation vocational context.

Platform development began with an analysis of cadets' learning needs and curriculum requirements. A 20-item needs-analysis questionnaire, rated on a five-point Likert scale from 1

(strongly disagree) to 5 (strongly agree), was used to examine cadets' perceptions of existing IELP learning media and their expectations for digital learning. Curriculum needs were explored through a focus group discussion involving aviation English lecturers and the Head of the Aeronautical Communication Study Program. The discussion identified relevant communication materials, learning objectives, competencies, and task types required for IELP preparation. These findings informed the design of the platform's learning flow, task sequence, interface, learning materials, practice activities, and assessment components. The resulting task structure included radiotelephony read-back, situation analysis, conversation-based questions, storytelling based on aviation illustrations, responses to communication problems, emergency communication tasks, and speaking activities based on aviation operational scenarios.

During the development stage, these components were incorporated into a web-based platform containing digital learning packages, speaking tasks, response-recording features, task instructions, lecturer-feedback facilities, and aviation communication practice materials. The prototype was evaluated by three experts: a registered IELP rater, a learning-media development expert, and an aeronautical communication expert. Expert validation focused on face and content validity and was conducted using a 10-item validation sheet (Mananggit et al., 2026). The indicators addressed the relevance of content to ICAO language proficiency descriptors, accuracy of aviation communication scenarios, clarity of task instructions, alignment between learning tasks and performance assessment, suitability of lecturer-feedback features, interface readability, navigation, accessibility, and suitability for autonomous practice. Each item was rated on a four-point scale (1 = not valid, 2 = less valid, 3 = valid, and 4 = very valid). Mean scores were interpreted as 1.00–1.75 = not valid, 1.76–2.50 = less valid, 2.51–3.25 = valid, and 3.26–4.00 = very valid. For analytical clarity, the 10 indicators were organized into four domains—content validity, task–assessment alignment, media usability, and learning support—and were rated individually before the overall mean validation score was calculated.

Following expert validation, the platform was implemented with the treatment group under lecturer guidance. Cadets were introduced to the platform, created user accounts, explored its learning features, completed assigned tasks, recorded spoken responses, and received lecturer feedback. The intervention lasted four weeks and comprised eight scheduled IELP preparation sessions of approximately 90 minutes each. Learning combined synchronous guidance with asynchronous practice, allowing cadets to engage with aviation communication tasks during and outside guided sessions. Both groups received the same instructional duration, topic coverage, lecturer support, and comparable task difficulty.

The primary difference concerned the instructional medium and feedback mechanism. The treatment group used the structured E-IELP platform to access learning packages, complete aviation communication tasks, record spoken responses, and receive integrated lecturer feedback. In contrast, the control group received lecturer explanations, participated in discussions, and completed comparable IELP-related activities through conventional online instruction without the platform's structured task packages, recording features, or integrated feedback system. Individual time-on-platform logs were not analyzed; accordingly, exposure to E-IELP was treated as structured instructional exposure rather than as a measure of individual usage intensity. After the four-week intervention, both groups completed a post-test containing tasks comparable in structure to those used in the pre-test but based on different topics to reduce the likelihood of memorization.

Data were collected using six sources or instruments: the cadets' needs-analysis questionnaire, curriculum needs analysis, expert validation sheet, cadets' response questionnaire, aviation communication performance test, and semi-structured interview guide. The post-implementation response questionnaire used a five-point Likert scale and examined ease of use, content completeness, interface quality, task clarity, and the overall learning experience. The aviation communication performance test served as both the pre-test and post-test and consisted of 10 tasks representing the types of activities provided through E-IELP. These tasks assessed listening and speaking performance in ICAO-aligned aviation communication contexts. The scoring rubric incorporated six ICAO language proficiency descriptors: pronunciation, structure, vocabulary, fluency, comprehension, and interaction. Each task received a single composite performance score on a five-point scale, with 1 representing very low performance and 5 representing very high

performance. The six descriptors informed the overall task-level judgment rather than being scored as separate subscales, and the final performance score was calculated as the mean of the 10 task scores.

Before scoring, the two lecturers calibrated their interpretation of the rubric and followed the same descriptor-based scoring procedure. Ambiguous responses were reviewed against the ICAO descriptors and resolved through consensus. Separate independent rater scores were not retained; consequently, inter-rater agreement statistics such as the intraclass correlation coefficient (ICC) or weighted kappa could not be calculated. Independent post-hoc rescoring was also not possible because the original performance recordings were unavailable in the archived study materials, which contained only the final consensus scores. The performance scores should therefore be interpreted as calibrated consensus ratings rather than as evidence of independently established inter-rater agreement. This limitation introduces potential rater bias and scoring dependence that cannot be quantified. The performance test had previously been piloted with 24 cadets and demonstrated high internal consistency (Cronbach's $\alpha = .877$). The semi-structured interviews with cadets and lecturers complemented the quantitative measures by exploring user experience, platform usability, learning engagement, lecturer feedback, and suggestions for further improvement (Killingback et al., 2020; Leung et al., 2022).

Quantitative and qualitative data were analyzed according to their respective purposes (Pilcher & Cortazzi, 2024). Descriptive statistics, including means, standard deviations, and percentages, were used to summarize the needs-analysis questionnaire, expert validation, cadets' responses, and performance scores. Expert-validation scores were interpreted using the predefined feasibility categories (Syamala et al., 2025), whereas the needs-analysis and cadet-response questionnaires were summarized using descriptive statistics and mean-percentage categorization. For the quasi-experimental evaluation, baseline comparability between the intact classes was examined using Welch's independent-samples t-test on the pre-test scores. Within-group changes from pre-test to post-test were assessed using paired-samples t-tests, while post-test differences between the treatment and control groups were examined using Welch's independent-samples t-test (Sarmiento-Campos et al., 2022; Wan & Lian, 2026). Effect sizes were reported alongside significance tests to support interpretation: Hedges' g was calculated for between-group comparisons and Cohen's d^z for within-group pre-test–post-test comparisons. Statistical significance was set at $p < .05$, with probability values below .001 reported as $p < .001$.

Qualitative interview data were analyzed thematically through familiarization, coding, initial theme generation, theme review, theme definition, and reporting (Ahmed et al., 2025; Naeem et al., 2023). The qualitative findings were used to elaborate on the quantitative results, particularly participants' experiences of platform usability, learning engagement, lecturer feedback, and aviation communication practice (Rizvi et al., 2025; Shonfeld et al., 2025). The curriculum focus-group data were likewise examined thematically to identify the communication topics, learning objectives, and competencies that informed platform development. Table 1 summarizes the alignment among the study objectives, data sources, instruments, analytical procedures, and expected outputs. Ethical procedures were followed throughout the study. Institutional permission was obtained before data collection; participants were informed about the purpose and procedures of the research, participation was voluntary, and questionnaire and performance data were anonymized and reported only in aggregate form. The institutional permission letter provided formal authorization for data collection within this classroom-based educational development study.

Table 1. Data Sources, Objectives, Instruments, and Analysis Techniques

Data source	Objective	Instrument format	Analysis technique	Output
Cadets' needs analysis questionnaire	To identify cadets' perceptions of existing IELP learning media and expectations for the E-IELP platform	20-item questionnaire using a five-point Likert scale	Descriptive statistics and mean percentage categorization	Cadets' needs for digital aviation communication learning media
Curriculum needs analysis	To identify aviation communication materials, learning objectives, and competencies required for platform development	Focus group discussion guideline	Thematic analysis of FGD notes	List of ICAO-aligned aviation communication topics and competencies
Expert validation sheet	To assess the feasibility of the E-IELP platform before implementation	10-item validation sheet using a four-point rating scale	Scoring categorization	Face validity and content validity of the platform
Cadets' response questionnaire	To examine cadets' responses after using the E-IELP platform	Questionnaire using a five-point Likert scale	Descriptive statistics and mean percentage categorization	Practicality and user acceptance of the platform
Aviation communication performance test	To measure cadets' aviation communication performance before and after the intervention	Listening and speaking performance test consisting of 10 ICAO-aligned tasks	Descriptive statistics, paired-samples t-test, and Welch's independent-samples t-test	Learning gains and comparison between treatment and control groups
Interview guide	To obtain qualitative data supporting the quantitative findings	Semi-structured interview guide	Thematic analysis	User experience, learning engagement, perceived benefits, and suggestions for improvement

RESULTS AND DISCUSSION

Needs Analysis for a Competency-Based E-IELP Platform

The needs analysis showed that cadets perceived the existing IELP learning media as insufficient to support flexible and authentic aviation communication practice. As summarized in Table 2, the aggregate score for previous learning media was low ($M = 1.6639$; $M\% = 33.29\%$). In contrast, cadets expressed very high expectations for digital learning media that were interactive, accessible regardless of time and place, motivating for autonomous learning, and aligned with aviation communication competencies ($M = 4.6806$; $M\% = 93.62\%$).

These results indicate that the E-IELP platform responded to a practical need in aviation vocational education (Rosyid et al., 2025). The low evaluation of previous learning media appears to reflect several instructional problems: limited access to practice materials outside class, limited authenticity of workplace communication scenarios, lack of integrated speaking-recording facilities, insufficient immediate or structured lecturer feedback, and limited variation in emergency or non-routine aviation communication tasks. In contrast, the high expectation score reflected cadets' need for flexible access, varied aviation scenarios, task clarity, and lecturer feedback. These needs are directly related to vocational communication competence because cadets must practice not only language forms but also workplace-oriented responses in routine and non-routine aviation situations.

Table 2. Summary of cadets' needs analysis

Aspect	N	SD	M	M%	Category
Former IELP learning media	48	.12705	1.6639	33.29%	Low
Expected digital learning media	48	.10159	4.6806	93.62%	Very high

Development of the E-IELP Platform

The curriculum needs analysis identified 40 aviation communication topics to be included in the learning packages, such as belly landing, bad weather, divert, engine fire, hijack, bird strike, go-around, engine failure, fuel shortage, volcanic ash, obstacle on runway, and other routine and non-routine aviation scenarios. These topics were used to design competency-based learning tasks aligned with ICAO Language Proficiency Requirements (International Civil Aviation Organization, 2016).

The platform was developed as a web-based learning environment that allows cadets to access learning packages, complete speaking tasks, record responses, and receive lecturer feedback. To clarify the interface pathway, each learning package followed a visible sequence: topic selection, task instruction, prompt display, oral response recording, lecturer feedback, and score review. Figure 1 illustrates the main learning task flow in the E-IELP platform, while Figure 2 provides interface examples showing the entry page and task dashboard used by cadets to begin and navigate the test sets. The screenshots clarify how cadets move from initial access, user identification, and course selection to task-set selection, task directions, and speaking-task completion within a structured aviation communication practice environment. Table 3 presents the main task types and their vocational learning functions. These tasks position the platform as a digital vocational learning medium that supports authentic practice, autonomous learning, and performance-based assessment rather than merely a technical website.

E-IELP learning task flow



Structured digital practice connects task completion, feedback, and performance assessment.

Figure 1. E-IELP Learning Task Flow

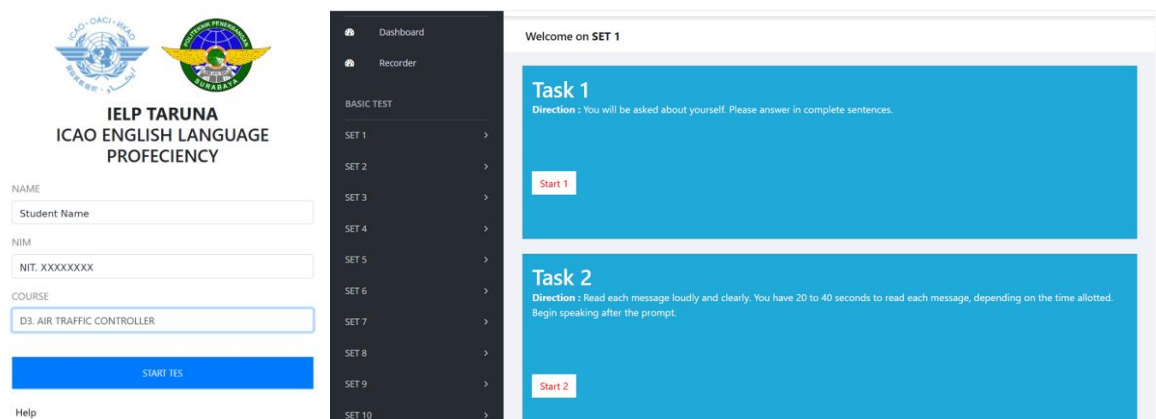


Figure 2. Interface examples of the E-IELP platform: (a) entry page for user identification and test initiation; (b) task dashboard showing the test sets and speaking-task flow

Table 3. Competency-based Learning Tasks in the E-IELP Platform

No.	Task type	Vocational learning function
1	Introduction	Provides orientation to the aviation communication topic in each package
2	Radiotelephony read-back	Trains pronunciation, clarity, and accuracy in routine aviation communication
3	Situation analysis	Develops the ability to interpret visual aviation situations and respond orally
4	Conversation-based questions	Trains comprehension of pilot-ATC interaction and spoken response
5	Storytelling from aviation illustrations	Develops fluency, sequence organization, and situation explanation
6	Response to communication problems	Trains clarification, problem-solving, and plain language use
7	Emergency communication response	Develops communication performance in non-routine and high-pressure situations
8	Malfunction system handling	Trains structured responses to operational problems
9	Opinion-based speaking task 1	Develops argumentation and professional communication confidence
10	Opinion-based speaking task 2	Strengthens fluency, interaction, and extended spoken response

Expert Validation and User Responses

The E-IELP platform was validated by three experts before implementation. As shown in Table 4, the mean validation score was 3.83 on a four-point scale, which falls into the very valid category based on the predefined scoring interval. The validators considered the content, interface, learning tasks, and alignment with aviation communication competencies to be appropriate for implementation. However, because only three validators were involved, the validation result should be interpreted as initial expert-feasibility evidence rather than broad external validation. The summary scores therefore support the instructional feasibility of the prototype in this study context, while further validation with more experts and item-level reporting is recommended in subsequent development. To make the validation basis more transparent, the feasibility claim is limited to the ten predefined indicators and should not be generalized to all possible aspects of digital aviation-English platforms.

Cadets also provided highly positive responses after using the platform. Table 5 shows that the highest response was related to ease of use, followed by completeness of materials, interface quality, ease of undertaking IELP practice, and overall learning experience. The overall mean per item was 4.93, with an aggregate percentage of 98.68%, indicating very high satisfaction and suggesting that the platform was practical and acceptable for aviation vocational education. Nevertheless, this exceptionally high score should be interpreted cautiously because novelty effects, social desirability, and cadets' positive expectations toward a new digital platform may have influenced responses. To reduce response bias, the questionnaire was administered anonymously, responses were not linked to course grades, and results were analyzed in aggregate form.

Table 4. Expert Validation Results

Expert	Qualification	Validation score	Category
1	Registered IELP rater	3.80	Very valid
2	Learning media development expert	4.00	Very valid
3	Aeronautical communication expert	3.70	Very valid
Mean	-	3.83	Very valid

Table 5. Cadets' Responses After Using the E-IELP Platform

Aspect	N	SD	M	M%	Category
Ease of using the platform	24	.00000	5.0000	100.00%	Very high satisfaction
Completeness of materials	24	.20412	4.9583	99.16%	Very high satisfaction
User-friendly interface	24	.20412	4.9583	99.16%	Very high satisfaction
Ease of undertaking IELP practice	24	.28233	4.9167	98.34%	Very high satisfaction
Overall learning experience	24	.38069	4.8333	96.66%	Very high satisfaction
Overall mean per item	24	-	4.9333	98.68%	Very high satisfaction

Effectiveness of the E-IELP Platform

The effectiveness of the E-IELP platform was evaluated using a pre-test–post-test control-group design. The treatment group used the E-IELP platform, while the control group received conventional online instruction. The design is summarized in Table 6.

Table 6. Control and Treatment Group Design

Group	Pre-test	Learning activity	Post-test
Control	Yes	Conventional online instruction	Yes
Treatment	Yes	Conventional guidance supported by the E-IELP platform	Yes

Before the intervention, the pre-test means of the control and treatment groups were relatively close ($M = 2.0000$ and $M = 1.8750$, respectively), indicating comparable initial performance at a descriptive level. A preliminary Welch's independent-samples t-test confirmed that the pre-test difference between the two groups was not statistically significant, $t(45.760) = 1.000$, $p = .323$, Hedges' $g = 0.28$. Because intact classes were used, this result was interpreted as evidence of baseline comparability rather than random equivalence. Table 7 shows that the control group improved from $M = 2.0000$ in the pre-test to $M = 2.2083$ in the post-test, while the treatment group improved from $M = 1.8750$ to $M = 4.0833$. Although both groups improved, the treatment group's gain was substantially larger.

Table 7. Descriptive Statistics of the Control and Treatment Groups

Group	N	Pre-test SD	Pre-test M	Post-test SD	Post-test M
Control	24	.41703	2.0000	.41485	2.2083
Treatment	24	.44843	1.8750	.28233	4.0833

Welch's independent-samples t-test showed a significant difference between the post-test scores of the control and treatment groups, $t(40.542) = -18.305$, $p < .001$, as presented in Table 8. The between-group effect size was very large, Hedges' $g = 5.20$. This value was retained after recalculating the standardized mean difference from the post-test mean difference and pooled standard deviation. However, it should be interpreted cautiously because the study involved a relatively small sample, a single institutional context, a five-point performance scale, and relatively small post-test standard deviations. The treatment group's post-test mean of 4.0833 on a five-point scale, together with its small standard deviation ($SD = .28233$), indicates restricted score dispersion near the upper end of the scale. The raw post-test mean gap between groups was 1.875 points, whereas the pooled variability was small; this combination mechanically inflates a standardized mean difference. Score compression and a possible ceiling effect may therefore have contributed to the exceptionally large value.

Compared with recent technology-enhanced language-learning evidence, the magnitude is unusual. A meta-analysis of 40 empirical studies reported a pooled Hedges' g of 0.812 for AI-supported English-language learning (Xu & Wang, 2024), while another meta-analysis of 49 studies reported a weighted standardized mean difference of approximately 0.982 for AI-supported second-language learning (Wu, 2024). In a recent quasi-experimental study of AI-enhanced blended speaking instruction, the overall between-group effect on speaking performance was partial eta squared = .07, with component effects of .07 for pronunciation and .06 for accuracy (Lai, 2026). Although these effect-size metrics are not directly interchangeable, they describe moderate-to-large effects rather than a standardized mean difference exceeding five. The present result may reflect the

combined influence of structured task repetition, scenario-specific practice, integrated lecturer feedback, the bounded response scale, restricted score dispersion, possible ceiling effects, and consensus-based scoring rather than the platform effect alone. Consequently, Hedges' g should not be interpreted as a stable population estimate until the finding is replicated using broader performance scales, blinded independent raters, larger samples, and multi-site designs. The result therefore indicates a strong instructional effect in this specific context rather than a generalizable estimate for all aviation vocational settings. Nevertheless, the result indicates that cadets who used the E-IELP platform achieved higher aviation communication performance than cadets who received conventional online instruction.

Table 8. Welch's Independent-samples t-test for Post-test Scores

Comparison	Levene's F	t	df	p	Effect size
Control post-test vs. treatment post-test	6.607	-18.305	40.542	< .001	Hedges' $g = 5.20$

The paired-samples t-test results in Table 9 show that the control group also demonstrated a statistically significant improvement from pre-test to post-test, $t(23) = -2.460$, $p = .022$, Cohen's $d^2 = 0.50$. In Table 9, SD refers to the standard deviation of the paired differences. Therefore, conventional instruction should not be interpreted as ineffective. However, the treatment group showed a much stronger improvement, $t(23) = -21.256$, $p < .001$; Cohen's $d^2 = 4.34$, indicating that structured use of the E-IELP platform provided stronger support for learning gains.

Table 9. Paired-samples t-test Results

Group comparison	SD difference	t	df	p	Interpretation	Effect size
Control pre-test and post-test	.41485	-2.460	23	.022	Significant but limited improvement	Cohen's $d^2 = 0.50$
Treatment pre-test and post-test	.50898	-21.256	23	< .001	Significant and larger improvement	Cohen's $d^2 = 4.34$

Qualitative Findings and Discussion

The interview data supported the quantitative results by showing that cadets perceived the E-IELP platform as accessible, useful, and relevant to their aviation communication practice. Three coded themes were identified from the interviews: flexible access to practice, authentic aviation communication tasks, and the value of lecturer feedback. One cadet stated that the web-based E-IELP platform helped users learn ICAO-standardized English more effectively and suggested that the platform could be introduced beyond the institution after further development. This response indicates that the platform was perceived not only as a test preparation tool but also as a learning medium that could support aviation communication training.

Anonymized interview excerpts further supported these themes. One cadet stated, "The platform helped me practice ICAO English more often because I could access the tasks outside class." Another cadet commented, "The aviation scenarios and lecturer feedback made the speaking practice closer to real communication situations." These excerpts illustrate how cadets perceived flexible access, authentic aviation-related tasks, and lecturer feedback as useful features of the learning experience.

Cadets and lecturers also identified several areas for improvement. The most frequently mentioned needs were a more attractive interface, more varied practice questions, clearer operational procedures, and richer features. These suggestions are important for vocational learning because repeated exposure to varied scenarios can help learners transfer competence from one situation to another. In aviation communication training, learners should be able to respond to different pictures, audio prompts, emergency situations, and communication problems rather than memorizing a limited set of responses.

From the perspective of vocational education, the findings suggest that the E-IELP platform supports three important dimensions (Budiarto et al., 2024; Primartadi et al., 2026). First, it supports competency-based learning by providing tasks aligned with aviation communication requirements.

Second, it supports authentic learning through workplace-related scenarios such as radiotelephony read-back, emergency communication, and malfunction situations. Third, it supports performance-based assessment by requiring cadets to complete speaking and listening tasks that reflect communicative performance rather than merely answering written questions. These features are consistent with technology-enhanced vocational and professional learning, in which digital media are expected to support practice, feedback, competence demonstration, and work-oriented learning transfer (Alptekin & Taneri, 2025; Marzalius & Jasril, 2026; Mohammad, 2026; Tran & Ma, 2025).

The greater improvement in the treatment group can be explained by the integration of repeated practice, authentic task design, digital access, and lecturer feedback. Compared with conventional online instruction, the platform required cadets to produce spoken responses, review task instructions, and receive guidance within a structured learning environment. This integration is important for vocational education because it links knowledge, practice, feedback, and assessment in ways that resemble workplace-oriented competence development.

The significant improvement in the control group should also be interpreted carefully. Conventional online instruction may still contribute to learning because cadets received exposure to IELP-related materials, lecturer explanation, and practice tasks. In addition, test familiarity and general learning progression may have contributed to the improvement. However, the larger gain in the treatment group suggests that conventional instruction alone may be less effective than instruction supported by a competency-based digital platform.

The findings have practical implications for aviation vocational institutions. E-IELP can be used as supplementary learning media to support cadets' preparation for ICAO language proficiency requirements and workplace communication tasks (Mohammad, 2026). For lecturers, the platform can facilitate task collection, learner monitoring, and formative feedback (Ada, 2021). For institutions, it offers a scalable learning resource that may reduce dependence on purely synchronous practice and provide more flexible access to authentic aviation communication materials (Wiboolyasarin et al., 2025).

Limitations and Future Development

This study has several limitations. First, the participants were limited to cadets from one aviation vocational institution, which may restrict generalizability. Second, although the intervention duration was specified as four weeks with eight 90-minute sessions, detailed individual time-on-platform and session-intensity records were not analyzed separately. Third, the aviation communication performance test was developed by the researchers, although its internal consistency was examined and the rater procedures were standardized through rubric calibration. Fourth, formal inter-rater reliability could not be calculated because the original performance recordings were not available in the archived study materials used for post-hoc analysis and independent rater-level scores were not retained; only the final consensus-score dataset was available.

Consequently, possible rater bias and scoring dependence remain threats to internal validity. Future studies should retain separate rater-level scores, independently double-score a prespecified subset of performances, and calculate ICC, weighted kappa, or another appropriate agreement index. Fifth, the study did not examine long-term retention or actual certification outcomes. Sixth, the improvement in the treatment group may have been influenced by the novelty of using a new digital platform. These limitations mean that the findings should be interpreted as preliminary, context-bound evidence of instructional effectiveness rather than proof of broad effectiveness across aviation vocational institutions. Future studies should include external benchmarks of aviation communication competence and stronger multi-site validation. The absence of separate demographic-equivalence testing also reinforces the need to interpret the group comparison as quasi-experimental evidence rather than randomized experimental evidence.

Future research should conduct multi-site implementation across aviation vocational institutions, examine long-term effects on IELP certification outcomes, and compare different platform features through experimental or design-based research. Further development may also integrate gamification, automatic speech recognition, pronunciation feedback, adaptive learning analytics, and richer scenario banks to support aviation communication competence more comprehensively (W. Li, 2025; Tsai, 2023; Z. Wang et al., 2024).

CONCLUSION

This study developed and evaluated a competency-based electronic ICAO English language proficiency (E-IELP) platform as a supplementary digital learning platform for aviation communication training in vocational education. The platform was produced through the ADDIE stages and designed to provide ICAO-aligned learning activities that connect aviation communication scenarios, spoken performance, lecturer feedback, and assessment. The findings indicate that the platform was feasible and practical for instructional use in the study context. Expert validation showed initial content and face validity, cadet responses indicated very high satisfaction, and the effectiveness test demonstrated that the treatment group achieved substantially higher post-test performance than the control group. Although conventional online instruction also produced a significant but limited improvement, the larger gain in the treatment group suggests that E-IELP may provide stronger support for aviation communication performance when integrated into structured IELP preparation. The study contributes to digital vocational learning by offering an empirically evaluated prototype for integrating workplace communication tasks, feedback, and performance assessment into aviation communication training. Practically, the platform may help aviation vocational institutions provide more authentic and flexible learning experiences for cadets preparing for ICAO language proficiency requirements. Future studies should confirm these findings through multi-site implementation, longer interventions, independent-rater assessment, individual usage analytics, and external proficiency benchmarks.

AUTHOR CONTRIBUTIONS STATEMENT

This journal uses the Contributor Roles Taxonomy (CRediT) to recognize individual author contributions, reduce authorship disputes, and facilitate collaboration.

Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
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C : Conceptualization

M : Methodology

So : Software

Va : Validation

Fo : Formal analysis

I : Investigation

R : Resources

D : Data Curation

O : Writing - Original Draft

E : Writing - Review & Editing

Vi : Visualization

Su : Supervision

P : Project administration

Fu : Funding acquisition

CONFLICT OF INTEREST STATEMENT

The authors declare that they have no known competing financial or non-financial interests that could have appeared to influence the work reported in this paper.

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