

Development of Quizizz-based Interactive Learning Media and Assessment to Enhance Critical Thinking Skills in Avionic Training

Hardinata¹, Yayat Ruhiat², Lukman Nulhakim³, Cucu Atikah⁴

1. Universitas Sultan Ageng Tirtayasa, Serang, Indonesia; nata.hardi@gmail.com

2. Universitas Sultan Ageng Tirtayasa, Serang, Indonesia; yruhiat09@gmail.com

3. Universitas Sultan Ageng Tirtayasa; Serang, Indonesia lukman.nulhakim@untirta.ac.id

4. Universitas Sultan Ageng Tirtayasa; Serang, Indonesia cucuatikah@untirta.ac.id

ARTICLE INFO

Keywords:

avionic training assessments;
HOTS in aircraft maintenance;
quizizz-based assessments;
critical thinking skills

Article history:

Received 2025-04-25

Revised 2025-05-28

Accepted 2025-12-23

ABSTRACT

Modern aircraft maintenance requires technicians to demonstrate higher-order thinking skills (HOTS) to diagnose and resolve complex avionic system failures. However, assessment practices in vocational avionic training often emphasize procedural recall rather than analytical and evaluative reasoning. This study addresses this gap by developing and evaluating Quizizz-based interactive learning media and HOTS-oriented assessments tailored to avionic training contexts. A research and development approach employing the ADDIE model was implemented using a pre-experimental one-group pretest-posttest design. The study involved 22 avionic trainees at the Lion Group Training Center, Tangerang. Data were collected through expert validation, trainee questionnaires, interviews, and pretest-posttest assessments. Statistical analyses included normality testing, paired-sample t-tests, and N-Gain analysis. Expert validation indicated high feasibility of the developed media, with acceptance rates of 83% from media experts and 88% from material experts, while trainee responses reached 86%. Descriptive statistics showed a substantial increase in posttest mean scores compared to pretest results. The paired-sample t-test revealed a statistically significant improvement in critical thinking skills ($p < 0.05$). The N-Gain score (mean = 0.58) indicated a moderate-to-high level of learning improvement. The findings suggest that scenario-based, gamified assessments delivered through Quizizz effectively support the development of critical thinking skills in avionic training. This study highlights the potential of integrating HOTS-oriented digital assessments in vocational education while recommending further multi-site and longitudinal research to strengthen generalizability.

This is an open access article under the [CC BY-NC-SA](https://creativecommons.org/licenses/by-nc-sa/4.0/) license.



Corresponding Author:

Hardinata

Universitas Sultan Ageng Tirtayasa, Serang, Indonesia; nata.hardi@gmail.com

1. INTRODUCTION

Modern aircraft operations are increasingly dependent on sophisticated avionic systems that integrate digital electronics, sensors, and embedded software to ensure safety, efficiency, and regulatory

compliance. As aircraft systems become more complex, aviation maintenance technicians are no longer required merely to follow procedural manuals but must also demonstrate strong higher-order thinking skills (HOTS), including analysis, evaluation, inference, and decision-making, particularly when diagnosing system malfunctions and performing troubleshooting tasks (Victor et al., 2018). Consequently, avionic training programs—especially within vocational and professional education contexts—must prioritize the development of critical thinking skills that align with authentic workplace demands rather than rely on rote memorization or recall-based assessments.

In vocational aviation education, assessment practices play a crucial role in shaping trainees' cognitive development. However, conventional assessment methods in avionic training often emphasize factual recall and procedural knowledge, while offering limited opportunities for trainees to engage in analytical reasoning or scenario-based problem solving (DKPPU, 2017; Kusuma et al., 2018). Such approaches are insufficient for preparing technicians to address real-world challenges, where system faults rarely present themselves in isolation and often require integrative reasoning across multiple subsystems. This gap highlights the need for assessment models that are explicitly designed to measure and train HOTS within authentic avionic contexts.

Technology-enhanced assessment platforms have emerged as promising tools for addressing these challenges. Gamified digital platforms, such as Quizizz, have been shown to increase learner engagement, motivation, and formative feedback quality while supporting the development of critical thinking through interactive and adaptive assessment mechanisms (Zuhriyah & Pratolo, 2020; Zhang & Crawford, 2023). Prior studies report that Quizizz-based assessments can enhance students' analytical and reflective thinking skills in general education settings, including science, language learning, and vocational subjects (Nashar et al., 2021; Holisoh et al., 2023). Nevertheless, existing research predominantly focuses on general classroom contexts and rarely examines how such platforms can be systematically adapted to the highly specialized and safety-critical domain of avionic maintenance training.

Moreover, while multiple-choice questions (MCQs) are often criticized for assessing lower-level cognition, recent studies suggest that MCQs can effectively measure higher-order thinking when they are carefully designed using realistic problem scenarios, plausible distractors, and context-rich stimuli (Kerkman & Johnson, 2014). In avionic training, scenario-based MCQs that simulate troubleshooting situations—such as navigation system failures, signal inconsistencies, or component malfunctions—offer significant potential to assess trainees' diagnostic reasoning and decision-making skills. However, empirical research examining the validity and effectiveness of HOTS-oriented MCQs specifically tailored to avionics troubleshooting remains limited.

To address this gap, this study integrates the ADDIE instructional design model with a Quizizz-based assessment framework to develop and validate scenario-driven HOTS MCQs for avionic maintenance training. The novelty of this research lies in its focus on (1) a vocational avionic training context, (2) the systematic integration of HOTS indicators into technical troubleshooting scenarios, and (3) the use of validated MCQs designed to reflect authentic avionics problem-solving processes. By situating digital assessment within real-world aviation maintenance scenarios, this study aims to contribute both methodologically and pedagogically to the advancement of technology-enhanced assessment in vocational and technical education.

Specifically, this study seeks to design, develop, and evaluate Quizizz-based interactive learning media and assessment instruments to enhance critical thinking skills among avionic trainees at the Lion Group Training Center in Indonesia. Through expert validation, empirical testing, and learning outcome analysis, the study examines the feasibility, reliability, and effectiveness of scenario-based HOTS assessments in supporting cognitive development aligned with industry-relevant competencies.

2. METHODS

This study employs the Research and Development (R&D) methodology to develop Quizizz-based learning media and assessments, addressing the need for interactive and gamified evaluation tools in avionic training. Quizizz was selected due to its real-time feedback, adaptive questioning, and cross-device compatibility, enhancing engagement and critical thinking. Its automated grading system and multimedia integration ensure assessment reliability while supporting interactive problem-solving and decision-making, key competencies in aviation education.

To ensure a structured development process, this study adopts the ADDIE model—a systematic instructional design framework consisting of five stages: Analysis, Design, Development, Implementation, and Evaluation.

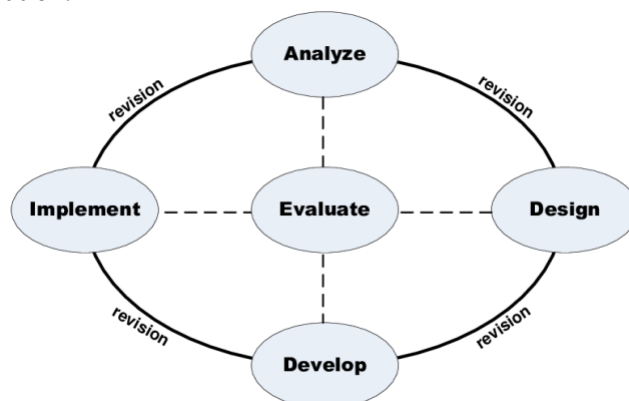


Figure 1. ADDIE Model procedure

Each phase contributes to maintaining the quality and relevance of the instructional media, guiding its refinement and applicability. To achieve the study's objectives, a needs assessment was conducted through observations and interviews with avionic instructors at the Lion Group Training Center (LGTC) in Tangerang. This assessment identified gaps in critical thinking evaluations, underscoring the necessity of incorporating technology-based solutions. The focus of this research is the development of Quizizz-based learning media and assessments of higher-order thinking skills (HOTS). A total of 22 students or trainees are undergoing a pretest–posttest evaluation to measure the effectiveness of Quizizz-based assessments in enhancing critical thinking skills.

In the avionics class, particularly in the "Aircraft Navigation System" lesson, an analysis identified learning needs and student characteristics, revealing a deficiency in supportive learning media and assessment tools. Consequently, a structured design was formulated to develop interactive learning media and quizzes that improve students' analytical and evaluative skills, ensuring alignment with the findings from the analysis and validation of material suitability through rigorous evaluation. The development stage encompassed the creation and expert validation of learning materials and quiz content, incorporating multimedia elements such as video clips and interactive components to enrich student engagement and understanding. Following refinement based on expert feedback, the learning media and assessments were implemented in the avionics class, utilizing a pre-test-post-test methodology to evaluate their impact on students' comprehension and critical thinking. A comprehensive evaluation was conducted to assess the effectiveness of the developed learning media and quizzes, identifying areas that need improvement to enhance understanding and critical thinking skills.

To assess the effectiveness, quality, and feasibility of the Quizizz-based learning media, a comprehensive set of research instruments was utilized. These tools ensure a structured evaluation, addressing both content validity and student engagement. The key instruments include: Expert Validity Assessments, HOTS Indicators Grid, HOTS Multiple-Choice Questions (MCQs) reliability, N-Gain

analysis, and the Student Response Analysis. Data from response analysis informs adjustments to learning media for optimal educational impact. The instrument grid details and analysis are as follows.

2.1 Material Expert Instrument

This instrument consists of 12 statements evaluating various aspects and indicators to assess the quality, relevance, and accuracy of the learning materials.

Table 1. Material Expert Instruments Grid

No.	Aspects	Item`s Indicator	Item No.
1	Relevance to Learning Objective	Clear alignment with the learning objectives supports the achievement of learning goals.	1
		Relevant to the subject matter and course requirements.	2
		Promotes critical thinking and problem-solving.	3
2	Content Accuracy	Reliable sources/references and up-to-date information.	4
		Correct terminology and definitions.	5
		Content reflects current standards and practices	6
3	Alignment with Standards	Consistent with educational/training standards.	7
		Aligns with curriculum frameworks and guidelines.	8
		Meets the expectations of educational/training authorities and stakeholders.	9
4	Language	Grammatically correct and free of spelling errors.	10
		Language is easy to read and understand	11
		The sentence structure was varied and engaging.	12

(Arikunto, 2018)

2.2 Media Expert Instrument

This instrument evaluates the feasibility of product development based on design, visual presentation, and reliability aspects. The following grid outlines the assessment criteria for media experts.

Table 2. Media Expert Instruments Grid

No.	Aspects	Item`s Indicator	Item No.
1	Visual Appeal and Design	Suitability of media design to learning objectives.	1
		Appropriate use of colors and fonts.	2
		Clear and visually appealing layout.	3
2	User-Friendly Interfaces	Clear and concise instructions for users	4
		Responsive design suitable for various devices (e.g., smartphones, tablets, computers).	5
		User feedback is easily accessible and functional.	6
3	Engaging Interactivity	Interactive elements that encourage active participation.	7
		Effective use of quizzes, polls, and other interactive tools.	8
		Activities that foster critical thinking and problem-solving.	9
4	Technical Functionality	Consistent and reliable performance.	10
		Quick loading times and smooth operation.	11
		Compatibility with various platforms and operating systems.	12

(Arikunto, 2018)

2.3 CT's Pre-Test and Post-Test Instrument

This instrument assesses the effectiveness of the learning tool in enhancing critical thinking skills. The evaluation is based on Facione's (2000), critical thinking indicators, including interpretation, analysis, evaluation, inference, and explanation.

Table 3. CT's Pre-Test and Post-Test Instrument Grid

CT Indicator	Assessment Criteria	Questions/Statements	Item No.
Interpretation	Understanding and clarifying the meaning of information.	A basic understanding of navigation system concepts.	1, 2
			3, 4
Analysis	Examining ideas and identifying arguments	Troubleshooting, starting from identifying components or system problems in a navigation system.	5
			6, 7
			8
Evaluation	Assessing the credibility of statements and reliability of sources	Questions about rectification and technical problem-solving in the aircraft navigation system.	9
			10, 11
			12
Inference	Draw conclusions based on the available information.	Questions that ask trainees to draw logical conclusions from given navigation system data.	13
			14, 15
			16
Explanation	Justifying methods and presenting arguments	Questions that ask trainees to explain procedures or the reasons behind certain actions.	17
			18, 19
			20

(Arikunto, 2018)

2.4 Students' Response Instrument

This instrument measures students' agreement with statements evaluating key assessment aspects, including engagement, user-friendliness, learning enhancement, and critical thinking.

Table 4. Students' Response Instruments Grid

Aspects	Indicator	Item No.
Engagement	Actively participated in learnings, Maintained sustained interest, and Interactive elements engagement.	1, 2, 3
User-Friendliness	Interface is intuitive, instructions are clear, and the design is efficient and accessible.	4, 5, 6
Learning Enhancement	Content improved understanding, Facilitated the acquisition of new skills, and deepened the overall learning experience.	7, 8, 9
Aspects	Indicator	Item No.
Critical Thinking	Strengthened the analytical abilities, encouraged effective problem-solving, and stimulated reflective decision-making.	10, 11, 12

(Arikunto, 2018)

This study employs a mixed-method approach, integrating qualitative and quantitative analysis to ensure comprehensive evaluation. Thematic coding was applied to qualitative data, providing structured insights, while expert assessments validated content feasibility and accuracy. Practicality evaluations were analyzed descriptively, and paired-sample t-tests were conducted to assess learning outcomes related to critical thinking. The following section details the analytical methods utilized:

Experts' Validity Analysis – A formula and criterion aspect were applied to assess the accuracy and reliability of expert evaluations, ensuring the data and instruments meet required standards. The following section details its components and calculations.

$$\text{Validity Expert (\%)} = \frac{\text{Total Score Achieved}}{\text{Total Score Expected}} \times 100\% \quad (1)$$

The following table is used as a validation benchmark to determine the category level or criteria as a result of evaluation by experts.

Table 5. Expert Validity Criteria

Percentage Range (%)	Category
81 – 100	Very Good
61 – 80	Good
41 – 60	Sufficient
21 – 40	Poor
0 – 20	Very Poor

(Sugioyono, 2015)

HOTS MCQs Analysis – This analysis evaluates the quality of Higher-Order Thinking Skills (HOTS) multiple-choice questions (MCQs) by assessing their validity and reliability. Validity ensures that the test measures its intended cognitive construct, while reliability reflects the consistency of test results across different administrations. The validity of question items is examined using Karl Pearson's product-moment correlation formula, which determines the relationship strength between item scores and overall test performance (Yayat Ruhiat, 2024).

$$r_{xy} = \frac{n\sum xy - (\sum x)(\sum y)}{\sqrt{\{n\sum x^2 - (\sum x)^2\}\{n\sum y^2 - (\sum y)^2\}}} \quad (2)$$

where:

r_{xy} = Pearson's correlation coefficient of question items.

x = Grain score ; y = Total score ; n = Number of samples.

The results obtained through the application of the formula mentioned above are subsequently organized and classified according to the criteria outlined in the table below.

Table 6. Criteria of question items' validity

Coefficient of Correlation	Validity Criteria
$r_{\text{calculate}} > r_{\text{table}}$	Valid
$r_{\text{calculate}} \leq r_{\text{table}}$	Not Valid

The reliability of the assessment tool was evaluated to determine the internal consistency of question items in measuring cognitive abilities. The reliability of multiple-choice questions was assessed using the Kuder-Richardson formula 20 (KR-20), which is suitable for dichotomous items, while Cronbach's alpha, analyzed in SPSS 26, was applied to ensure overall consistency in measuring students' critical thinking skills. This combined approach validates the accuracy and stability of the instrument for assessing higher-order thinking.

$$r_i = \frac{K}{K-1} \left[1 - \frac{\sum p_i q_i}{st^2} \right] \quad (3)$$

Where:

r_i = KR₂₀ reliability index (coefficient).

K = Number of items on the test.

p_i = Proportion of the examinees passing items.

q_i = 1 – p_i (proportion of the examinees failing items).

st^2 = Total variance of scores.

The calculated reliability results were assessed based on established criteria, providing a comprehensive benchmark for evaluating the test's consistency and accuracy. Table 7 outlines the standards used to ensure the reliability of the assessment tool.

Table 7. Criteria of the Reliability Test

KR 20 Values	Interpretation
≥ 0.90	Excellent
0.80 - 0.89	High
0.70 - 0.79	Average
0.60 - 0.69	Low
< 0.60	Unacceptable

(Sugioyono, 2015)

N-Gain Analysis – The effectiveness of Quizizz-based learning media and assessment tool in enhancing critical thinking skills is evaluated through pre-test and post-test score comparisons. The N-Gain test quantifies improvement relative to the maximum possible gain, with student performance analyzed using specific calculations outlined below.

$$\text{Normalize (N) – Gain} = \frac{\text{Post test Score} - \text{Pre test Score}}{\text{Maximum Score} - \text{Pre test Score}} \quad (4)$$

Table 8. Categorizes the effectiveness of a learning intervention based on the calculated N-Gain score.

Table 8. Degree of N-Gain Score

N-Gain Score (g)	Qualification Degree
$g > 0.7$	High
$0.3 \leq g \leq 0.7$	Moderate
$g < 0.3$	Low

(Sugioyono, 2015)

Student Response Analysis – Observers assessed the feasibility of the research implementation, with the percentage of assessment execution calculated using the formula provided below.

$$\text{Appropriateness (\%)} = \frac{\text{total score}}{\text{maximum of total score}} \times 100\% \quad (5)$$

The calculation results of the appropriateness percentage of students whose responses were interpreted according to the categories presented in Table 9 below.

Table 1. Interpretation Criteria of Student Responses

Implementability (%)	Rating Category
90 – 100	Excellent
80 – 89	Good
70 – 79	Sufficient
60 – 69	Less Adequate
< 60	Not Adequate

(Arikunto, 2018)

3. FINDINGS AND DISCUSSION

3.1 Finding

The development research resulted in a Quizizz-based learning medium and a critical thinking skills assessment instrument for avionic trainees in aircraft navigation systems. The assessment tool

comprises 20 scenario-based multiple-choice questions (MCQs) designed to evaluate higher-order thinking skills (HOTS). The ADDIE development model, consisting of five stages: Analyze, Design, Development, Implementation, and Evaluation, guides the structured development process.

3.1.1 Analyze Stage

The analysis begins with a comprehensive review of literature on interactive learning media and higher-order thinking skill assessments to enhance critical thinking. A needs analysis follows, conducted through observations and interviews with an avionic instructor at the Lion Group Training Center (LGTC) in Tangerang. Findings reveal that avionic trainees had not been assessed for critical thinking skills, with prior assessments relying on Computer-Based Testing (CBT) for online settings and paper-based methods for offline settings. Researchers then identify key concepts, aligning learning objectives with critical thinking subskill indicators to establish a framework for developing learning media and assessment tools.

3.1.2 Design Stage

The Quizizz-based learning media and assessments were designed following established product standards, ensuring reliability in learning design, appearance, content, presentation, and language. A flowchart outlined process dynamics, while a storyboard structured illustrations, descriptions, and quiz formats for the web-based interactive interface. The media development phase focused on aircraft navigation system content, integrating objectives, summaries, quizzes, and pre-/post-tests for web and smartphone platforms. Design tasks included creating images, layouts, videos, teaching materials, and quiz content uploaded to Quizizz. Validity experts assessed and validated the learning media and assessment tools.

3.1.3 Development Stage

During the development phase, expert validation was conducted to establish the validity of the learning media and assessment instruments. Experts evaluated the developed products, providing recommendations for refinement. Validation sheets were utilized to document expert judgments on media and material validity, determining the necessity for revisions or suitability for limited testing. The outcomes of this expert validation are presented below:

Material Expert Result

Table 10. Summary of Material Expert Validation Result

Evaluation Aspect	Score (out of 5)	Percentage	Rating Category
Relevance to Learning Objective	4.67	93%	Excellent
Content Accuracy	4.33	87%	Good
Alignment with standards	4.33	87%	Good
Linguistic	4.00	80%	Good
Average Score	4.42	88%	Good

Table 10 demonstrates that the learning materials achieved good evaluation results, indicating strong expert validation across all assessed criteria. Experts confirmed the materials' accuracy, relevance to learning objectives, alignment with established standards, usability, skill assessment efficacy, practicality, and comprehensiveness. These findings substantiate that the developed materials are effective and appropriate for evaluating and enhancing critical thinking skills.

Media Expert Result

Table 11. Summary of Media Expert Validation Result

Evaluation Aspect	Score (out of 5)	Percentage	Rating Category
Visual Appeal and Design	4.00	80%	Good
User-friendly interfaces	4.33	87%	Good
Engaging Interactivity	4.33	87%	Excellent
Technical Functionality	3.67	73%	Sufficient
Average Score	4.17	83%	Good

Based on Table 11, media expert validation indicates high quality and effectiveness. Expert feedback highlights the tool's engaging design, interactivity, user-friendly interface, well-integrated multimedia elements, and technical functionality. However, technical functionality may be affected by factors such as internet speed, hardware limitations, and the learning curve required for users to fully understand its operation. Despite these challenges, the results confirm the learning media and assessment tool's suitability for enhancing and evaluating students' critical thinking skills in educational and training settings.

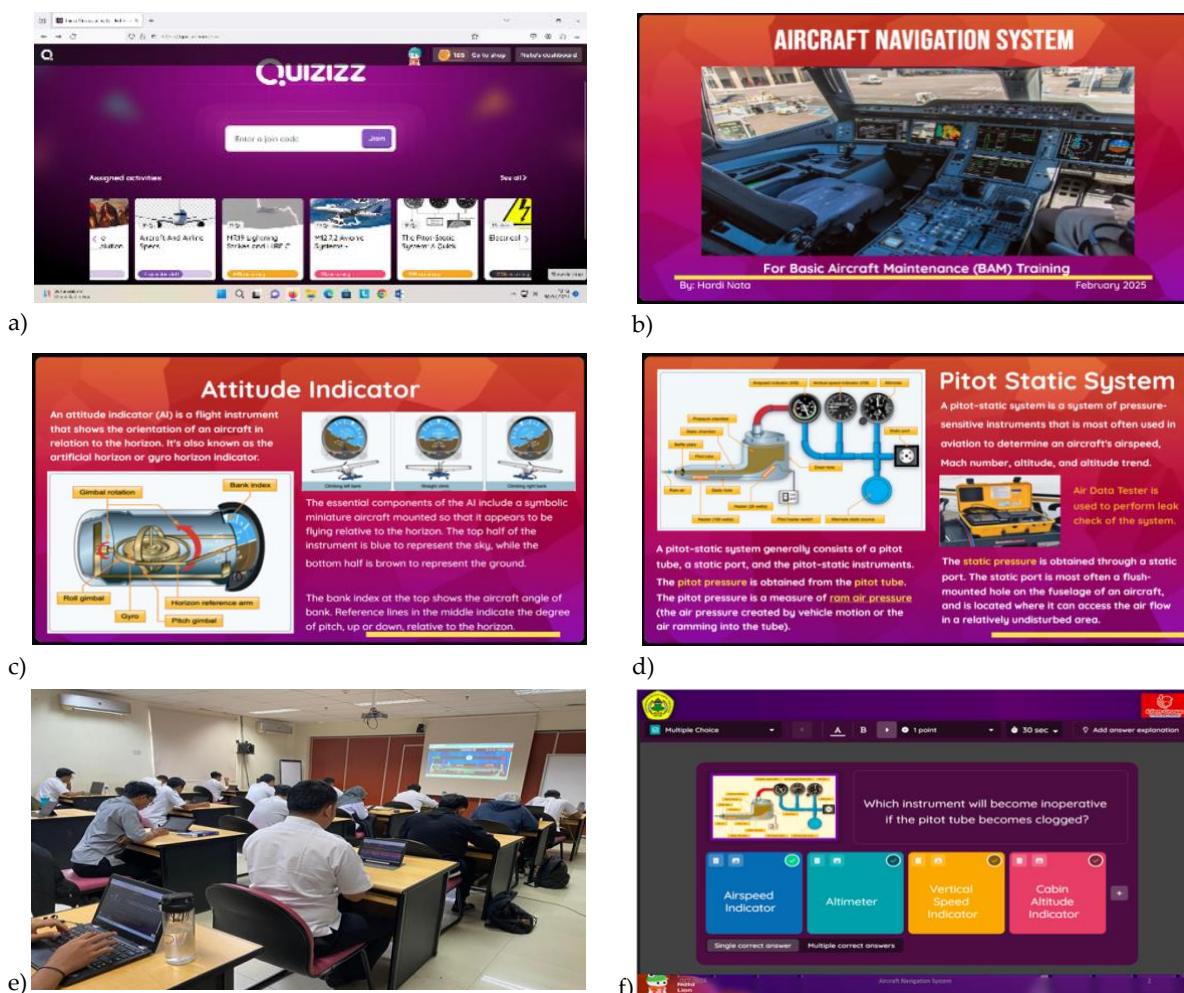


Figure 2. The presentation of Learning Media and Evaluation: a) Quizizz Application, b) First page Learning Material, c) Material 1, d) Material 2, e) Student interface, and f) Multiple-Choice Question (MCQ) Assessment.

The images showcase the refined learning media and assessment formats, designed to align with learning objectives and critical thinking indicators. Optimized through an iterative process, these tools were integrated into Quizizz to enhance engagement and cognitive skill development.

Validity Test Result

Following a limited trial, the validity of the test items was assessed using the product-moment correlation formula, as introduced by Karl Pearson. The validity of the multiple-choice questions (MCQs) was further analyzed using the biserial point correlation formula in Microsoft Excel. The final results of this analysis are presented in the table below:

Table 12. MCQs Validity Test Result

Multiple-choice questions (MCQs)			
Test Item	R-account (Rxy)	R-table	Validity Criteria
1	0.572	0.432	Valid
2	0.468	0.432	Valid
3	0.536	0.432	Valid
4	0.498	0.432	Valid
5	0.524	0.432	Valid
6	0.572	0.432	Valid
7	0.498	0.432	Valid
8	0.457	0.432	Valid
9	0.479	0.432	Valid
10	0.593	0.432	Valid
11	0.448	0.432	Valid
12	0.423	0.432	Valid
13	0.551	0.432	Valid
14	0.436	0.432	Valid
15	0.468	0.432	Valid
16	0.436	0.432	Valid
17	0.448	0.432	Valid
18	0.479	0.432	Valid
19	0.479	0.432	Valid
20	0.480	0.432	Valid

Based on Table 12, the validity analysis data indicate that all multiple-choice test items were valid, as the R-account values exceeded the R-table thresholds. Reliability was determined based on student test results. The validity analysis of multiple-choice question test items was conducted using the biserial point correlation formula (CORREL function) in Microsoft Excel. Items were considered valid if the biserial correlation coefficient (r) was more significant than the R-table value. The R-value of the product-moment table was determined based on the number of subjects and a 5% significance level.

Reliability Test Result

The results of the reliability testing analysis, based on data from small-scale trials, are summarized in the following table.

Table 13. Reliability Test Result

Cronbach's Alpha Based on		
Cronbach's Alpha	Standardized Items.	N of Items
0.843	0.700	20

The reliability results, calculated using the Kuder-Richardson formula, indicated strong internal consistency, with the Cronbach's Alpha of 0.843 for the limited-scale test. This suggests that the multiple-choice instrument effectively assesses higher-order thinking skills with high reliability.

3.1.4 Implement Stage

This stage involves implementing the learning media and assessment tools in a real-world educational or training setting. It includes administering pre-tests and post-tests to students and collecting data on their performance in critical thinking skills.

Effectiveness Test Result

The effectiveness of learning media and higher-order thinking skills (HOTS) assessment tools is evaluated through a structured pre-test and post-test analysis. The collected data are analyzed using statistical methods in SPSS 26, including the normality test, the pretest-posttest comparison, the paired-sample t-test to determine significant differences, and the N-Gain test to quantify learning improvement.

Normality Test

The normality test using Kolmogorov-Smirnov and Shapiro-Wilk was conducted to assess whether the pre-test and post-test scores follow a normal distribution. Since the total sample size is less than 50, specifically 22 students, the Shapiro-Wilk test was selected as the appropriate normality test instead of Kolmogorov-Smirnov, which is typically used for larger samples. The results are as follows:

Table 14. Test of Normality Result

	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pretest CT's MCQs	.162	22	.138	.947	22	.270
Posttest CT's MCQs	.200	22	.022	.913	22	.053

a. Lilliefors Significance Correction

Based on Table 14, from the Shapiro-Wilk significance value (p-value) result, the pre-test score ($p = 0.270$) and the post-test score ($p = 0.053$) are more than 0.05, indicating the data is normally distributed.

Practicality Test

The descriptive statistics of pre-test and post-test scores provide an overview of students' performance before and after the implementation of the learning media and HOTS assessment tools.

Table 15. Pre-test and Post-test Result

	Descriptive Statistics					
	N	Minimum	Maximum	Sum	Mean	Std. Deviation
Pretest CT's MCQs	22	52.00	72.00	1388.00	63.0909	5.07946
Posttest CT's MCQs	22	76.00	92.00	1848.00	84.0000	4.93771
Valid N (listwise)	22					

Based on Table 15, the post-test mean (84.00) exceeds the pre-test mean (63.09), indicating improved understanding and critical thinking skills. The standard deviation reflects learning variability, while the higher maximum score highlights gain among high-achieving students. These descriptive statistics provide a foundation for further analysis, including the paired-sample t-test and N-Gain test, to assess the learning intervention's effectiveness.

Paired-Sample t-Test

The paired-sample t-test was conducted to evaluate the statistical significance of differences between pre-test and post-test scores after implementing the learning media and HOTS assessment tools. The results are as follows:

Table 16. Paired Samples t-Test Result

	Paired Differences					T	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower Upper				
Pair 1 Pretest CT's MCQs - Posttest CT's MCQs	-20.90909	1.71573	.36579	-21.66980	-20.14838	-57.161	21	.000

Based on Table 16, the mean difference between pre-test and post-test scores indicates a significant improvement in students' critical thinking skills. The t-value (-57.16) reflects the magnitude of this difference, while the p-value (0.000) confirms statistical significance ($p < 0.05$). These results validate the effectiveness of the Quizizz-based learning media and HOTS assessment tools in enhancing higher-order cognitive skills in avionic learning outcomes.

N-Gain Test

The N-Gain score was calculated to assess the effectiveness of the learning intervention in improving students' critical thinking skills. The results are presented as follows:

Table 17. N-Gain Score Result

	Descriptive Statistics					
	N	Minimum	Maximum	Sum	Mean	Std. Deviation
N_Gain_Score	22	.45	.71	12.66	.5754	.08133
N_Gain_Percent	22	45.45	71.43	1265.99	57.5449	8.13314
Valid N (listwise)	22					

Based on Table 17, the N-Gain score measures students' learning improvement relative to the maximum possible gain. The obtained score falls within the $0.3 \leq g \leq 0.7$ range, indicating moderate effectiveness. The average N-Gain value (0.58) demonstrates a substantial increase in post-test performance, classifying the learning enhancement within the medium-to-high criteria. These results confirm that the Quizizz-based learning media and HOTS assessment tools effectively enhance students' cognitive development and critical thinking skills in avionic learning.

Student Response Result

The following table presents the student response results regarding using learning media and the interactive HOTS (Higher-Order Thinking Skills) assessment. The practicality of assessment tools

positively impacted learning outcomes and critical thinking skills by enhancing students' engagement and participation.

Table 18. Student Response Result

Aspect	Average Score (out of 5)	Positif Feedback	Remark / Comment
Engagement	4.50	90%	Students found the tools engaging and interactive
User-friendliness	4.50	90%	Majority of students reported ease of use
Learning Enhancement	4.25	85%	Students experienced an improvement in learning
Critical Thinking Skills	4.00	80%	Tools effectively promoted critical thinking
Average:	4.31		Overall Percentage: 86%

Based on Table 3.9, the overall positive feedback indicates that the learning media and assessment tools are well-designed and effective in enhancing critical thinking skills and improving student learning experiences. Students expressed a high level of satisfaction with the interactive HOTS assessments, noting that the tools were engaging, user-friendly, and contributed significantly to their learning. These overwhelmingly positive responses suggest that the learning media and assessments are successful in fostering critical thinking skills.

3.1.5 Evaluation Stage

At the evaluation stage of the ADDIE model, researchers conduct a comprehensive assessment to determine the feasibility and effectiveness of the developed learning media and interactive HOTS assessment in enhancing students' critical thinking skills. This evaluation involves examining the practicality and usability of the media in field tests, as well as analyzing students' performance and engagement. An expert review is also conducted, where subject matter experts assess the validity, and reliability of the assessment items, ensuring their effectiveness in measuring higher-order thinking skills. Student feedback is crucial in refining the materials and enhancing their effectiveness and engagement. Combining expert reviews and student input provides a well-rounded analysis of the learning media's impact and areas for further improvement.

Discussion

The findings of this study demonstrate that the integration of Quizizz-based interactive assessments significantly improved avionic trainees' critical thinking skills, as indicated by increased post-test scores, a moderate-to-high N-Gain, and positive learner responses. While these results align with prior research reporting the effectiveness of gamified digital assessments in enhancing higher-order cognitive skills (Nashar et al., 2021; Wahyuni et al., 2023), the present study extends existing knowledge by situating these outcomes within a specialized vocational avionic training context. This contextual specificity is critical, as cognitive demands in avionics differ substantially from those in general academic disciplines due to the safety-critical and system-oriented nature of aviation maintenance tasks.

One key explanation for the effectiveness of Quizizz lies in its capacity to combine immediate feedback, adaptive pacing, and gamified elements within formative assessment practices. Immediate feedback allows trainees to reflect on incorrect reasoning and adjust their cognitive strategies in real time, which is essential for developing analytical and evaluative thinking (Zhang & Crawford, 2023). In contrast to traditional paper-based or static computer-based tests commonly used in avionic training, Quizizz promotes active cognitive engagement by requiring learners to interpret problem scenarios, evaluate response alternatives, and make decisions under time constraints. These features align with

cognitive theories of learning that emphasize active processing, metacognitive regulation, and feedback-driven learning as prerequisites for higher-order thinking development (Facione, 2015).

The avionic training context itself plays a decisive role in shaping how higher-order thinking skills are developed and assessed. Avionic maintenance tasks typically involve diagnosing faults across interconnected systems rather than addressing isolated problems. Consequently, the scenario-based MCQs developed in this study—focused on aircraft navigation systems and troubleshooting cases—encouraged trainees to analyze system behavior, infer causal relationships, and evaluate corrective actions. This contextualized assessment approach supports situated cognition theory, which posits that knowledge and thinking skills are best developed within authentic task environments (Kerkman & Johnson, 2014). Compared to generic HOTS assessments reported in previous Quizizz studies conducted in general education settings (Zuhriyah & Pratolo, 2020; Holisoh et al., 2023), the avionics-specific scenarios in this study likely contributed to deeper cognitive engagement and more meaningful learning outcomes.

Despite the widespread criticism that multiple-choice questions primarily assess lower-order cognitive skills, the findings of this study provide evidence that MCQs can effectively measure higher-order thinking when designed using realistic technical scenarios and well-constructed distractors. This supports earlier arguments that MCQs, when grounded in problem-based contexts, can assess analysis, evaluation, and inference rather than mere recall (Kerkman & Johnson, 2014). In avionic training, where standardized assessment formats are often required for certification and compliance, the use of HOTS-oriented MCQs offers a pragmatic solution that balances cognitive rigor with operational feasibility.

From a theoretical perspective, this study contributes to the growing body of literature on technology-enhanced assessment by demonstrating how gamified platforms can be aligned with higher-order cognitive frameworks, such as Facione's critical thinking model, within vocational education. The integration of HOTS indicators into scenario-driven assessments reinforces the argument that digital tools should not merely digitize traditional tests but should be intentionally designed to support complex cognitive processes. However, the study remains limited in its ability to establish causal relationships due to the absence of a control group and reliance on a one-group pretest-posttest design. This methodological constraint necessitates cautious interpretation of effectiveness claims and highlights the need for quasi-experimental or experimental designs in future research.

Practically, the findings suggest that vocational training institutions and aviation training centers can leverage Quizizz as a feasible and scalable assessment tool to enhance critical thinking without requiring extensive infrastructure or software installation. For instructors, the platform facilitates rapid assessment, automated scoring, and data-driven feedback, enabling more responsive instructional decision-making. Nevertheless, successful implementation depends on instructors' ability to design high-quality, scenario-based questions that accurately reflect workplace challenges. Without such pedagogical alignment, the benefits of gamification may be reduced to superficial engagement rather than substantive cognitive development.

In summary, this study underscores that the effectiveness of Quizizz in enhancing higher-order thinking skills is not inherent to the platform itself but emerges from the interaction between technological affordances, pedagogical design, and the specific cognitive demands of avionic training. By embedding HOTS-oriented assessments within authentic troubleshooting scenarios, this research demonstrates a pathway for advancing assessment practices in vocational and technical education while acknowledging the theoretical and methodological limitations that warrant further investigation.

4. CONCLUSION

This study demonstrates that the ADDIE model provides an effective framework for developing Quizizz-based interactive learning media and higher-order thinking skills (HOTS) assessments in

avionic training contexts. The findings indicate that the developed assessments are valid, reliable, and effective in enhancing trainees' critical thinking skills, learning outcomes, and engagement through scenario-based, gamified evaluation. Despite these positive results, the study is limited by its reliance on a single training cohort, the absence of a comparison group, and a focus on multiple-choice assessments, which restricts the generalizability of findings and the exploration of broader cognitive expressions such as open-ended problem-solving. In addition, the study did not examine long-term retention or sustained engagement, which are critical factors in vocational competency development. Future research should employ experimental or quasi-experimental designs across multiple training sites, integrate mixed-method approaches, and explore diverse assessment formats to better capture complex cognitive processes and evaluate the long-term impact of gamified digital assessments in vocational and technical education.

REFERENCES

- Balqis, A. S., & Andriani, A. E. (2024). Development of Learning Evaluation Based on Automatic Assessment through Quizizz Paper Mode to Improve Students' Natural and Social Sciences Learning Outcomes. *Jurnal Penelitian Pendidikan IPA*, 10(6), 3357–3366. <https://doi.org/10.29303/jppipa.v10i6.7251>
- Dewi, A. F., Handayani, S., & Garnadi, S. G. (2022). Implementation of Hots-Based Learning on Packaging Learning Material to Improve Critical Thinking Ability of Class X APHP 1 SMKN 1 Pacet. 165–181. <https://doi.org/10.17509/edufortech.v7i2>
- DKPPU. (2017). AC147- Mod. 13 Contents- Instrument and Navigation System. In *DKU, PKPPU* (2nd ed.).
- Facione, P. A. (2000). *The Disposition Toward Critical Thinking: Its Character, Measurement, and Relationship to Critical Thinking Skill*.
- Facione, P. A. (2015). *Critical Thinking: What It Is and Why It Counts*. <https://www.researchgate.net/publication/251303244>
- Firdaus, H., Syafrizal, S., & Nulhakim, L. (2024). Improving learning quality through the implementation of electronic teaching materials. *Journal of Education and Learning*, 18(3), 727–733. <https://doi.org/10.11591/edulearn.v18i3.21362>
- Gustini, H., Ruhiat, Y., & Nulhakim, L. (2023). Effectiveness Of Nearpod-Based Interactive Learning Media on Environmental Pollution To Train Critical Thinking Skills. *Universitas Sultan Ageng Tirtayasa*, 10(1).
- Haniko, P., Anggreini Sarumaha, Y., Satria, E., & Hs, N. (2023). Building Students' Critical Thinking Skill through Problem-Based Learning Model. *Jurnal Kajian Pendidikan FKIP Universitas Dwijendra*, 14(1), 92–98. <http://ejournal.undwi.ac.id/index.php/widyaaccarya/index>
- Harawi, W., Nasution, R., & Nasution, A. S. (2021). Quizizz: Science learning media in elementary school in developing critical thinking skills. In *Journal of Science Education Research Journal* (Vol. 2021, Issue 1). www.journal.uny.ac.id/jser
- Holisoh, A., Setiani, H., Firdaus, H., Nulhakim, L., & Ruhiat, Y. (2023). Analysis of the Need for Canva-Based Electronic Modules to Improve Vocational Learning Outcomes. *Jurnal Penelitian Pendidikan IPA*, 9(9), 6772–6779. <https://doi.org/10.29303/jppipa.v9i9.4514>
- Kadrija, R., Shatri, Z. G., & Këndusi, V. V. (2022). Effects of Critical Thinking Implementation on Enhancing of Teaching Quality. *Journal of Educational and Social Research*, 12(6), 236–245. <https://doi.org/10.36941/jesr-2022-0159>
- Kerkman, D., & Johnson, A. (2014). Challenging Multiple-Choice Questions to Engage Critical Thinking. *InSight: A Journal of Scholarly Teaching*, 9. <https://doi.org/10.46504/09201408ke>
- Kusuma, E. D., Gunarhadi, G., & Riyadi, R. (2018). The Strategies to Improve Critical Thinking Skills through Problem-Based Quantum Learning Model at Primary School. *International Journal of Multicultural and Multireligious Understanding*, 5(4), 123. <https://doi.org/10.18415/ijmmu.v5i4.213>

- Moore, B., & Stanley, Todd. (2018). *Critical thinking and formative assessments : increasing the rigor in your classroom*. Eye On Education.
- Nashar, Nurhasanah, A., & Fauzan, R. (2021). The Effectiveness of Critical Thinking Ability on the Basis of Quizizz Application Viewed from Problem Based Learning Model in History Learning of Senior High School. In N. A. F. R. Nashar (Ed.), *IOP Conference Series: Earth and Environmental Science* (Vol. 747, Issue 1). IOP Conference: Earth and Environmental Science. <https://doi.org/10.1088/1755-1315/747/1/012046>
- Pamela, A. A., & Hariani, D. (2021). The Development of Hots Assessment Instrument using Quizizz During Covid 19 Pandemic in 11th Grade Biology Second Semester. *Berkala Ilmiah Pendidikan Biologi (BioEdu)*, 11(1). <https://doi.org/10.26740/bioedu.v11n1.p107-115>
- Pujiastuti, L., Cathrin, S., & Wati, U. A. (2024). Teachers' Self-Efficacy and Professional Competence in Writing HOTS Questions Through In-House Training. *AL-ISHLAH: Jurnal Pendidikan*, 16(3). <https://doi.org/10.35445/alishlah.v16i3.5679>
- Puspita, T. Y. (2020). Development of Quizizz-based Learning Media on Basic Computer and Network Subjects. *Indonesian Journal Of Educational Research And Review*, 3, 106–112. <https://doi.org/10.23887/ijerr.v3i3.30949>
- Victor, C. H., Johnson, M. E., & Eismin, T. (2018). *A Hands-on Project for Avionics Systems Course in Aviation A Hands-on Project for Avionics Systems Course in Aviation Engineering Technology Program*. <https://digitalcommons.unomaha.edu/aviationfacprocPleasetakeourfeedbacksurveyat>: https://unomaha.az1.qualtrics.com/jfe/form/SV_8cchtFmpDyGfBLE
- Wahyuni, W., Mariatun, I. L., & Sholeh, Y. (2023). Development of Quizizz Game-Based Interactive Learning Media to Improve Learning Outcomes. *Edunesia: Jurnal Ilmiah Pendidikan*, 5(1). <https://doi.org/10.51276/edu.v5i1.545>
- Zhang, Z., & Crawford, J. (2023). EFL learners' motivation in a gamified formative assessment: The case of Quizizz. *Education and Information Technologies*, 29(5), 1–23. <https://doi.org/10.1007/s10639-023-12034-7>
- Zuhriyah, S., & Pratolo, B. W. (2020). Exploring students' views in the use of quizizz as an assessment tool in english as a foreign language (efl) class. *Universal Journal of Educational Research*, 8(11), 5312–5317. <https://doi.org/10.13189/ujer.2020.081132>