

Quizalize-Based Digital Assessment for Learning Motivation and Critical Thinking in SDG 4-Oriented IPAS Learning

Tri Mei Suci Setyaningsih^{1*}, Ngatmini¹, Joko Sulianto¹

¹Master of Elementary Education, Graduate School, Universitas PGRI Semarang (UPGRIS), Semarang, Indonesia.

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Corresponding Author:

Tri Mei Suci Setyaningsih

trimeisuci2020@gmail.com

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Abstract: Developing a valid and effective digital assessment instrument is essential for supporting SDG 4-oriented elementary education. This study aimed to develop and evaluate a Quizalize-based digital assessment instrument for measuring students' learning motivation and critical thinking skills in IPAS learning. A Research and Development (R&D) approach using the ADDIE model was employed, comprising the analysis, design, development, implementation, and evaluation stages. Data were collected through observations, interviews, expert validation sheets, student response questionnaires, the ARCS learning motivation questionnaire, and a Higher-Order Thinking Skills (HOTS)-based critical thinking test. Expert validation yielded a feasibility score of 91.11%, while the practicality test involving 30 fourth-grade students produced a score of 90.21%, indicating that the instrument was highly feasible and highly practical. Effectiveness testing involved 60 fourth-grade students, consisting of 30 students in the experimental group and 30 students in the control group. Critical thinking scores increased from 54.53 to 83.13, while the experimental group demonstrated significantly higher learning motivation than the control group ($M = 76.77$ vs. 66.57). Findings indicate that the Quizalize-based assessment instrument is feasible, practical, and effective for supporting digital assessment of learning motivation and critical thinking in elementary IPAS learning.

Keywords: Critical thinking; Digital assessment instrument; IPAS learning; Learning motivation; Quizalize

Introduction

Educational assessment has evolved from a simple measurement activity into an evidence-based system that supports instructional decision-making. In contemporary education, assessment is no longer intended merely to classify student performance, but to generate valid evidence of learning that can guide teachers in improving instruction (Sakdiah et al., 2023). Formative assessment theory emphasizes the continuous use of assessment evidence to identify students' learning needs and support further learning (Goertzen & Schils, 2023). From the perspective of measurement theory, the quality of an assessment instrument depends on validity, reliability, and construct alignment, ensuring that the instrument

accurately represents the competencies being measured, including both cognitive and affective domains.

The rapid advancement of digital technology has further transformed assessment practices in education. Digital assessment environments provide opportunities to improve the efficiency of data collection, scoring, feedback, and interpretation of learning outcomes. Learning analytics dashboards, for example, have been shown to enhance the interpretation of student learning progress in structured digital environments (Li et al., 2023). Similarly, gamified and adaptive assessment systems can increase students' engagement, participation, and learning performance by integrating features such as instant feedback, rewards, leaderboards, and personalized learning experiences (Zhang & Crawford, 2024; Cigdem et al., 2024). These developments indicate that digital assessment has the

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potential not only to improve assessment efficiency but also to support more meaningful learning experiences.

Learning motivation and critical thinking skills are two essential competencies in twenty-first-century education. Learning motivation encourages students to engage actively, persist in learning tasks, and achieve better learning outcomes, while critical thinking enables students to analyze information, evaluate evidence, solve problems, and make informed decisions. In elementary education, the development of these competencies is particularly important because students are in the foundational stage of forming learning habits and reasoning skills (Julianto et al., 2023). Recent studies have shown that digital learning environments and gamification strategies can support the development of critical thinking by increasing engagement, active participation, and problem-solving activities (Saputra et al., 2025). Inquiry-based and problem-based instructional approaches have also been found to improve elementary students' critical thinking abilities (Susilawati & Supriyatno, 2023).

The need to strengthen motivation and critical thinking is also relevant to the implementation of the Merdeka Curriculum in Indonesia. The curriculum emphasizes meaningful learning experiences, inquiry, collaboration, creativity, and higher-order thinking (Afifa et al., 2024). Integrated Science and Social Studies, or IPAS, as a core subject in elementary schools, provides opportunities for students to investigate real-world phenomena and construct knowledge through authentic learning experiences. Therefore, assessment in IPAS learning should not only measure conceptual understanding but also evaluate students' affective and higher-order cognitive competencies. In this context, digital assessment platforms offer promising opportunities to design assessment instruments that are more interactive, efficient, and aligned with twenty-first-century learning demands (Lafifa & Rosana, 2023).

However, despite the advancement of digital assessment, assessment practices in elementary education remain largely conventional and tend to focus on lower-order cognitive skills. Existing assessment practices often separate cognitive and affective measurement, resulting in fragmented learner profiles that are less useful for instructional decision-making (Putri & Susanti, 2026). This condition reflects a persistent conceptual tension between the theoretical expectation of integrated competency assessment and classroom practices that still rely on single-domain instruments. Schellekens et al. (2024) reported that many assessment programs fail to integrate multiple competency domains into a unified framework, while Kessels et al. (2024) emphasized that fragmented assessment reduces the accuracy of learner profiling and limits the effectiveness of instructional decision-making.

Previous studies have demonstrated the benefits of digital and gamified assessment in improving student engagement, motivation, learning achievement, and higher-order thinking skills. Technology-supported learning environments have been shown to promote critical thinking through interactive and inquiry-oriented learning activities (Mejia & Sargent, 2023), while structured digital learning activities can improve students' higher-order cognitive performance (Hsu et al., 2022). Other studies have also emphasized the role of scaffolded formative assessment, learning analytics, and technology-enhanced learning environments in strengthening students' engagement, self-regulation, and learning experiences (Psyllou et al., 2023). Nevertheless, most previous research has focused on the effectiveness of digital media or gamified learning activities rather than on the development of validated digital assessment instruments.

This gap is particularly evident in elementary IPAS learning, where limited attention has been given to the development of digital assessment instruments that simultaneously measure affective and higher-order cognitive domains. Existing studies generally examine learning motivation and critical thinking separately rather than integrating both constructs within a single assessment system (Atika & Purbosari, 2026). As a result, empirical evidence regarding the validity, practicality, and effectiveness of integrated digital assessment instruments for measuring students' learning motivation and critical thinking skills remains limited.

Therefore, this study addresses the identified gap by developing a Quizalize-based digital assessment instrument for elementary IPAS learning. The novelty of this study lies in the integration of gamified digital assessment features within Quizalize to simultaneously measure students' learning motivation as an affective domain and critical thinking skills as a higher-order cognitive domain (Lestari, 2023). This design shifts Quizalize from a gamified instructional tool into a structured psychometric assessment instrument aligned with formative assessment and measurement theory principles. Accordingly, this study aims to develop a Quizalize-based assessment instrument for IPAS learning and to examine its validity, practicality, and effectiveness in measuring elementary students' learning motivation and critical thinking skill (Utaminingsih et al., 2023).

Method

Research Design

This study employed a Research and Development (R&D) design using the ADDIE model, which consists of five stages: analysis, design, development, implementation, and evaluation. Li & Sun (2024) state

that the ADDIE model provides a systematic framework for developing educational instruments through structured and sequential stages. Spatioti et al. (2022) also emphasize that ADDIE is appropriate for instrument development because each stage supports the refinement and evaluation of the developed instrument.

In this study, the ADDIE model was used to develop a Quizalize-based digital assessment instrument for measuring students' learning motivation and critical thinking skills in IPAS learning. Quizalize was positioned strictly as a digital assessment instrument, not as a learning intervention. This position is in line with Black & Wiliam (2023), who explain that assessment functions as a process for collecting evidence of student learning to support evaluation and instructional decision-making.

Therefore, this study did not use a one-group pretest-posttest design because the purpose was not to examine the effect of Quizalize on improving students' competencies. The implementation stage was limited to instrument try-out, expert validation, revision, reliability testing, and practicality testing. The quality of the developed instrument was examined based on

validity, reliability, practicality, and feasibility as an assessment tool. This is consistent with Orak et al. (2023), who emphasize that the quality of an instrument should be supported by validity and reliability evidence before field implementation.

Research Setting and Participants

The study was conducted at SDN Gayam, Bogorejo District, Blora Regency, Central Java, Indonesia, during the 2025/2026 academic year. The participants were all 30 fourth-grade students enrolled in IPAS learning. Since the population was relatively small, this study used saturated sampling by involving the entire population.

This technique was chosen to avoid selection bias and to ensure that all students had equal opportunities to participate in the digital assessment trial. In line with Feters & Molina-Azorin (2023), clear participant selection is important to strengthen methodological consistency and the credibility of research data. Before data collection, permission was obtained from the school principal, classroom teacher, and students' parents, and all collected data were treated confidentially for research purposes.

Development Procedures

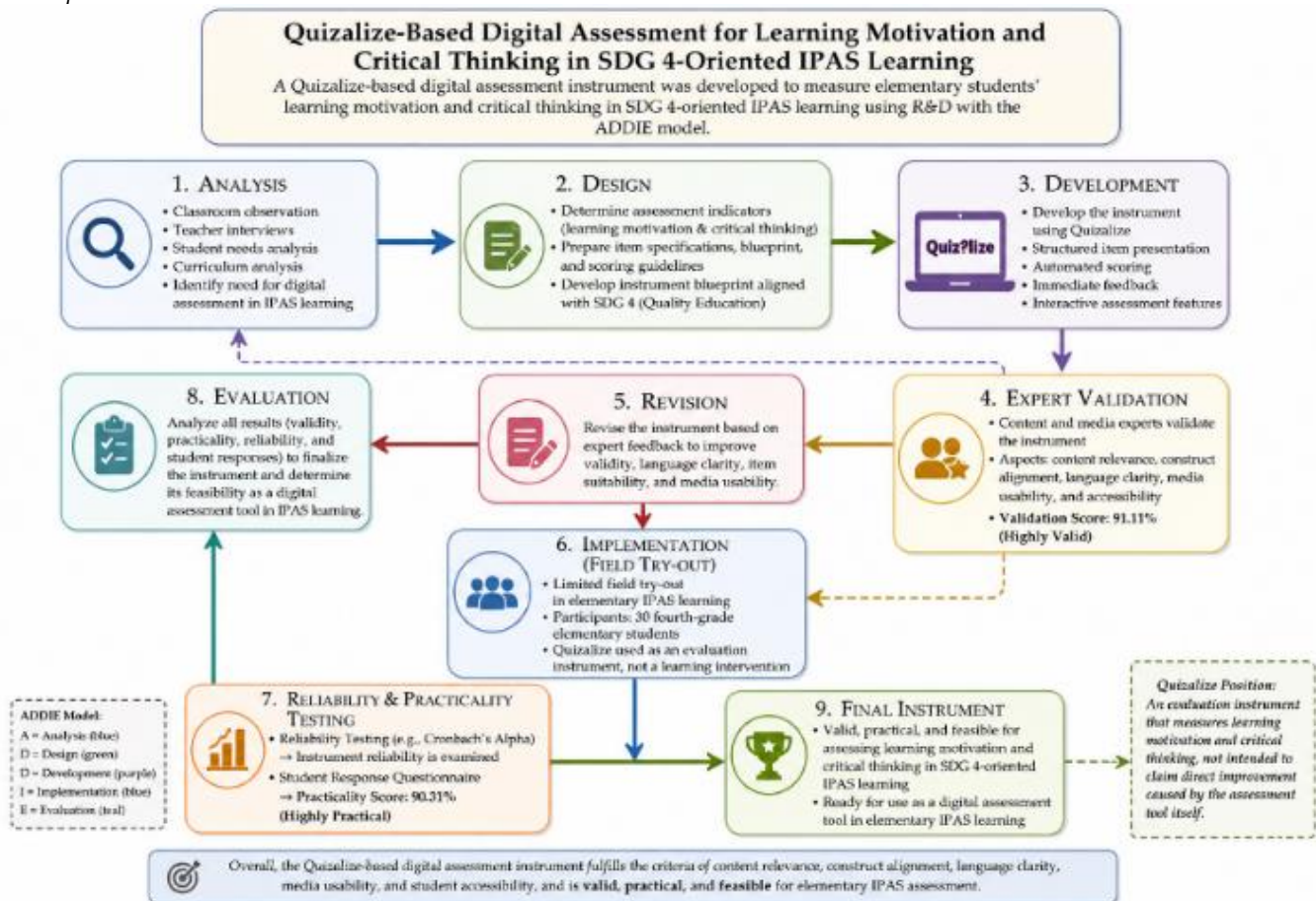


Figure 1. Development procedure of the Quizalize-based digital assessment instrument (Sari et al., 2024)

The development of the Quizalize-based digital assessment instrument was conducted using the ADDIE model, consisting of analysis, design, development, implementation, and evaluation stages. The ADDIE model was selected because it provides a systematic and iterative framework for designing, validating, revising, and evaluating educational assessment instruments. Li & Sun (2024) also emphasize that ADDIE supports structured instrument development because each stage contributes to the refinement of the final instrument.

In the analysis stage, classroom observation, teacher interviews, student needs analysis, and curriculum analysis were conducted to identify the need for a digital assessment instrument in IPAS learning. In the design stage, assessment indicators, item specifications, scoring guidelines, and instrument blueprints were prepared based on learning motivation and critical thinking constructs. In the development stage, the instrument was created using Quizalize and validated by content and media experts. The validation focused on content relevance, construct alignment, language clarity, item suitability, media usability, and feasibility (Kurniawan et al., 2024).

The implementation stage was limited to a field try-out of the developed assessment instrument with 30 fourth-grade students. This stage was not intended as a learning intervention, but as a procedure to examine the practicality, reliability, and usability of the instrument in a classroom assessment context. In the evaluation stage, expert feedback, student responses, reliability results, and practicality data were analyzed to revise and finalize the Quizalize-based digital assessment instrument. This procedure ensured that the developed instrument was evaluated based on its validity, reliability, practicality, and feasibility as a digital assessment instrument (Putri et al., 2023).

Research Instruments

The instruments used in this study were prepared based on the research needs and the stages of ADDIE development. Each instrument had a different function, including measuring students' learning motivation and critical thinking, assessing practicality, and validating the feasibility of the Quizalize-based digital assessment instrument (Rahmawati et al., 2024). The details are presented in Table 1.

Table 1. Research instruments

Instrument	Number of Items	Respondents	Purpose
Learning Motivation Questionnaire	20	Grade IV students	To measure students' learning motivation
Critical Thinking Skills Test (HOTS)	15	Grade IV students	To measure students' critical thinking skills
Student Response Questionnaire	16	Grade IV students	To assess the practicality of the developed instrument
Content Expert Validation Sheet	17	Content experts	To assess content validity and material feasibility
Media Expert Validation Sheet	19	Media experts	To evaluate media feasibility and usability

The learning motivation questionnaire was developed based on the ARCS motivational model, which includes attention, relevance, confidence, and satisfaction (Putra et al., 2024). The critical thinking skills test was developed based on critical thinking indicators, including interpretation, analysis, evaluation, inference, and explanation. The student response questionnaire was used to examine the practicality of the developed instrument, while content and media expert validation sheets were used to assess the validity and feasibility of the Quizalize-based digital assessment instrument (Martini et al., 2024).

Validity and Reliability Testing

Validity and reliability testing were conducted to ensure that the Quizalize-based digital assessment instrument met the required quality standards before field implementation. Instrument validity was examined through expert judgment involving content and media experts. The validation data were analyzed using descriptive percentage analysis to determine the feasibility of the instrument based on content relevance,

construct alignment, language clarity, item suitability, media usability, and overall feasibility. The validation result reached 91.11%, indicating that the instrument was highly valid. Reliability was examined using Cronbach's Alpha to measure the internal consistency of the instruments (Arifin & Wulandari, 2023). The learning motivation questionnaire obtained a Cronbach's Alpha coefficient of 0.934 for 20 items, while the critical thinking skills test obtained a coefficient of 0.911 for 15 items. These results indicate that both instruments were reliable and feasible for use in the field try-out.

Reliability testing was conducted using Cronbach's Alpha to examine the internal consistency of the learning motivation questionnaire and the critical thinking skills test. A coefficient of 0.70 or higher was considered acceptable (Suryani & Mahendra, 2024).

Data Collection

Data collection was conducted to obtain information on the development, validation, reliability, and practicality of the Quizalize-based digital

assessment instrument. The techniques included classroom observation, semi-structured interviews, expert validation sheets, student response questionnaires, learning motivation questionnaires, critical thinking skills tests, and documentation. Observation and interviews were used in the analysis stage to identify existing assessment practices, student characteristics, and the need for a digital assessment instrument in IPAS learning (Waluyo & Uska, 2024).

Expert validation sheets were used to assess content relevance, construct alignment, language clarity, item suitability, media usability, and feasibility. The validation results became the basis for revising the developed instrument before the field try-out. During the field try-out, all 30 students completed the student response questionnaire to examine practicality. The learning motivation questionnaire was used to measure students' motivational aspects, while the critical thinking skills test was used to measure students' critical thinking based on predetermined indicators (Mukti et al., 2025).

These instruments were used to collect measurement data on the quality and usability of the developed assessment instrument, not to prove learning improvement caused by Quizalize. The use of digital instruments in learning contexts requires clear design,

accessibility, and pedagogical suitability to support reliable data collection (Parsons et al., 2024).

Data Analysis Techniques

Data were analyzed using descriptive quantitative and qualitative techniques to examine the quality of the Quizalize-based digital assessment instrument. Expert validation data were analyzed using an expert validation percentage by comparing the obtained score with the maximum score and multiplying it by 100%. This analysis was used to determine the validity and feasibility of the instrument based on expert judgments (Ulyani et al., 2023).

Practicality data were obtained from student response questionnaires completed by 30 students and analyzed using a percentage formula to determine the usability and accessibility of the developed instrument in elementary IPAS assessment. Reliability data were analyzed using Cronbach's Alpha to examine the internal consistency of the learning motivation questionnaire and the critical thinking skills test. Qualitative feedback from experts, teachers, and students was analyzed descriptively and used as the basis for revising and finalizing the instrument (Safira et al., 2024).

Table 2. Data analysis techniques

Data	Source	Analysis Technique	Output
Expert validation	Content and media experts	Descriptive percentage analysis	Instrument validity and feasibility
Student response questionnaire	30 Grade IV students	Descriptive percentage analysis	Instrument practicality
Learning motivation questionnaire	30 Grade IV students	Cronbach's Alpha	Internal consistency of motivation instrument
Critical thinking skills test	30 Grade IV students	Cronbach's Alpha	Internal consistency of critical thinking instrument
Expert, teacher, and student feedback	Experts, teacher, and students	Descriptive qualitative analysis	Revision and final refinement

Overall, these procedures ensured that the Quizalize-based digital assessment instrument was systematically evaluated and finalized based on validity, reliability, practicality, and feasibility as an assessment tool for IPAS learning.

Result and Discussion

Development of the Quizalize-based IPAS assessment instrument followed the ADDIE model, beginning with a needs analysis to identify instructional problems and assessment requirements in fourth-grade IPAS learning at SDN Gayam. Classroom observations and interviews involving one classroom teacher and 30 fourth-grade students revealed that learning activities

were still dominated by conventional instruction, while assessment practices relied primarily on paper-based tests.

Students experienced difficulties in analyzing problems, constructing logical arguments, and solving higher-order thinking tasks. Both teachers and students expressed the need for an interactive digital assessment instrument capable of measuring learning motivation and critical thinking skills. Based on these findings, Quizalize was selected as the development platform because it provides automated scoring, immediate feedback, and gamified assessment features suitable for elementary school students.

Based on the identified needs, the assessment instrument was designed by preparing the assessment blueprint, learning motivation questionnaire, HOTS-

based critical thinking items, scoring rubric, and Quizalize assessment flow. The prototype was then developed by integrating assessment items, instructional images, feedback settings, and automatic scoring into the Quizalize platform.



Figure 2. Needs analysis activities at SDN Gayam



Figure 3. Development process of the Quizalize-based IPAS assessment instrument

The completed prototype consisted of a digital assessment interface including the login page, quiz dashboard, assessment questions, leaderboard, and automatic feedback page. These features were designed to provide an interactive assessment experience while enabling teachers to monitor students' performance efficiently.

Before classroom implementation, the prototype underwent expert validation involving one subject matter expert and one media expert. Several revisions were made based on the validators' recommendations, including improving language clarity, refining visual layout, adjusting interface consistency, and enhancing the presentation of assessment items. After revision, the

instrument was considered suitable for classroom implementation.

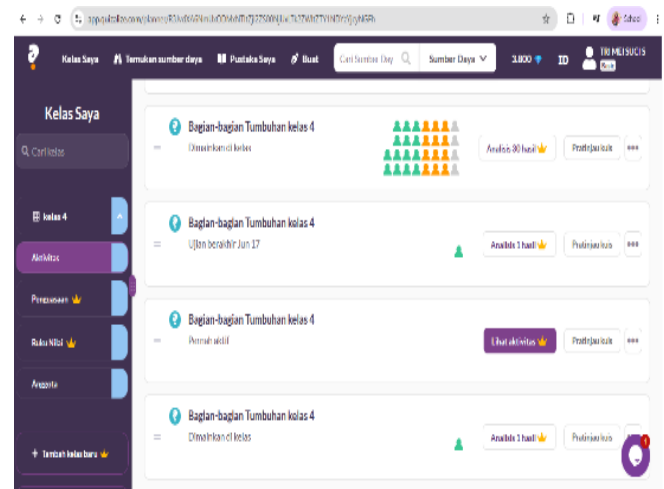


Figure 4. Interface of the developed Quizalize-based assessment instrument

The development of the Quizalize-based IPAS assessment instrument began with a needs analysis conducted at SDN Gayam. This stage involved classroom observations and interviews with the fourth-grade classroom teacher and 30 fourth-grade students. The purpose of the needs analysis was to identify existing assessment practices, students' learning conditions, and the necessity of developing a technology-based assessment instrument capable of measuring both learning motivation and critical thinking skills.

The observations revealed that IPAS instruction was still dominated by conventional teaching methods, particularly lectures and question-and-answer sessions. Learning media were limited to textbooks and whiteboards, which were insufficient to encourage students' active participation. Among the 30 students observed, only approximately seven students actively participated during classroom activities. Assessment practices were predominantly paper-based and had not integrated digital technology. Furthermore, students experienced difficulties in analyzing problems, identifying relevant information, constructing logical arguments, drawing conclusions, and solving higher-order thinking questions.

The interview findings supported the observation results. Students expressed positive attitudes toward digital learning platforms and preferred interactive assessment activities. The classroom teacher also acknowledged that technology-based assessment could increase students' learning motivation while simultaneously facilitating the development of critical thinking skills. Based on these findings, Quizalize was selected as the platform for developing the digital IPAS

assessment instrument because it provides interactive quizzes, automatic scoring, immediate feedback, and a user-friendly interface suitable for elementary school students.

Product Validation Results

The feasibility of the developed instrument was evaluated by one subject matter expert and one media expert. The validation assessed content accuracy,

alignment with curriculum objectives, assessment quality, language clarity, interface design, and technical usability.

The instrument achieved an overall feasibility score of 91.11%, indicating that it met the required standards for content validity, construct appropriateness, language clarity, visual presentation, and technical quality. Therefore, the product was considered appropriate for implementation in elementary IPAS learning.

Table 3. Expert validation results

Validator	Obtained Score	Maximum Score	Percentage (%)	Category
Subject Matter Expert	79	85	92.94	Highly Feasible
Media Expert	85	95	89.47	Highly Feasible
Average	164	180	91.11	Highly Feasible

Product Practicality Results

The practicality of the Quizalize-based IPAS assessment instrument was evaluated after implementation by 30 fourth-grade students using a response questionnaire consisting of 16 statements.

Table 4. Product practicality results

Component	Value
Number of Respondents	30 students
Number of Statements	16
Obtained Score	433
Maximum Score	480
Percentage	90.21%
Category	Highly Practical

The practicality score reached 90.21%, indicating that the instrument was highly practical. Students reported that the assessment platform was easy to access, simple to operate, visually attractive, and enjoyable to use. The immediate feedback and gamified features of Quizalize encouraged students to participate actively throughout the assessment process.

Critical Thinking Skills Results

The effectiveness of the Quizalize-based IPAS assessment instrument in improving students' critical thinking skills was evaluated using a pretest-posttest design involving 30 students in the experimental class.

Table 5. Descriptive statistics of critical thinking scores

Table 7. Paired samples t-test for critical thinking skills

Variable	Mean Pretest	Mean Posttest	Mean Difference	t	df	Sig. (2-tailed)
Critical Thinking Skills	54.53	83.13	-28.60	-72.019	29	< .001

Learning Motivation Results

Learning motivation was measured using a questionnaire administered before and after implementation. The effectiveness analysis involved 60

Description	Pretest	Posttest
Number of Students	30	30
Highest Score	63	89
Lowest Score	45	78
Mean Score	54.53	83.13
Category	Moderate	High

Students' average critical thinking score increased from 54.53 before implementation to 83.13 after implementation, representing an improvement of 28.60 points.

Table 6. Comparison of critical thinking scores

Statistics	Pretest	Posttest	Improvement
Mean Score	54.53	83.13	28.60
Highest Score	63	89	26
Lowest Score	45	78	33

Before hypothesis testing, the normality assumption was examined using the Kolmogorov-Smirnov test. The obtained significance value (Asymp. Sig. = 0.200) exceeded 0.05, indicating that the data were normally distributed.

The paired-samples *t*-test demonstrated a statistically significant improvement in students' critical thinking skills, $t(29) = -72.019$, $p < .001$, confirming that the Quizalize-based assessment instrument effectively enhanced students' higher-order thinking skills.

students, consisting of 30 students in the experimental group and 30 students in the control group.

The descriptive results indicate that both groups had comparable levels of learning motivation before the intervention. However, after implementation, the

experimental group achieved a considerably higher posttest mean than the control group, suggesting that the Quizalize-based assessment instrument positively influenced students' learning motivation.

Table 8. Descriptive statistics of learning motivation score

Variable	Group	N	Mean	SD	Minimum	Maximum
Learning Motivation (Pretest)	Experimental	30	58.73	3.53	53	66
Learning Motivation (Posttest)	Experimental	30	76.77	2.50	72	80
Learning Motivation (Pretest)	Control	30	58.73	3.53	53	66
Learning Motivation (Posttest)	Control	30	66.57	3.35	61	73

Prior to hypothesis testing, the Shapiro-Wilk test confirmed that all datasets were normally distributed.

Table 9. Shapiro-Wilk normality test

Group	Test	Statistic	df	Sig.
Experimental	Pretest	0.973	30	0.618
Experimental	Posttest	0.968	30	0.472
Control	Pretest	0.975	30	0.654
Control	Posttest	0.964	30	0.381

All significance values exceeded 0.05, indicating that the assumption of normality was satisfied. The homogeneity assumption was subsequently examined using Levene's test.

Since all significance values were greater than 0.05, the variances between groups were considered homogeneous. An independent-samples *t*-test was then conducted to compare posttest learning motivation scores between the experimental and control groups.

The independent-samples *t*-test revealed a statistically significant difference in learning motivation

between the experimental and control groups, $t(58) = 13.55, p < .001$. The experimental group demonstrated significantly higher learning motivation after using the Quizalize-based IPAS assessment instrument. Furthermore, the effect size (Cohen's $d = 3.50$) indicated a very large practical effect, demonstrating that the developed instrument substantially improved students' learning motivation.

Table 10. Levene's test for homogeneity of variance

Variable	Test	F	Sig.
Learning Motivation	Pretest	0.218	0.642
Learning Motivation	Posttest	0.487	0.488

Overall, the findings demonstrate that the Quizalize-based IPAS assessment instrument is highly feasible, highly practical, and effective in improving both students' critical thinking skills and learning motivation, supporting its implementation as a digital assessment tool in elementary IPAS learning.

Table 11. Independent samples t-test for learning motivation

Variable	Group	N	Mean	SD	t	df	Sig. (2-tailed)	Cohen's d
Learning Motivation	Experimental	30	76.77	2.50	13.55	58	< .001	3.50
Learning Motivation	Control	30	66.57	3.35				

Discussion

The high feasibility score (91.11%) indicates that the Quizalize-based IPAS assessment instrument met the pedagogical, technical, and content validity standards required for elementary digital assessment. The ADDIE model ensured that the instrument aligned with curriculum objectives, learner characteristics, and digital usability. Consistent with recent research, valid digital assessment depends on the integration of sound assessment design, user-friendly interfaces, and technology-enhanced feedback to support evidence-based instructional decisions (Cabero-Almenara et al., 2023). Accordingly, Quizalize represents a feasible digital assessment instrument for measuring learning motivation and critical thinking skills.

Achieving a practicality score of 90.21% indicates that the instrument can be implemented efficiently in elementary classrooms. Its intuitive interface, clear

instructions, and immediate feedback enabled students to complete assessment activities independently while reducing technical barriers. Similar findings suggest that practical digital assessment platforms enhance user engagement and facilitate more effective classroom assessment practices (Raji & Dommett, 2024). Consequently, Quizalize offers a practical and user-friendly assessment solution for elementary IPAS learning.

Significant improvement in students' critical thinking skills demonstrates that Quizalize effectively supports higher-order thinking through interactive and feedback-oriented assessment. Immediate feedback and problem-based assessment encouraged students to analyze, evaluate, and justify their responses more critically. This finding supports previous studies showing that technology-enhanced formative assessment promotes critical thinking by fostering active

participation and reflective learning (Fraillon et al., 2023).

Higher learning motivation in the experimental group indicates that Quizalize created a more engaging assessment environment than conventional assessment. Gamified features and real-time feedback encouraged students' participation and sustained their interest throughout the assessment process. Similar evidence suggests that digital formative assessment improves motivation by increasing engagement, autonomy, and enjoyment in learning (Ng & Lo, 2023).

Advancing SDG 4 requires assessment practices that integrate technology with meaningful learning evaluation. Findings suggest that Quizalize supports data-driven assessment while promoting critical thinking, learning motivation, and digital competence in elementary IPAS learning. Similar studies emphasize that technology-enhanced assessment contributes to quality education by strengthening student-centered learning and sustainable educational practices (Campillo-Ferrer & Miralles-Martínez, 2023).

Extending previous research, the present study demonstrates that Quizalize functions not only as a gamified learning platform but also as a validated digital assessment instrument for measuring learning motivation and critical thinking skills. Unlike earlier studies focusing mainly on engagement, this research integrates product development, validation, practicality, and effectiveness evaluation within a single framework. These findings reinforce the view that educational technology should provide valid evidence of student learning to support instructional improvement (Kimmons & Jensen, 2023).

Conclusion

The present study developed and evaluated a Quizalize-based digital assessment instrument for measuring elementary students' learning motivation and critical thinking skills in IPAS learning. The instrument demonstrated high feasibility (91.11%) and high practicality (90.21%), indicating that it met the pedagogical, technical, and usability requirements for classroom implementation. Effectiveness testing involving 60 fourth-grade students (30 in the experimental group and 30 in the control group) showed that students who participated in technology-enhanced assessment using the Quizalize-based instrument achieved higher critical thinking scores and learning motivation than those in the conventional assessment group. The experimental group showed an increase in the mean critical thinking score from 54.53 to 83.13, while also demonstrating significantly higher learning motivation than the control group. These findings

indicate that integrating Quizalize into classroom assessment provides interactive assessment experiences, immediate feedback, and efficient performance monitoring, thereby supporting the assessment of higher-order thinking and learning motivation in elementary IPAS learning. Accordingly, the developed instrument can be recommended as a feasible, practical, and effective digital assessment tool for technology-enhanced classroom assessment that supports the implementation of SDG 4 by promoting quality, student-centered education. Future research is recommended to examine the implementation of the instrument across different grade levels, subject areas, and broader educational contexts involving larger and more diverse samples. Further studies may also investigate the long-term contribution of technology-enhanced assessment to students' higher-order thinking, learning motivation, self-regulated learning, and other twenty-first-century competencies, as well as compare the effectiveness of Quizalize with other digital assessment platforms.

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Author Contributions

Conceptualization, investigation, resources, writing – original draft preparation, visualization, project administration, funding acquisition, T.M.S.S.; methodology, formal analysis, T.M.S.S. and N.; writing – review and editing, supervision, N. and J.S. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest

The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

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