

## DEVELOPMENT OF AN ARTICULATE STORYLINE-BASED COGNITIVE INTERACTIVE DIAGNOSTIC ASSESSMENT IN VOCATIONAL HIGH SCHOOL MATHEMATICS: A NEEDS ANALYSIS

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### ABSTRACT

Conventional mathematics assessments in vocational high schools often fail to accurately map students' prerequisite skills, highlighting an urgent gap in early learning diagnosis. Addressing this limitation, this study investigates the empirical prerequisites for developing an innovative interactive cognitive diagnostic assessment using Articulate Storyline, which uniquely integrates automated feedback and digital interactivity into formative evaluation. A mixed-methods sequential exploratory design was employed for this research. Qualitative insights were gathered via semi-structured interviews with purposively sampled mathematics teachers, while quantitative data were collected through a valid and reliable questionnaire administered to 420 tenth-grade students across seven public vocational high schools in Tegal Regency using proportional sampling. Findings reveal a critical inadequacy in current traditional evaluation methods to comprehensively identify students' prior knowledge. Furthermore, both educators and learners exhibited a profound demand for a digital diagnostic tool featuring immediate automated feedback, contextualized visual elements, and review mechanisms that foster independent learning. The integration of multimedia technology with cognitive diagnostic testing offers a significant theoretical and practical contribution by transforming outcome-based evaluations into adaptive, self-regulated learning experiences. Ultimately, developing this interactive instrument is highly relevant for strengthening mathematical readiness, ensuring accurate diagnosis of competencies, and promoting meaningful learning.

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### INTRODUCTION

Education plays a strategic role in shaping the quality of human resources that are adaptive to developments in science and technology. In the context of 21st-century learning, mathematics serves not only as a means of mastering

concepts but also as a vehicle for developing critical thinking and problem-solving skills. Maghfiroh & Dasari (2023) emphasized that mathematical critical thinking skills are part of higher-order thinking skills that need to be developed through appropriate learning approaches. However, students' mathematical problem-solving abilities remain at an average level and tend to decline at more complex problem-solving stages (Amalina & Vidákovich, 2023; Farida et al., 2024). This condition indicates a fundamental gap between the demands of mathematics learning and students' actual achievements.

One primary factor contributing to this decline is the suboptimal mapping of students' prerequisite skills before introducing new materials. Mastery of these basic concepts is crucial; students with a solid foundational understanding effortlessly navigate advanced topics, whereas weaknesses in basic concepts inevitably cause ongoing learning difficulties (Eka et al., 2025). Unfortunately, current school evaluations are predominantly outcome-oriented and consistently fail to uncover these early learning barriers (Duskri & Ar-Raniry, 2014; Säfström et al., 2024). To resolve this, diagnostic assessments must be utilized to pinpoint initial abilities, misconceptions, and specific learning needs early on (Firmanzah & Sudiby, 2021; Motulo et al., 2024). Within a differentiated learning framework, these early diagnoses empower teachers to tailor their instructional strategies to diverse student profiles effectively (Pratiwi et al., 2024).

To execute such diagnostic evaluations efficiently and engagingly, the integration of digital technology offers a highly promising solution. The utilization of interactive technological tools not only increases student engagement and motivation but also helps visualize abstract mathematical concepts in a more concrete manner (Reinita & Putri, 2024; Guña-Moya et al., 2024). Specifically, Articulate Storyline 3 stands out due to its comprehensive multimedia features, encompassing animation, audio, video, and interactive quizzes. Extensive research indicates that media developed via Articulate Storyline significantly enhances learning outcomes, conceptual comprehension, and student independence (Maylani & Sumardi, 2024; Gultom & Siagian, 2023; Putri et al., 2021), proving to be both valid and practically effective in mathematics education (Schoenherr et al., 2024; Handika et al., 2025).

Beyond mere visual interactivity, a critical component of modern diagnostic assessment that technology facilitates is the delivery of prompt and constructive feedback. Immediate responses help students instantly recognize and rectify their errors, thereby refining their cognitive processes (Morris et al., 2021; Nicol, 2021; Misnawati et al., 2025). Conventional assessments typically lack this immediacy, leaving a gap in individualized remediation. Furthermore, while students are highly reliant on technology, passive technological consumption can inadvertently diminish independent learning and conceptual mastery, ultimately degrading learning outcomes (Kurniawati, 2023; Anggela & Rusdi, 2024). Thus, the assessment format must actively involve students, transforming passive testing into an active, self-regulated learning experience.

Despite its substantial potential, Articulate Storyline has predominantly been used for instructional delivery rather than as a specialized diagnostic assessment tool. This creates a noticeable gap between the ideal formative evaluation which requires rapid feedback and technological optimization and actual classroom practices. Developing this interactive instrument also necessitates rigorous validation, as valid and reliable instruments are absolute prerequisites for generating accurate educational data and ensuring precise measurements of student competencies (Septi et al., 2024; Febriana & Setiawati, 2024; Richter & Richter, 2024).

Based on the aforementioned rationale, this study aims to analyze the empirical needs for developing an Articulate Storyline-based Interactive Cognitive Diagnostic Assessment for vocational high school mathematics. The findings are expected to provide a foundational blueprint for designing evaluations that are adaptive, valid, and capable of comprehensively mapping students' initial abilities. As a distinct novelty, this research pioneers the fusion of multimedia interactivity and automated formative feedback into a single diagnostic framework specifically tailored to proactively detect and remediate mathematical learning barriers in vocational education.

## METHOD

This study employed a Research and Development (R&D) approach focused on the initial needs analysis stage to formulate product specifications for an Articulate Storyline-based Interactive Cognitive Diagnostic Assessment. A mixed-methods sequential exploratory design was utilized to obtain an in-depth and measurable understanding of field

conditions. This design is considered highly relevant to ensure the resulting analysis accurately reflects school realities and serves as a solid foundation for product development (Sakir, 2024; Saparudin et al., 2022). Conducted between February and March 2026, the research involved seven State Vocational High Schools in Tegal Regency. The primary subjects were 420 tenth-grade students, selected to represent the early phase of vocational education where systematic mapping of prerequisite abilities is crucially needed. Additionally, mathematics teachers were selected as supporting subjects using purposive sampling, based on criteria such as actively teaching tenth grade, utilizing classroom assessments, and willingness to participate.

Data were collected using two main instruments: semi-structured interview guides for teachers and a needs-analysis questionnaire for students. The qualitative interviews explored current assessment practices, implementation barriers, and the demand for digital evaluation tools. The quantitative student questionnaire, structured on a five-point Likert scale, was developed using specific indicators encompassing the need for automated feedback, interactivity, visual appeal, and follow-up mechanisms (Handika et al., 2025; Yaseen et al., 2025). To ensure rigorous measurement, the questionnaire was tested for validity using the Pearson Product Moment correlation and for reliability using Cronbach's Alpha. The instrument was deemed highly reliable as the Cronbach's Alpha value exceeded the minimum threshold, indicating excellent internal consistency for accurate data collection (Indartini & Mutmainah, 2024). The specific indicators used to measure student needs are presented in Table 1.

**Table 1.** Indicators of Student Needs Analysis

No	Indicator
1.	I need an assessment that provides automatic feedback on every response given.
2.	I understand math concepts better when there is feedback.
3.	I would be more interested if the assessment were presented in an interactive and colorful format.
4.	The visual display and animation make me more enthusiastic about working on the questions.
5.	I have a digital device to access technology-based assessments.
6.	I prefer doing digital assessments rather than on paper.
7.	I want to review the results of the assessments I have done (there is a quiz review).
8.	I want there to be a follow-up on the assessment results.
9.	I want to be able to study and practice questions anytime without waiting for a teacher.
10.	I wanted an assessment that I could use as independent practice at home.
11.	It is easier for me to understand questions if they are related to everyday life problems.
12.	I am more motivated when the questions relate to real situations.
13.	I am interested in trying a digital-based interactive diagnostic assessment (Articulate Storyline).
14.	I believe interactive diagnostic assessments can help me understand mathematical concepts.

Source:(Handika et al., 2025; Yaseen et al., 2025)

Data analysis was systematically conducted for both qualitative and quantitative datasets. Qualitative data from teacher interviews were analyzed using an interactive model comprising data reduction, data presentation, and conclusion drawing, with data validity rigorously maintained through source triangulation. The findings established the conceptual requirements for the assessment features. Concurrently, quantitative data from the student questionnaires were analyzed by calculating the average scores, which were subsequently converted into five necessity levels ranging from very low to very high based on structured interval divisions (Sugiyono, 2022). This comprehensive analysis provided a robust empirical foundation to justify the subsequent development of the interactive diagnostic assessment.

## RESULT AND DISCUSSION

### Result

#### Results of the Validity and Reliability Test of the Student Needs Analysis Questionnaire

Before distributing the student needs analysis questionnaire, the instrument's validity and reliability were tested. This process aimed to ensure that the questionnaire met eligibility criteria, had a good level of accuracy, and was consistent, allowing it to serve as a sound basis for decision-making regarding the development of an Articulate

Storyline-based interactive cognitive diagnostic assessment. The results of the instrument's validity test are presented in Table 2.

**Table 2.** Interpretation of the Validity of the Student Needs Analysis Questionnaire Trial

Indicator	r-value	r-table	Information
P1	0,731	0,329	Valid
P2	0,562	0,329	Valid
P3	0,689	0,329	Valid
P4	0,669	0,329	Valid
P5	0,697	0,329	Valid
P6	0,587	0,329	Valid
P7	0,653	0,329	Valid
P8	0,701	0,329	Valid
P9	0,679	0,329	Valid
P10	0,510	0,329	Valid
P11	0,718	0,329	Valid
P12	0,831	0,329	Valid
P13	0,666	0,329	Valid
P14	0,723	0,329	Valid

Based on the initial data results, the instrument consisting of 14 statement items showed that all items were declared valid. Determination of validity was carried out through a trial on 36 respondents ( $N = 36$ ) with a significance level of 5%, resulting in an r-table value of 0.329. Data analysis was carried out systematically using SPSS version 25 software with the criteria that an item is declared valid if the r-value is greater than r table, and is declared invalid if the r-value is smaller than r-table.

After the validity test stage was completed, a reliability test was conducted using SPSS version 25 software. The results of the instrument reliability test analyzed using the SPSS program showed a Cronbach's Alpha value of 0.903. This value indicates that the instrument has a very high level of internal consistency. An instrument is said to be reliable if it has an alpha coefficient of more than 0.60. Based on these criteria, the instrument in this study can be declared reliable because the Cronbach's Alpha value obtained exceeds the minimum limit set ( $0.903 > 0.60$ ). In addition, a reliability coefficient above 0.90 indicates that the instrument has a very good level of reliability, making it suitable for use as a data collection tool in this study.

### Teacher Needs Analysis

The primary finding from the qualitative analysis indicates a significant pedagogical gap in current evaluation methods, simultaneously revealing an urgent need for interactive, technology-driven diagnostic tools. The thematic analysis of the interview data demonstrates that while educators currently utilize conventional oral and written assessments to gauge general student readiness, these traditional modalities lack the diagnostic granularity required to map individual cognitive profiles comprehensively. Teachers reported that although preliminary assessments are crucial for tailoring instructional strategies, the manual implementation of these conventional methods creates analytical blind spots, preventing them from accurately identifying the specific initial abilities and weaknesses of each student before introducing new mathematical concepts.

Beyond identifying the limitations of traditional testing, the findings analytically reveal a critical pedagogical transition toward digital interactivity. The data shows that integrating interactive digital assessments is not merely a strategy to capture students' initial attention, but rather a functional necessity for immediate cognitive correction. Educators emphasized that instantaneous, automated feedback is instrumental in helping students recognize and rectify their conceptual errors in real-time. Drawing from educators' empirical experiences, students exhibit a significantly

more positive response and heightened intrinsic motivation when engaging with digital media compared to static paper-based formats, further validating the necessity of this technological shift.

Specifically, the qualitative synthesis analytically substantiates the selection of Articulate Storyline as the optimal development platform to bridge this evaluation gap. Teachers identified that a diagnostic tool must possess not only high visual appeal to sustain student engagement but also robust interactive features to automate the feedback loop. Because Articulate Storyline inherently accommodates these exact technical and pedagogical specifications, its application is deemed highly relevant. Ultimately, the findings confirm that developing an Articulate Storyline-based interactive cognitive diagnostic assessment is an empirically justified intervention, equipping teachers with an accurate, data-driven mechanism to map students' initial mathematical abilities.

### Student Needs Analysis

A student needs analysis was conducted to identify their perceptions of the development of interactive diagnostic assessments in mathematics learning. A questionnaire was distributed to 420 10th-grade students at Tegal Regency State Vocational High Schools. The data obtained from the questionnaire were then analyzed using a Likert scale with five alternative answer choices. The results of the student needs questionnaire analysis are presented in Table 3.

**Table 3.** Results of the Student Needs Analysis Questionnaire

No	Indicator	Average	Category
1.	I need an assessment that provides automatic feedback on every response given.	4,19	High
2.	I understand math concepts better when there is feedback.	3,93	High
3.	I would be more interested if the assessment were presented in an interactive and colorful format.	3,66	High
4.	The visual display and animation make me more enthusiastic about working on the questions.	3,70	High
5.	I have a digital device to access technology-based assessments.	3,36	Moderate
6.	I prefer doing digital assessments rather than on paper.	3,30	Moderate
7.	I want to review the results of the assessments I have done (there is a quiz review).	3,99	High
8.	I want there to be a follow-up on the assessment results.	4,31	Very High
9.	I want to be able to study and practice questions anytime without waiting for a teacher.	3,73	High
10.	I wanted an assessment that I could use as independent practice at home.	3,66	High
11.	It is easier for me to understand questions if they are related to everyday life problems.	3,43	High
12.	I am more motivated when the questions relate to real situations.	3,67	High
13.	I am interested in trying a digital-based interactive diagnostic assessment (Articulate Storyline).	3,33	Moderate
14.	I believe interactive diagnostic assessments can help me understand mathematical concepts.	3,50	High

Table 3 presents the quantitative synthesis of students' needs regarding the Articulate Storyline-based Cognitive Interactive Diagnostic Assessment. Rather than merely reflecting a superficial preference for technology, the data analytically reveals a targeted demand for pedagogical utility. While basic interest in digital formats over paper and overall device availability yielded relatively lower averages ( $M = 3.30-3.36$ ), the functional and evaluative aspects of the assessment scored significantly higher. Most notably, the imperative for post-assessment follow-up emerged as the paramount need ( $M = 4.31$ , very high category), closely followed by the demand for automated

feedback ( $M = 4.19$ ). Analytically, this disparity indicates that students are not primarily driven by the novelty of digital tools; rather, they are expressing a critical need for formative evaluation mechanisms that conventional methods currently fail to provide. Furthermore, strong preferences for post-quiz reviews ( $M = 3.99$ ) and the capability to learn independently without waiting for teacher intervention ( $M = 3.73$ ) substantiate a clear drive toward self-regulated learning. Ultimately, these findings empirically justify that the proposed interactive assessment must prioritize dynamic feedback architectures and cognitive tracking to effectively bridge students' conceptual gaps, rather than merely digitizing traditional paper-based tests.

### Discussion

The findings of this study systematically demonstrate that students' high demand for automated feedback, follow-up results, and accurate mapping of initial abilities is not merely a preference for convenience, but rather a critical response to the limitations of conventional evaluations that often delay cognitive reinforcement. Analytically, this underscores the theoretical premise that cognitive diagnostic assessments are fundamental for pinpointing specific cognitive strengths and isolating learning barriers, which in turn directly facilitates the implementation of targeted learning differentiation (Anisah & Yuli Amreta, 2024; Juwita et al., 2024). To ensure that this diagnostic process effectively empowers students to independently recognize and overcome their learning difficulties in real-time, integrating these adaptive assessment mechanisms into accessible, mobile-based digital platforms becomes theoretically and practically indispensable (Rostika et al., 2025).

Beyond mere functional utility, the empirical data reveal a profound pedagogical need for aesthetics and interactivity in mathematical evaluations. The students' strong preference for visually engaging and contextualized assessment interfaces analytically justifies the selection of Articulate Storyline; it serves not just as a delivery medium, but as a cognitive scaffold. This aligns with previous evidence demonstrating that Articulate Storyline-based interactive multimedia possesses high construct validity and practical efficacy in bridging abstract mathematical concepts to concrete understanding (Hanantha et al., 2025). Therefore, the integration of such digital media transcends superficial visual attraction; it functions as a strategic pedagogical intervention engineered to deepen cognitive engagement, reduce extraneous cognitive load, and systematically train students' complex problem-solving skills (Daryanes et al., 2023).

Furthermore, the prominent data showing students' desire to actively review quiz outcomes and receive immediate feedback signifies a critical shift from passive test-taking toward active, self-regulated learning. From a theoretical standpoint, formative feedback serves as a catalyst for cognitive correction; it has been rigorously shown to enhance students' intrinsic motivation by providing a clear, actionable pathway toward mastering core competencies (Aust et al., 2024). When students are provided with structured opportunities for self-assessment and critical reflection facilitated by clear instructions and comparative answer models their meta-cognitive accuracy and capacity for self-regulation undergo significant improvement (Hepner et al., 2024). Consequently, the review and follow-up features conceptualized in this study are empirically validated as essential mechanisms for fostering deep mathematical reflection.

Synthesizing these insights, the practical implications of this research dictate that developing an Articulate Storyline-based Interactive Cognitive Diagnostic Assessment requires a sophisticated feedback architecture that is highly personalized, instantaneous, and authentically contextualized. The analytical integration of such advanced technologies into formative assessments potentially extending to artificial intelligence applications promises to revolutionize both individualized formative tracking and collaborative evaluation frameworks (Cuéllar et al., 2025; Fuentes-Nieto et al., 2025). A technologically aided contextual approach, specifically utilizing Articulate Storyline, has proven highly effective not only in elevating students' logical reasoning but also in fortifying their academic self-efficacy (Ariffah & Rusnilawati, 2023). Ultimately, this interactive assessment transcends its traditional role as a mere measurement instrument; it is conceptually transformed into a dynamic pedagogical vehicle designed to cultivate intrinsic motivation, intellectual independence, and a profoundly meaningful mastery of mathematical concepts.

## CONCLUSION

This study was driven by the urgency to map the initial mathematical abilities of vocational high school students through a needs analysis for the development of an Articulate Storyline-based Interactive Cognitive Diagnostic Assessment. The analysis results indicate a very strong empirical demand from both educators and students for an assessment instrument that transcends the limitations of conventional outcome evaluation. Both specifically require automated feedback features, quiz review mechanisms, and digital interactivity capable of rapidly detecting cognitive barriers, thereby enabling the implementation of more precise and targeted differentiated learning strategies.

The primary contribution of this research lies in establishing a conceptual and empirical foundation for integrating cognitive diagnostic assessments with digital multimedia an approach that remains rarely explored within the context of vocational education. Theoretically and practically, these findings demand a paradigm shift from passive traditional evaluation toward interactive formative assessments that empower students' self-regulation and motivation. Moving forward, future research is highly recommended to focus on the design and extensive validation stages of this instrument prototype, including exploring the potential integration of artificial intelligence to enhance diagnostic accuracy. Ultimately, this interactive innovation is expected to not only function as a measurement tool but also transform into a catalyst for more adaptive, independent, and meaningful mathematics learning.

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