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DEVELOPMENT OF A DIGITAL COGNITIVE DIAGNOSTIC ASSESSMENT FOR DIFFERENTIATED LEARNING IN VOCATIONAL HIGH SCHOOLS

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Abstrak

Transformasi digital dalam pendidikan menuntut penerapan asesmen yang mampu mengidentifikasi kebutuhan belajar peserta didik secara cepat, akurat, dan mendukung pembelajaran berdiferensiasi. Namun, pelaksanaan asesmen diagnostik di sekolah menengah kejuruan masih belum dimanfaatkan secara optimal sebagai dasar pengambilan keputusan pembelajaran. Penelitian ini bertujuan mengembangkan model asesmen diagnostik kognitif digital berbasis Slido untuk pembelajaran Pendidikan Pancasila serta menguji validitas, kepraktisan, dan keterterapannya. Penelitian menggunakan pendekatan Research and Development (R&D) dengan model pengembangan ADDIE. Data dikumpulkan melalui observasi, wawancara, angket, validasi ahli, dan instrumen asesmen diagnostik digital, kemudian dianalisis secara deskriptif kuantitatif dan kualitatif. Hasil penelitian menunjukkan bahwa model memperoleh rata-rata validasi ahli sebesar 90,63%, kepraktisan sebesar 90,17%, keterterapan sebesar 92,23%, dan respons siswa sebesar 91,95%, yang seluruhnya berkategori sangat baik. Temuan ini menunjukkan bahwa model asesmen diagnostik kognitif digital berbasis Slido valid, praktis, dan layak diterapkan untuk mengidentifikasi pengetahuan awal serta miskonsepsi peserta didik secara real time, meningkatkan keterlibatan belajar, dan mendukung pembelajaran berdiferensiasi pada pembelajaran Pendidikan Pancasila di sekolah menengah kejuruan.

Kata kunci : Asesmen Diagnostik Kognitif Digital; Pembelajaran Berdiferensiasi; Slido; Pendidikan Pancasila; Sekolah Menengah Kejuruan.

Abstract

Digital transformation in education requires the implementation of assessments that can quickly and accurately identify students' learning needs and support differentiated instruction. However, diagnostic assessments in vocational high schools are still not being optimally utilized as a basis for instructional decision-making. This study aims to develop a Slido-based digital cognitive diagnostic assessment model for Pancasila Education and to test its validity, practicality, and applicability. The study employed a Research and Development (R&D) approach using the ADDIE development model. Data were collected through observations, interviews, questionnaires, expert validation, and the digital diagnostic assessment instrument, and were then analyzed using both quantitative and qualitative descriptive methods. The results showed that the model achieved an average expert validation score of 90.63%, a

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practicality score of 90.17%, a feasibility score of 92.23%, and a student response rate of 91.95%, all of which were categorized as "very good." These findings indicate that the Slido-based digital cognitive diagnostic assessment model is valid, practical, and suitable for identifying students' prior knowledge and misconceptions in real time, enhancing learning engagement, and supporting differentiated instruction in Pancasila Education courses at vocational high schools.

***Keywords**: Digital Cognitive Diagnostic Assessment; Differentiated Learning; Slido; Pancasila Education; Vocational High School.*

I. Introduction

The rapid transformation in education during the digital age has fundamentally changed the paradigms of learning and assessment at all levels of education. Twenty-first-century education no longer emphasizes merely the acquisition of factual knowledge but increasingly focuses on the development of higher-order thinking skills, problem-solving abilities, collaboration, communication, and digital literacy. In this context, assessment is positioned not merely as a tool for measuring learning outcomes, but as an integral component of the learning process, supporting meaningful instructional decision-making. Digital assessment environments provide opportunities to collect evidence of student learning more efficiently while enabling teachers to gain richer insights into students' readiness, characteristics, and educational needs. As a result, assessment practices have shifted from a summative orientation toward formative and diagnostic approaches that emphasize learning improvement and continuous feedback (Pallitt et al., 2023; Redecker et al., 2024).

The increasing integration of technology into assessment practices has prompted educational institutions to adopt digital assessment systems capable of supporting personalized, student-centered learning. Previous research has shown that digital assessment enhances flexibility, accessibility, and immediate feedback while fostering student engagement and participation (Niculescu et al., 2024). Furthermore, digital technology facilitates the collection and visualization of assessment data, enabling teachers to make more informed pedagogical decisions and design instructional strategies aligned with students' diverse learning characteristics (Rienties et al., 2022). These developments are highly relevant to the implementation of differentiated instruction, which requires accurate information about students' prior knowledge and readiness to learn.

From this perspective, diagnostic assessment is strategic because it allows teachers to identify students' prior knowledge and misconceptions before instruction begins. Diagnostic assessment serves not only as a measurement tool but also as a pedagogical mechanism that supports adaptive learning. However, research indicates that many teachers still face challenges in implementing assessment systematically and utilizing assessment results to enhance learning (Lüdtke et al., 2024). Similar findings were reported by Geiger et al. (2021), who emphasized that pedagogical factors significantly influence the effectiveness of diagnostic assessment practices

and teachers' ability to translate assessment information into meaningful learning interventions.

The growing use of artificial intelligence and digital technology has further expanded opportunities for improved assessment practices. Recent studies show that technology-supported assessment environments provide more authentic, interactive, and data-driven learning. These environments also foster student self-reflection and participation (Luckin et al., 2024; Chiu et al., 2024). Furthermore, artificial intelligence and digital assessment systems are now recognized as valuable tools. Both support classroom-based formative assessment and enhance educational measurement (Muntean et al., 2024; Sugiyo et al., 2025). These developments demonstrate that digital assessment is an instructional innovation. It is not merely a technological replacement for conventional testing procedures.

Student engagement is also a key aspect of the digital learning environment. Interactive technology has been shown to increase participation, encourage collaborative discussion, and motivate students to express their ideas with greater confidence. Studies examining the use of Slido have found that online polling platforms positively influence student engagement and classroom interaction by creating a more inclusive and enjoyable learning environment (Hughes et al., 2022; Mahmud et al., 2024). Such an interactive environment aligns with the Cognitive-Affective-Social Theory of Learning in Digital Environments (CASTLE), which emphasizes that effective digital learning must integrate cognitive, affective, and social dimensions simultaneously (Schneider et al., 2022).

In vocational education, particularly in Indonesian vocational high schools, digital diagnostic assessment is becoming increasingly important due to the diverse backgrounds of students. Students have varying academic foundations, digital skills, and levels of motivation. This diversity requires a teaching approach based on accurate information about their readiness. Previous research indicates that students are generally prepared to navigate digital environments, although support mechanisms and pedagogical integration are still necessary (Kuzminska et al., 2024). Thus, digital diagnostic assessment can significantly support personalized learning and differentiated instruction.

Preliminary observations of 10th-grade TKI students at SMK Putra Indonesia in Malang indicate that current diagnostic assessment practices are still conducted conventionally and tend to be incidental. Interviews with teachers revealed that assessment results have not been systematically used to design differentiated instruction. Additionally, some students were hesitant to express their opinions despite having adequate conceptual understanding. These findings suggest that current assessment practices do not yet fully accommodate student characteristics and the demands of contemporary digital learning.

Further questionnaire data indicate positive responses to the implementation of digital assessment, which is considered relevant to the learning material, useful for

identifying prior knowledge, and capable of creating a more enjoyable learning experience. Students also reported some difficulties in using smartphone-based technology, indicating adequate digital readiness among learners. These findings support previous research showing that digital assessment contributes to positive learning experiences, higher motivation, and increased student engagement (Niculescu et al., 2024; Hughes et al., 2022).

Although the integration of digital assessment technology is on the rise, previous studies have largely focused on formative assessment systems or the adoption of technology in higher education contexts. Research on the systematic development of a digital cognitive diagnostic assessment model to support differentiated learning in vocational secondary education remains scarce. Furthermore, existing studies tend to emphasize technological tools rather than pedagogical models that integrate diagnostic assessment, student engagement, and instructional decision-making. Therefore, this study proposes a Slido-based digital cognitive diagnostic assessment model specifically designed for Pancasila Education instruction in vocational high schools.

This study aims to develop a Slido-based digital cognitive diagnostic assessment model for 10th-grade TKI students at SMK Putra Indonesia in Malang. This study also examines the feasibility of the model and user feedback to support meaningful and engaging digital learning.

II. Reseach Method

This study employs a Research and Development (R&D) approach to develop a pedagogical product in the form of a Slido-based digital cognitive diagnostic assessment model for Pancasila education in vocational high schools. The research and development approach was chosen because the objective of this study goes beyond merely describing phenomena or examining relationships between variables; rather, this study aims to produce an educational product that addresses actual learning needs and can be applied in real educational contexts. Educational R&D emphasizes the systematic design, development, evaluation, and refinement of products through an iterative process involving users and empirical testing (Borg & Gall, 1983; Gall et al., 2007).

To develop a Slido-based digital cognitive diagnostic assessment model, this study adopted the ADDIE development model developed by Branch (2009). The ADDIE model was chosen because it provides a systematic, flexible, and appropriate framework for the development of digital learning products, from needs analysis to product evaluation. The five stages of this model—Analysis, Design, Development, Implementation, and Evaluation—allow the development process to proceed in phases, incorporating expert validation, user testing, and product refinement based on evaluation results. Therefore, all research procedures were designed to consistently follow the stages of the ADDIE model without combining it with other development

models, ensuring that the methodological flow remains logical, systematic, and easy to replicate (Branch, 2009).

A. Research Procedure

1. Analysis

The analysis phase aimed to identify the requirements for developing a Slido-based digital cognitive diagnostic assessment model. The analysis was conducted through classroom observations, interviews with Pancasila Education teachers, the distribution of needs analysis questionnaires to students, and a review of instructional documents. This activity focused on identifying student characteristics, learning conditions, existing assessment practices, the school's technological readiness, and teachers' needs regarding digital diagnostic assessment tools. The results of the analysis served as the basis for determining the specifications of the product to be developed in accordance with user needs (Branch, 2009).

2. Design

Based on the results of the needs analysis, the design phase involved developing a conceptual design for a Slido-based digital cognitive diagnostic assessment model. This phase included the formulation of assessment objectives, diagnostic indicators, an instrument rubric, the model's implementation workflow, the design of the Slido user interface, and the development of learning support tools. The design was carried out to ensure that all product components are aligned with the learning objectives and the characteristics of the students.

3. Development

During the development phase, a prototype of a Slido-based digital cognitive diagnostic assessment model was created in accordance with the design that had been formulated. The products developed included a conceptual model, a diagnostic assessment instrument, a user guide, and digital media integrated with the Slido platform. Subsequently, the products were validated by three experts: a learning evaluation expert, an educational technology expert, and a Pancasila education expert. The validation was conducted to assess the appropriateness of the product's content, constructs, presentation, language, and feasibility of implementation. Feedback and recommendations from the validators were used as the basis for revisions, resulting in a prototype suitable for user testing.

4. Implementation

The product, once validated, was then implemented in phases through three types of trials: a limited trial, an expanded field trial, and an operational trial. The limited trial involved ten students to identify initial weaknesses in the product. The expanded field trial involves thirty students to assess the practicality of the model, while the operational trial involves forty-five students to evaluate the product's implementation in real-world learning conditions. During implementation, Pancasila Education teachers serve as primary users and provide feedback on the model's implementation.

5. Evaluation

Formative evaluation was conducted at each stage of development through an analysis of expert validation results, teacher feedback, student feedback, observation results, and findings during the pilot testing phase. The evaluation aims to identify the product's weaknesses and serve as the basis for continuous revisions until a valid, practical, and implementable Slido-based digital cognitive diagnostic assessment model for Pancasila education is achieved (Branch, 2009).

B. Reseach Participants and Locations

This study was conducted on November 11, 2025, at SMK Putra Indonesia in Malang, East Java, Indonesia. The school was selected through purposive sampling because it has implemented the Merdeka Curriculum and possesses adequate technological infrastructure to support a digital learning environment. Additionally, the diversity of students' academic backgrounds and learning characteristics made this school an ideal location for developing and evaluating a digital diagnostic assessment model.

Participants consisted of 10th-grade students enrolled in the Industrial Chemical Engineering (TKI) program and a Pancasila Education teacher. Product testing was conducted in three phases. A limited field test involving ten students was conducted to identify weaknesses in the prototype and obtain initial feedback on usability. An expanded field test involving thirty students was conducted to examine the practicality and consistency of implementation. The operational testing involved forty-five students to evaluate the model's application under actual classroom conditions. Data collection instruments included observation sheets, interview guides, validation sheets, questionnaires, and a digital cognitive diagnostic assessment tool integrated into the Slido platform.

A limited field test involving ten students was conducted to identify weaknesses in the initial prototype. Subsequently, an expanded field test involving thirty students was conducted to assess the practicality and consistency of the product's implementation. Finally, operational testing involved forty-five students to evaluate the applicability and overall quality of the developed model. Civics teachers participated throughout the development process and provided pedagogical feedback regarding the product's implementation.

C. Data Collection Instruments

Data collection utilized both qualitative and quantitative instruments, reflecting the nature of educational development research that employs a mixed-methods approach (Creswell & Plano Clark, 2018). These instruments include:

1. A needs analysis questionnaire to identify baseline conditions and user requirements;
2. An expert validation questionnaire to assess content validity, construct validity, and usability;
3. A practicality questionnaire administered to teachers and students;

4. Semi-structured interview guidelines to explore perceptions and experiences related to the implementation of digital assessment;
5. Observation sheets to document learning activities and the assessment process; and
6. A digital cognitive diagnostic assessment instrument integrated into the Slido platform.Semua instrumen dikembangkan secara sistematis dan ditinjau untuk memastikan relevansi isi serta konsistensi dengan tujuan penelitian. Prosedur pengembangan instrumen mengikuti rekomendasi yang diajukan oleh Fraenkel dkk. (2012), yang menekankan validitas dan kesesuaian alat ukur.

D. Data Collection Techniques

Various techniques were used to ensure data triangulation and enhance the credibility of the findings. Observations were conducted to review classroom conditions and existing assessment practices. Semi-structured interviews with teachers and student representatives were conducted to obtain in-depth information about their learning experiences and needs. Questionnaires were distributed to collect quantitative data on user perceptions and the practicality of the product. In addition, student responses collected via the Slido platform were used to gather evidence of the implementation of the developed assessment model.

E. Data Analysis

Qualitative and quantitative analyses were used. Qualitative data obtained from interviews, observations, and open-ended comments were analyzed using the interactive model proposed by Miles and Huberman (1994), which consists of data reduction, data presentation, and drawing conclusions. This approach facilitates a comprehensive interpretation of user experiences and the implementation process.

Qualitative data were analyzed using the Miles and Huberman interactive model, which includes data reduction, data presentation, and drawing conclusions. Quantitative data were analyzed using descriptive statistics and percentage analysis to determine the levels of validity, practicality, and applicability of the developed model. The interpretation of percentage scores followed predefined criteria to classify results into the categories of excellent, good, fair, poor, and very poor. Average scores and percentages were calculated to determine the levels of validity, practicality, and applicability of the developed model. Descriptive statistical analysis is widely used in educational development studies to support decision-making during the revision and finalization of products (Gall et al., 2007). The integration of qualitative and quantitative data allows for triangulation and strengthens the reliability of the findings. Such integration is recommended in mixed-methods research because it provides a more comprehensive understanding of educational phenomena and product quality (Creswell & Plano Clark, 2018).

III. Findings and Results

A. Reseacrh Findings

The development of a Slido-based digital cognitive diagnostic assessment model was carried out systematically through the stages of needs analysis, prototype design, product development, limited field testing, expanded field testing, and operational testing. The results obtained at each stage indicate that the model, developed incrementally, achieved progressively higher levels of validity, practicality, and applicability in Pancasila Education instruction for 10th-grade TKI students at SMK Putra Indonesia in Malang.

The results of the needs analysis indicate that the diagnostic assessment practices currently carried out by teachers are still incidental in nature and have not been systematically integrated into lesson planning. Interviews and classroom observations show that assessment activities generally focus only on gathering initial information and are not followed up with structured pedagogical interventions. These findings align with previous research confirming that diagnostic assessment is still not being utilized optimally because teachers often face difficulties in translating assessment results into appropriate instructional decisions (Geiger et al., 2021). Furthermore, the diversity of students' academic backgrounds and learning readiness in vocational high schools necessitates more adaptive and responsive assessment practices.

Survey data show that students responded positively to digital assessment practices. Most students felt that digital assessments were relevant to the learning material and helped them identify their prior knowledge before the learning process began. Students also found smartphone-based technology easy to use and believed it created a more enjoyable learning experience. These findings support previous research showing that digital assessment can increase student participation and create more meaningful learning (Niculescu et al., 2024). Students' digital readiness also reflects the growing importance of technological competencies in modern education (Kuzminska et al., 2024).

Based on these findings, an initial prototype of a digital cognitive diagnostic assessment model was developed. This model consists of five interconnected components: a conceptual framework, an assessment structure, a diagnostic instrument, the Slido platform, and implementation guidelines. The diagnostic instrument was designed to identify students' understanding and misconceptions regarding the topic "The Nature of Freedom of Expression in Accordance with Pancasila Values." Various question formats, such as multiple-choice and open-ended questions, were used to obtain comprehensive information about students' cognitive profiles. Slido was chosen for its ability to facilitate real-time interaction and visualization of responses, as well as for providing anonymity, which can encourage student participation.

Before conducting the field study, the initial prototype was validated by three experts: an educational evaluation expert, an educational technology expert, and a Pancasila education expert. The results of the expert validation are presented in Table 1.

Table 1. Expert Validation Results

Aspects Evaluated	Percentage (%)	Category
Model Components	92,50	Excellent
Assessment Instruments	90,00	Excellent
Implementation Procedures	91,25	Excellent
Language Appropriateness	88,75	Excellent
Average	90,63	Excellent

The initial design also includes a systematic implementation process. Teachers prepare diagnostic questions via the Slido platform before the lesson begins; students complete the assessment using their personal devices; response patterns are automatically visualized; and teachers use the resulting data to design differentiated learning activities. Thus, the product developed serves not only as a technological tool but also as a pedagogical framework that supports instructional decision-making.

The first phase of the field test involved ten students and aimed to identify weaknesses in the prototype. Observational results showed that students were enthusiastic about using the digital platform and did not experience significant difficulties accessing Slido. Quantitative results indicated an average effectiveness rate of 81.6%, with the highest scores—nearly 88.9%—in the areas of ease of access and clarity of questions. However, students' independence in answering questions without teacher assistance remained relatively low, at around 66.7%. Qualitative data indicated that some students still relied on teacher guidance, particularly when answering reflective questions. The quantitative results obtained during the limited field testing are summarized in Table 2.

Table 2. Results of a Limited Field Trial

Indicators	Persentage (%)	Category
Ease of Use	87,50	Excellent
Clarity of Instructions	85,00	Excellent
Appeal	90,00	Excellent
Usefulness	88,75	Excellent
Average	87,81	Excellent

The findings indicate that the prototype has been able to accommodate students' familiarity with digital technology, but still requires refinement to support independent thinking skills. The Slido-based diagnostic assessment model proved effective in increasing student engagement and supporting differentiated learning practices. These findings align with the research by Hughes et al. (2022), which reported that interactive polling platforms can enhance classroom participation and interaction. Furthermore, the results of this study also support the Cognitive-Affective-Social Theory of Learning in Digital Environments (CASTLE), which emphasizes the integration of cognitive, affective, and social aspects in digital learning (Schneider et al., 2022). Teachers' reflections on the use of Slido indicate that digital interaction platforms can increase student engagement and self-confidence while reducing anxiety during the learning process (Mahmud et al., 2024). The anonymity feature provided by Slido creates a psychologically safe learning environment, encouraging students to be more confident in expressing their ideas and opinions.

Based on the results of the first evaluation phase, several revisions were made, including simplifying the user instructions, refining the reflective questions, and

improving the interface layout. These revisions aim to enhance ease of use while supporting students' independent thinking. These gradual improvements reflect the principle that educational technology must be integrated pedagogically, rather than merely replacing conventional tools. This perspective aligns with the framework proposed by Redecker et al. (2024), which emphasizes that digital assessment must support meaningful learning processes and provide actionable information to improve the quality of learning.

The second phase consisted of an expanded field test involving thirty students. The implementation during this phase proceeded more smoothly and naturally compared to the previous phase. Students demonstrated higher levels of confidence and independence, while technical issues related to internet connectivity or platform accessibility were virtually nonexistent. Quantitative analysis results showed that all indicators achieved an effectiveness rate above 93%, with the clarity of questions and the suitability of using Slido as an initial learning assessment reaching approximately 97%. The results of the expanded field test are presented in Table 3, with a score of 88.9%. However, the level of student independence in answering questions without teacher assistance remains relatively low, at around 66.7%. Qualitative data indicate that some students still rely on teacher guidance, particularly when answering reflective questions. The quantitative results obtained during the limited field test are summarized in Table 2.

Table 3. Expanded Field Test Results

Indicator	Persentage (%)	Category
Practicality	89,20	Excellent
Interaction	91,00	Excellent
Diagnostic Functions	90,30	Excellent
Average	90,17	Excellent

Qualitative findings indicate that students focused more on the substance of the questions than on how to operate the platform. Teachers reported that visualizations of response patterns allowed them to identify students' levels of understanding more efficiently and supported the planning of differentiated instruction. The availability of real-time data helped teachers identify differences in students' critical thinking abilities and adjust their instructional strategies accordingly. The increase in students' independence and self-confidence suggests that repeated exposure to digital diagnostic assessments contributes positively to learning engagement and self-regulated learning. These findings are consistent with the research by Rienties et al. (2022), which confirms that data-driven assessment practices can enhance the responsiveness of instruction and promote active learning.The results of the operational testing are summarized in Table 4.

Table 4. Operational Test Results

Indicators	Persentage (%)	Category
Applicability	91,40	Excellent
Effectiveness	92,10	Excellent
Student Engagement	93,20	Excellent
Average	92,23	Excellent

Hasil angket menunjukkan bahwa siswa memberikan respons positif terhadap model yang dikembangkan. Sebagian besar siswa menyatakan bahwa asesmen

diagnostik digital yang digunakan relevan dengan materi kebebasan berpendapat dan selaras dengan nilai-nilai Pancasila. Mereka juga menilai asesmen tersebut membantu dalam mengukur tingkat pemahaman sebelum pembelajaran dimulai. Penggunaan telepon pintar dan platform Slido terbukti meningkatkan keterlibatan, interaksi, motivasi, dan partisipasi siswa selama proses pembelajaran. Rincian respons siswa terhadap model asesmen diagnostik kognitif digital berbasis Slido disajikan pada Tabel 5.

Table 5. Student Responses to a Slido-Based Digital Cognitive Diagnostic Assessment Model

Indicators	Persentage (%)	Category
Ease of Access	90,50	Excellent
Interaction	91,80	Excellent
Motivation	92,40	Excellent
Learning Engagement	93,10	Excellent
Avarage	91,95	Excellent

These findings indicate that the Slido-based diagnostic assessment model can enhance student engagement while supporting differentiated instruction. These results align with the findings of Hughes et al. (2022), who noted that interactive polling platforms can increase participation and interaction in learning. Furthermore, the results of this study also support the perspective of Schneider et al. (2022) regarding the Cognitive-Affective-Social Theory of Learning in Digital Environments (CASTLE), which emphasizes the importance of integrating cognitive, affective, and social dimensions in digital learning.

B. Discussion

The increase in student engagement observed during the operational testing phase supports the findings of previous research on the role of digital interaction technology in fostering participation and collaborative learning. Hughes et al. (2022) reported that online polling platforms can create a more inclusive classroom environment by encouraging students to participate without fear of making mistakes. Similar findings were also presented by Mahmud et al. (2024), who found that the use of Slido positively contributed to student engagement and strengthened communication between teachers and students. In this study, anonymity and real-time interaction encouraged students who were usually reluctant to express their opinions to become more active in class discussions.

Another key finding relates to teachers' perceptions of the practicality of the developed model. Teachers reported that the automatic visualization of student responses significantly reduced the time needed to identify students' prior knowledge. Response data generated through Slido allows teachers to group students based on their level of understanding and organize learning activities more systematically. These findings reinforce the argument that digital assessment systems can provide meaningful data to support instructional planning and pedagogical decision-making (Rienties et al., 2022). In line with this, Redecker et al. (2024) emphasize that electronic assessment tools should not be viewed merely as technological innovations, but as instruments that support evidence-based teaching.

The operational testing also showed that the developed product has a high level of practicality and applicability. Students encountered only minor technical difficulties and were able to complete the assessment independently using their personal

devices. These results indicate that vocational high school students possess sufficient digital competencies to participate in technology-supported learning environments. Previous research has also shown that students generally have a good level of readiness for digital learning, although pedagogical support remains necessary to optimize the benefits of technology integration in education (Kuzminska et al., 2024).

In addition to supporting cognitive assessment, the developed model also facilitates a reflective learning process. Open-ended questions integrated into the Slido platform allow students to connect Pancasila Education concepts with real-world social situations and democratic values. Thus, the assessment activity not only promotes conceptual understanding but also self-reflection and the internalization of values. These findings align with the Cognitive-Affective-Social Theory of Learning in Digital Environments (CASTLE), which states that meaningful digital learning occurs through the interaction of cognitive, affective, and social dimensions (Schneider et al., 2022). Through interactive digital assessments, students are encouraged to think critically, express their opinions, and appreciate the diversity of perspectives.

From the perspective of educational evaluation, the results of this study indicate that diagnostic assessment needs to be positioned as an integral part of the learning process, not merely an administrative activity conducted before the learning begins. Previous research has emphasized the importance of formative and diagnostic assessments in improving the quality of learning and supporting personalized learning (Pallitt et al., 2023). However, many assessment practices still focus solely on data collection without utilizing the obtained information for the benefit of learning. This research seeks to address the issue thru the development of a systematic model that integrates digital technology, assessment practices, and differentiated learning.

The research findings also indicate that the developed model contributes to strengthening teachers' assessment literacy. The availability of visualized student response data allows teachers to make learning decisions more systematically and accurately. These results confirm previous research that emphasizes that a digital assessment framework can enhance teacher assessment literacy and support evidence-based learning practices. Similar findings were presented by Lüdtke et al. (2024), who stated that digital formative assessments help teachers conduct evaluations more effectively and consistently. Furthermore, the development of artificial intelligence and educational technology increasingly emphasizes the importance of data-driven assessment practices in creating meaningful learning experiences (Luckin et al., 2024; Muntean et al., 2024).

Compared to previous research, this study offers several distinctive contributions. Most previous research focused on the use of digital assessment tools or online polling systems, whereas this study develops a comprehensive pedagogical model by integrating cognitive diagnostic assessments, differentiated learning, and the values of Pancasila Education within the context of vocational education. Previous research generally focused on the implementation of digital assessments, online survey systems, and formative assessments in higher education environments (Pallitt et al., 2023; Niculescu et al., 2024; Hughes et al., 2022). On the contrary, this research produces a pedagogical model specifically designed for vocational secondary education and contextualized in the learning of Pancasila Education. In addition, the developed model not only utilizes Slido as a technological tool but also integrates diagnostic assessment principles, differentiated learning, and Pancasila values into a cohesive framework.

The novelty of this research lies in the development of a systematic digital cognitive diagnostic assessment model that combines the advantages of technology and pedagogical functions. This model allows teachers to identify students' cognitive readiness, support differentiated learning, and enhance students' active engagement in a democratic learning environment. Thus, the resulting product is not only an assessment instrument but also a pedagogical innovation capable of addressing the challenges of education in the digital era.

Nevertheless, several limitations of the research need to be considered. First, the research was conducted only at one vocational high school and involved students from one skill program, so the generalization of the findings is still limited. Second, the research focuses more on the feasibility and applicability of the product rather than its long-term effectiveness. Third, the implementation of the model was only conducted in the subject of Pancasila Education, so it has not yet covered other fields of study. Therefore, future research can expand the application of the model to various educational contexts and examine its impact on higher-order thinking skills and long-term student learning outcomes.

Overall, the research results indicate that the Slido-based digital cognitive diagnostic assessment model has a high level of validity, practicality, and applicability to support Pancasila education in vocational high schools. This model contributes to increasing student engagement, facilitating differentiated learning, and strengthening pedagogical decision-making by teachers. Therefore, digital diagnostic assessments should not only be viewed as evaluation technology but also as pedagogical strategies that support meaningful learning and the development of 21st-century competencies.

IV. Conclusion

This research successfully developed a digital cognitive diagnostic assessment model based on Slido to support Pancasila Education learning in vocational high schools thru a Research and Development (R&D) approach with the ADDIE development model. The developed model is not only a digital assessment instrument but also a pedagogical framework that systematically integrates diagnostic assessment, digital technology, and differentiated learning. The model development was carried out thru the stages of needs analysis, design, development, implementation, and evaluation, resulting in a product that aligns with the characteristics of the learners and the learning needs in the digital era.

The research results show that the developed model meets the criteria of being valid, practical, and feasible to implement. Validation by three experts obtained an average score of 90.63% with a very good category, indicating that the model components, assessment instruments, implementation procedures, and linguistic aspects have met the feasibility standards. Furthermore, the extended field test yielded a practicality level of 90.17%, while the operational test achieved an applicability level of 92.23%. Student responses to the model's implementation also reached 91.95% with a very good category, indicating that the model is easy to use, capable of enhancing interaction, and encouraging active student engagement during the learning process. These findings prove that the Slido-based digital cognitive diagnostic assessment model effectively helps teachers identify students' prior knowledge and misconceptions in real time, making it a useful foundation for developing more targeted differentiated learning.

Theoretically, this research enriches the study of digital diagnostic assessment by offering a pedagogical model that integrates assessment functions, digital technology, and differentiated learning within the context of Pancasila Education in vocational high schools. Practically, this model provides a reference for teachers to conduct diagnostic assessments in a more systematic, data-driven, and learner-centered manner. Therefore, the digital cognitive diagnostic assessment based on Slido is not only worthy of being viewed as an innovation in learning technology but also as a pedagogical strategy that supports learning decision-making, enhances the quality of the teaching and learning process, and strengthens the development of students' competencies in line with the demands of 21st-century education.

V. References

Borg, W. R., & Gall, M. D. (1983). *Educational research: An introduction* (4th ed.). New York, NY: Longman.

Branch, R. M. (2009). *Instructional design: The ADDIE approach*. New York, NY: Springer.

Chiu, T. K. F., et al. (2024). Using generative artificial intelligence tools to explain and enhance experiential learning for authentic assessment. *Education Sciences*. https://doi.org/10.3390/educsci14111172

Creswell, J. W., & Plano Clark, V. L. (2018). *Designing and conducting mixed methods research* (3rd ed.). Thousand Oaks, CA: Sage Publications.

Fraenkel, J. R., Wallen, N. E., & Hyun, H. H. (2012). *How to design and evaluate research in education* (8th ed.). New York, NY: McGraw-Hill.

Gall, M. D., Gall, J. P., & Borg, W. R. (2007). *Educational research: An introduction* (8th ed.). Boston, MA: Pearson Education.

Geiger, V., et al. (2021). Identifying pedagogical factors influencing the use of diagnostic assessment in secondary classrooms. *Mathematics Education Research Journal*. https://doi.org/10.1007/s13394-021-00392-5

Hughes, M., et al. (2024). On the use of an online polling platform for enhancing student engagement in an engineering module. *Education Sciences, 14*(5), 536. https://doi.org/10.3390/educsci14050536

Kuzminska, O., et al. (2024). Digital competence of higher education applicants. *Information Technologies and Learning Tools*. https://doi.org/10.33407/itlt.v101i3.5530

Luckin, R., et al. (2024). Challenges and opportunities for classroom-based formative assessment and artificial intelligence. *Computers and Education: Artificial Intelligence*. https://doi.org/10.1016/j.caeai.2024.100213

Lüdtke, O., et al. (2024). Towards a framework to support the implementation of digital formative assessment in higher education. *Assessment & Evaluation in Higher Education*. https://doi.org/10.1080/02602938.2024.2344700

Mahmud, S., et al. (2025). Teachers' reflections on utilizing Slido to enhance learner engagement. *World Journal of English Language, 15*(5), 242. https://doi.org/10.5430/wjel.v15n5p242

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook* (2nd ed.). Thousand Oaks, CA: Sage Publications.

Muntean, C. H., et al. (2024). Exploring the potential of artificial intelligence tools in educational measurement and assessment. *Education Sciences*. https://doi.org/10.3390/educsci14090984

Niculescu, B., et al. (2024). Digital assessment: A survey of Romanian higher education teachers' practices and needs. *Education Sciences*. https://doi.org/10.3390/educsci14020158

Pallitt, N., et al. (2023). Online formative assessment in higher education: A review of the literature. *Education Sciences*. https://doi.org/10.3390/educsci13080756

Redecker, C., et al. (2024). A meta-synthesis study on the use of e-assessment tools in education. *Education Sciences*. https://doi.org/10.3390/educsci14030241

Rienties, B., et al. (2022). Formative assessment strategies for students' conceptions: The potential of learning analytics. *British Journal of Educational Technology*. https://doi.org/10.1111/bjet.13195

Sugiyo, R. A., Effendi, Y. R., & Iswahyudi, D. (2025). The impact of AI ChatGPT on the challenges and opportunities for civics teachers in the Gen Z era. *Jurnal PTI (Pendidikan dan Teknologi Informasi)*, *12*(2), 87–97. https://doi.org/10.35134/jpti.v12i2.240

Schneider, S., et al. (2022). The cognitive-affective-social theory of learning in digital environments (CASTLE). *Educational Psychology Review, 34*(3), 1025–1059. https://doi.org/10.1007/s10648-021-09626-5