

TECHNOLOGY-BASED INQUIRY LEARNING MODEL: VALIDITY TESTING OF MODEL BOOKS AND LEARNING KITS TO ENHANCE HIGH SCHOOL STUDENTS' 21ST-CENTURY SKILLS

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Abstrak

Penelitian ini bertujuan untuk menganalisis validitas instrumen model pembelajaran *Technology-Based Inquiry*, produk penelitian, serta perangkat pembelajaran yang dikembangkan untuk meningkatkan keterampilan abad ke-21 peserta didik sekolah menengah atas pada mata pelajaran Bahasa Indonesia. Produk yang dikembangkan meliputi buku model pembelajaran, buku panduan guru, buku kerja peserta didik, dan perangkat penilaian. Penelitian ini menggunakan metode *Research and Development* (R&D) dengan model pengembangan Plomp yang terdiri atas tiga tahap, yaitu penelitian pendahuluan (*preliminary research*), perancangan dan pengembangan prototipe (*design and development of prototypes*), serta evaluasi (*evaluation*). Pada tahap ini, penelitian telah mencapai tahap penelitian pendahuluan dan perancangan serta pengembangan prototipe. Oleh karena itu, sebelum dilakukan uji kepraktisan dan efektivitas, ketiga produk penelitian dan perangkat penilaian divalidasi oleh ahli (dosen) dan *peer reviewer*. Hasil analisis menunjukkan bahwa: (1) hasil validasi *peer reviewer* memperoleh skor rata-rata 0,86 untuk buku model pembelajaran, 0,84 untuk buku panduan guru, 0,85 untuk buku kerja peserta didik, dan 0,86 untuk perangkat penilaian; dan (2) hasil validasi ahli memperoleh skor rata-rata 0,87 untuk buku model pembelajaran, 0,85 untuk buku panduan guru, 0,85 untuk buku kerja peserta didik, dan 0,86 untuk perangkat penilaian. Seluruh produk dan perangkat penilaian berada pada kategori validitas sangat tinggi. Dengan demikian, produk penelitian dan perangkat penilaian yang dikembangkan dinyatakan memiliki tingkat validitas sangat tinggi dan layak untuk dilanjutkan pada tahap uji kepraktisan dan efektivitas di lapangan.

Kata kunci: *Technology-Based Inquiry*, keterampilan abad ke-21, pembelajaran Bahasa Indonesia, *Research and Development*, model Plomp, validitas.

Abstract

This study aims to analyze the validity of the Technology-Based Inquiry learning model instrument, its research products, and the corresponding instructional materials designed to enhance the 21st-century skills of senior high school students in Indonesian language subjects. The developed products include a learning model book, a teacher's guide, a student workbook, and learning assessments. This study employs Research and Development (R&D) utilizing the Plomp development model, which comprises three phases: preliminary research, design and development of prototypes, and evaluation. Currently, this research has progressed through the preliminary research and prototype design development phases. Consequently, prior to practicality and effectiveness testing, the three research products and the assessment tools

underwent validation by both experts (lecturers) and peers. Based on the analysis, the product validation results are as follows: First, from the peer review, the learning model book scored an average of 0.86, the teacher's guide scored 0.84, the student workbook scored 0.85, and the assessment tools scored 0.86, all falling into the 'very high' validity category. Second, from the expert validation, the learning model book obtained an average score of 0.87, the teacher's guide scored 0.85, the student workbook scored 0.85, and the assessment tools scored 0.86. In conclusion, all research products and assessments achieved a 'very high' validity status, indicating they are highly viable for subsequent practicality and effectiveness field testing.

Keywords: *Technology-Based Inquiry*, 21st-century skills, Indonesian language learning, *Research and Development*, Plomp model, validity.

INTRODUCTION

The importance of language as a communication tool in the 21st century has become a fundamental necessity to support the effectiveness and quality of the learning process. Learning activities are systematically and contextually structured to stimulate student interaction and generate relevant ideas, thereby maximizing the achievement of students' language learning outcomes [1]. Students are required to comprehend, manage, and create effective communication across various forms and contents, including oral, written, and multimedia formats. Furthermore, proficiency in language as a communication tool enables students to express innovative ideas, both during peer discussions and when solving problems within the learning process [2].

Communication skills serve as a key indicator of 21st-century education and represent an essential competency that students must master. Students are required to communicate clearly and functionally, making it imperative that these skills are explicitly trained in the classroom. In this regard, [3] states that communication skills are indispensable for 21st-century students to ensure effective, efficient, and engaging communication. This aligns with the argument put forward by [4] which emphasizes that schools must equip students with 21st-century skills through innovative learning models designed to cultivate communication proficiency.

Communication skills play a pivotal role in navigating the paradigm shifts of 21st-century life, alongside critical thinking, collaboration within group dynamics, creativity and innovation, and digital literacy skills [5], [6], [7], [8]. These communication skills benefit students by enabling them to identify accurate information sources, filter information to construct new knowledge, and utilize that information for

personal development. One strategic approach to fostering these communication skills is through the study of the Indonesian language.

The Indonesian language subject in schools aims to enhance students' communication skills, both orally and in writing. In this regard, [9] states that students learning the Indonesian language must be proficient in communication, enabling them to construct ideas, thought outcomes, and scientific arguments in a responsible and academically ethical manner, as well as disseminate them through various media to both the academic community and the public. A paramount component of effective communication is speaking proficiency. Culturally, while students are highly fluent when communicating outside the school environment, their fluency often diminishes when required to speak in front of the class. Students are generally unaccustomed to expressing their opinions clearly and comprehensively in both oral and written forms. Consequently, the speaking aspect of language learning has not been fully mastered by students. This lack of mastery leads to low self-confidence during classroom presentations, causing students to experience nervousness, fear of making mistakes, and anxiety when expressing their opinions [10].

Indonesian language education holds significant potential for realizing this educational role. According to [11] the Indonesian language subject is expected to equip students with advanced communication skills within the scientific domain. This proficiency is anchored in a comprehensive mastery of language knowledge, linguistic functions, and the diverse methods of producing texts from various sources. Consequently, students are expected to write and speak proficiently in academic Indonesian. In line with this perspective, [12] posits that in addition to fostering communication skills, the Indonesian language subject must be capable of developing language proficiency within the students' social environment. This development enables students to internalize various moral, religious, and social values within their community, while simultaneously empowering them to study other scientific disciplines effectively.

Students are expected to compete effectively in the Industrial Revolution 4.0 era by enhancing their 21st-century skills. However, in reality, Indonesian education faces significant challenges in developing these competencies. This is evidenced by the Programme for International Student Assessment (PISA) report released by the OECD in

2018, which revealed that Indonesian students' reading proficiency fell below the baseline level, with an average score of 371 compared to the OECD average of 487. This condition indicates that students' reading literacy is limited to recognizing basic facts within a concept; they have not yet developed the critical thinking skills required to communicate, connect ideas with other concepts, solve problems, and draw conclusions [13].

Furthermore, Indonesian students perform well in comprehending single texts but struggle with multiple texts. While they are proficient in locating, evaluating, and reflecting on information, they remain weak in deep information comprehension. The assessment reported by [14] PISA interprets that students' 21st-century skills encompassing critical thinking, analysis, problem-solving, collaboration, information literacy, media literacy, and Information and Communication Technologies (ICT) literacy fostered through the learning process remain low [15]. To address these issues, the government reinstated the 2013 Curriculum in [16].

The Technology-Based Inquiry learning model actively engages students in learning and discovering insights aligned with specific concepts. By posting concept-related questions, students can deduce general principles and apply them to language learning. Furthermore, integrating technology boosts students' confidence in their self-discovered ideas. Access to information is also expanded through various digital channels, such as utilizing the internet to retrieve literature relevant to the studied concepts. This aligns with prior findings indicating that internet utilization enhances student comfort and self-confidence in conceptual comprehension [15], [17]. Therefore, internet integration is essential to adapt to contemporary advancements and deliver meaningful learning experiences that capture student engagement [18], [19].

To ensure that the Indonesian language learning process using this inquiry-based model functions effectively and enhances 21st-century skills, it must be integrated with technology. This integration should address behavioral, emotional, and cognitive learning effectiveness while incorporating technological tools that facilitate both teachers and students in delivering and comprehending the material. Consequently, learning objectives can be optimally achieved, fostering greater student activity throughout the learning process.

The novelty of this study lies in its attempt to address the gaps in previous research by implementing a technology-based inquiry framework. The practical application of the Technology-Based Inquiry learning model aims to explore: (1) critical thinking, problem-solving, and creative skills through a discovery-based process; and (2) collaboration and communication skills through group performance, encompassing both peer-to-peer and student-to-teacher interactions. This Technology-Based Inquiry learning model is adapted from the conventional inquiry model, anchored in cognitive and constructivist learning theories. Furthermore, the design of this technology-integrated inquiry model is underpinned by cybernetic learning theory, as its implementation requires students to communicate and manage information from available technological sources to complete learning tasks [20]. Therefore, further development through subsequent research is essential to refine this learning model and yield more innovative scholarly works.

Consequently, developing an adequate learning model is imperative, which is expected to support the achievement of these educational objectives. The development of a learning model aimed at enhancing the 21st-century skills of senior high school students fundamentally requires a feasibility evaluation. This is conducted to ensure that the developed research products comprising the learning model book, teacher's guide, student workbook, and assessment tools are viable for classroom use. A rigorous approach to evaluating product feasibility is through content validity testing. Content validity refers to the extent to which the elements within an assessment instrument are relevant and representative of the targeted construct to align with specific assessment objectives. It is one of the most commonly utilized types of validity to establish instrument reliability during the initial stages of instrument development [22]. In other words, the primary objective of content validity is to minimize instrument construction errors and maximize the probability of achieving construct validity indices in subsequent studies. To establish content validity, the following systematic steps are employed: (1) conducting a comprehensive literature review to capture the essence of the related items; (2) performing a general review of each item using a three-point scale (unnecessary, useful but not essential, and essential); (3) submitting the items to experts within the respective field for review; (4) calculating the Content Validity Ratio (CVR) for each item using the Lawshe method; and (5) eliminating items that fail to

reach the critical significance level, adhering to the critical values outlined in the Lawshe method [23].

There are several methods available to evaluate content validity, one of which is Aiken's V content validity coefficient. Utilizing Aiken's V for content validation provides a comprehensive assessment profile for measurement instruments evaluating both cognitive and non-cognitive aspects. Within the context of developing the Technology-Based Inquiry learning module, the function of Aiken's V is to determine the feasibility of the product content based on ratings provided by raters, ensuring alignment with the learning model's syntax. This assumes that each of the n raters examines every item and assigns a rating based on a c -category ordinal scale (ranging from the lowest to the highest category) to reflect their evaluation of the content validity of the assessed aspects [23]. Specifically, two raters evaluated the feasibility of the research products comprising the learning model book, teacher's guide, student workbook, and assessment tools based on their respective indicators or components. Consequently, conducting content validity testing is paramount in the development of the Technology-Based Inquiry learning model to ascertain the viability of the generated research products. However, comprehensive findings regarding the validity testing outcomes of the Technology-Based Inquiry learning model aimed at enhancing the 21st-century skills of senior high school students remain unexplored. Therefore, this study aims to determine the validity of these research products, specifically the learning model book, teacher's guide, student workbook, and the corresponding learning assessment tools.

METHOD

The development of educational practices can be carried out through Research and Development (R&D) methods [24], [25]. *Research and Development is a research methodology employed to develop and validate instructional products, which are subsequently tested for their practicality and effectiveness* [25]. Similarly, the Technology-Based Inquiry learning model was developed using this research and development approach, specifically guided by the Plomp development model framework.

Based on the Plomp model, the development process consists of three distinct phases: (1) Preliminary Research, which involves conducting literature studies, needs and context analyses, curriculum analysis, and the formulation of a conceptual framework; (2) Design and Development of Prototypes, which entails designing interventions followed by formative evaluation; and (3) Evaluation, which serves as a summative evaluation phase to determine whether the intervention fulfills the specified criteria [26].

The information and theoretical insights gathered from both the literature review and needs analysis were utilized to design and develop the conceptual framework for the Technology-Based Inquiry learning model. According to [26] the conceptual framework developed encompasses the product's characteristics and objectives, as well as the core components of the Technology-Based Inquiry learning model, namely its syntax, principles of reaction, social system, and support system.

2.1 Prototype Design and Development Phase

This phase aims to design interventions based on the findings from the preliminary research phase. The activities conducted include structuring the components of the Technology-Based Inquiry learning model and developing the required instruments. A formative evaluation is employed during this phase, as formulated by Tessmer in Plomp & Nieveen. The evaluation methods applied in this phase consist of self-evaluation, expert review, one-to-one evaluation, small-group evaluation, and field testing.

2.1.1 Prototype 1

Based on the analysis results from the preliminary research phase, the Technology-Based Inquiry learning model was designed. The outcome of this initial prototype design is designated as Prototype 1. The subsequent step involved experts validating the instruments used for collecting validity, practicality, and effectiveness data. Once the instruments were declared valid by the experts, a self-evaluation was conducted on Prototype 1. The self-evaluation instrument utilized the same item questions as the validation instrument. This self-evaluation was carried out to identify design errors and was conducted by peers.

The purpose of the self-evaluation was to achieve product criteria that are relevant, scientifically grounded, consistent, and possess the expected practicality. Following this process, Prototype 1 was revised to produce Prototype 2, which then proceeded to the next evaluation phase.

2.1.2 Prototype 2

Once Prototype 2 was established, an expert review was conducted. This validation process was carried out by several educational experts. The validation targeted the Technology-Based Inquiry learning model, which was operationalized through the validation of the learning model book, student workbook, teacher's guide, and the 21st-century skills assessment instruments. The validation process encompassed three dimensions: (1) content validity, which evaluates whether the structured learning model book, student workbook, teacher's guide, and 21st-century skills instruments are feasible and aligned with the predetermined development elements; (2) construct validity, which assesses the consistency and alignment of the components within the learning model book, student workbook, teacher's guide, and 21st-century skills instruments with the established development elements; and (3) language validity, which ensures that the language utilization conforms to proper grammatical and spelling standards.

The validation was performed by experts in their respective fields to gather constructive feedback regarding all validity aspects of the Prototype 2 design. The validation of Prototype 2 involved five experts, consisting of lecturers from Universitas Negeri Padang and Universitas PGRI Sumatera Barat.

No	Nama	Bidang Kepakaran
1	Prof. Agustna, M.Hum	Indonesian Language Learning Models
2	Dr. Sulastri, M.Pd.	Educational Science
3	Dr. Faiza Rini, M.Kom.	Educational Technology
4	Dr. Abdurrahman, M.Pd.	Linguistics
5	Dr. Silvia Marni, M.Pd.	Indonesian Language Education

Table 1. List of Validators (Lecturers)

Based on the feedback and recommendations from the experts, Prototype 2 was revised. The validation process was conducted through written feedback and constructive discussions until a consensus was reached among the experts, confirming

that the developed Technology-Based Inquiry learning model was valid. Consequently, Prototype 3 was established.

2.1.3 Prototype 3

Subsequently, Prototype 3 was evaluated using two formative evaluation methods: (a) One-to-one evaluation, which involved selecting three students representing high, medium, and low academic abilities, respectively, to provide qualitative feedback on the developed student workbook. Concurrently, the teacher was also interviewed to gather their perspective regarding the learning model book, student workbook, and teacher's guide; (b) Small-group evaluation, where the revised learning model book, teacher's guide, and student workbook were implemented across two groups of students, with each group comprising four participants. The students were requested to provide feedback on the designed materials. Similarly, the teacher's input regarding the learning model book, teacher's guide, and student workbook was also obtained. Based on the constructive feedback provided by both the students and the teacher, the research products were iteratively revised. Following these comprehensive evaluations of Prototype 3, the materials were refined to establish the final prototype, which was subsequently utilized for field testing.

2.1.4 Prototype final

The final formative evaluation within this comprehensive phase is the field test. In this stage, the final prototype is implemented under real classroom conditions to ascertain the quality of the Technology-Based Inquiry learning model in enhancing students' 21st-century skills. The field testing is conducted at senior high schools that have already implemented the *Kurikulum Merdeka* (Independent Curriculum). The selection of the control and experimental classes at each designated school is determined using a purposive sampling technique, specifically chosen based on a predetermined objective of selecting classes with the highest average academic performance.

2.2 Instruments for Validity, Formative Evaluation, and Practicality Assessment

All instruments utilized in this study were validated prior to deployment using instrument validation assessment sheets. The outcomes of the instrument validation

and subsequent revisions demonstrated that the validation, formative evaluation, and practicality instruments were highly viable for validating the developed products. The full list of the instruments employed in this study is presented in Table 2.

Number	Assessment Instrument	Instrument
1	Instrument validation assessment sheets	Validation/self-evaluation: Learning model book, Teacher's guide, Student workbook
2	Formative evaluation assessment sheets	Formative evaluation: One-to-one evaluation, Small-group evaluation
3	Practicality instrument assessment sheets	Practicality: Teacher responses, Student responses

Table 2. Instruments for Validity, Formative Evaluation, and Practicality Assessment

The validation instruments serve to gather data regarding the validity of the developed learning model book, teacher's guide, student workbook, and 21st-century skills assessment tools. The developed validation instruments are anchored in evaluation indicators for content validity, construct validity, and language validity. The specific instruments utilized to collect the validation data are presented in Table 3 below.

Number	Instrument	Technique	Aspect
1	Learning Model Book Validation	Questionnaire	Rationalization of supporting concepts
			Model components
			Book construction
			Language
2	Teacher's Guide Validation	Questionnaire	Book construction
			Language
			Rationalization of supporting
3	Student Workbook Validation	Questionnaire	Book construction
			Language
			Rationalization of supporting

Table 3. Validation Instruments

RESULTS AND DISCUSSION

The validation results of Prototype 2 of the Technology-Based Inquiry learning model were evaluated by both peers and experts (lecturers). In this section, the peers and experts were requested to assess and provide constructive recommendations for refining Prototype 2 as a fundamental prerequisite to fulfill the first criterion of intervention quality, namely validity.

3.1 Peer Validation Results of the Technology-Based Inquiry Learning Model

The validation results of Prototype 2 of the Technology-Based Inquiry learning model were obtained from both peers and experts. In this section, the peers were requested to assess and provide constructive recommendations for refining Prototype 2 to fulfill the first criterion of intervention quality, which is validity. The assessment encompassed content, construct, and language viability. This evaluation was carried out by peers.

Number	Name	Area of Expertise	Affiliation
1	Rahayu Tri Setiawati, M.Kom	Educational Technology	Universitas PGRI Sumbar
2	Rahayu Fitri, M.Pd.	Indonesian Language Education	Universitas PGRI Sumbar
3	Ricci Kardo, M.Pd., Kons.	Educational Science	Universitas PGRI Sumbar
4	Rina Sartika, M.Pd.	Linguistics	Universitas PGRI Sumbar
5	Yulia Pebriani, M.Pd.	Indonesian Language Education	Universitas PGRI Sumbar

Table 4. List of Peers (Peer Reviewers)

Based on the feedback from the peers and the validity calculation results, Prototype 2 was revised to establish a valid product. The data analysis was conducted based on the scores assigned by the validators. The processing of the product validity data was performed using the formula [27].

Product	Component	Validity	
		Score (V)	Category
Learning Model Book	Construct:		
	1. Presentation	0,86	Very High
	2. Graphics	0,81	Very High
	Content:		
	1. Learning model rationale	0,87	Very High
	2. Theoretical basis of the learning model	0,87	Very High
	3. Learning model syntax	0,85	Very High
	4. Social system	0,85	Very High
	5. Reaction principles	0,87	Very High
	6. Support system	0,87	Very High
		0,87	Very High

Product	Component	Validity	
		Score (V)	Category
	7. Instructional and nurturant effects	0,86	Very High
	8. Language		
	Average	0,86	Very High
Teacher's Guide	Construct:		
	1. Presentation	0,85	Very High
	2. Graphics	0,81	Very High
	Content:		
	1. General guidelines	0,87	Very High
	2. Specific guidelines	0,85	Very High
	3. Language	0,86	Very High
	Average	0,85	Very High
Student Workbook	Construct:		
	1. Presentation	0,86	Very High
	2. Graphics	0,86	Very High
	3. Workbook Viability	0,85	Very High
	4. Language	0,85	Very High
	Average	0,85	Very High
Assessment	Construct	0,87	Very High
	Content Validity	0,85	Very High
	Language	0,85	Very High
	Average	0,86	Very High

Table 5. Peer Validation Results of the Research Products

Based on the validation results presented in Table 5, it is evident that the Technology-Based Inquiry learning model compiled into the learning model book and complemented by the teacher's guide, student workbook, and 21st-century skills assessment tools achieved a Very High validity category. Examining each component, the learning model book obtained an average validity score of 0.86 (Very High). The teacher's guide reached an average validity score of 0.85 (Very High), while the student workbook also achieved an average validity score of 0.85 (Very High). Furthermore, the assessment tools yielded an average validity score of 0.86 (Very High). Consequently, Prototype 2 of the Technology-Based Inquiry learning model is deemed feasible and viable for implementation in Indonesian language instruction at the senior high school level. This version of Prototype 2 is subsequently designated as Prototype 3 of the Technology-Based Inquiry learning model, which was then utilized in the one-to-one and small-group evaluations.

3.2 Expert Validation Results of the Technology-Based Inquiry Learning Model

Based on the expert validation data, the evaluation process involved experts in presentation, linguistics, typography/graphics, and content. All validators assessed the products in accordance with the specific aspects established for the learning model book, teacher's guide, student workbook, and assessment tools. Furthermore, the linguistics expert conducted a specific validation on the short story writing assessment tools, focusing on the aspects of content viability, language propriety, orthographic/writing mechanics, and graphical viability. This validation phase was carried out by five experts, all of whom are university lecturers specializing in their respective fields.

Number	Name	Area of Expertise
1	Prof. Agustna, M.Hum	Indonesian Language Learning Models
2	Dr. Sulastri, M.Pd.	Educational Science
3	Dr. Faiza Rini, M.Kom.	Educational Technology
4	Dr. Abdurrahman, M.Pd.	Linguistics
5	Dr. Silvia Marni, M.Pd.	Indonesian Language Education

Table 6. List of Expert Validators (Lecturers)

Based on the experts' feedback and recommendations, Prototype 2 was revised. The validation process involved written evaluations and discussions until a consensus was reached, confirming that the developed Technology-Based Inquiry learning model was valid, thereby yielding Prototype 3. Data analysis was conducted using the scores assigned by the validators, and the product validity data were processed using the formula [27].

Produk	Komponen	Validitas	
		Skor (V)	Keterangan
Learning Model Book	Construct:		
	1. Presentation	0,84	Very High
	2. Graphics	0,81	Very High
	Content:		
	1. Learning model rationale	0,88	Very High
	2. Theoretical basis of the learning model	0,88	Very High
	3. Learning model syntax	0,85	Very High
	4. Social system	0,83	Very High
	5. Reaction principles	0,86	Very High
	6. Support system	0,88	Very High
	7. Instructional and nurturant effect	0,86	Very High
	8. Language	0,85	Very High

	Average	0,87	Very High
Teacher's Guide	Construct:		
	1. Presentation	0,86	Very High
	2. Graphics	0,81	Very High
	Content:		
	1. General guidelines	0,86	Very High
	2. Specific guidelines	0,85	Very High
	3. Language	0,85	Very High
	Average	0,85	Very High
Student Workbook	Construct:		
	1. Presentation	0,86	Very High
	2. Graphics	0,75	High
	3. Workbook Viability	0,86	Very High
	4. Language	0,85	Very High
	Average	0,85	Very High
Assessment	Construct	0,87	Very High
	Content Validity	0,84	Very High
	Language	0,85	Very High
	Average	0,86	Very High

Tabel 7. Hasil Validasi oleh Ahli (Dosen) Produk Penelitian

Based on the validation results presented in Table 7, it is evident that the Technology-Based Inquiry learning model encompassing the learning model book, teacher's guide, student workbook, and 21st-century skills assessment tools achieved a Very High validity category, with average validity scores of 0.87 for the learning model book, 0.85 for the teacher's guide, 0.85 for the student workbook, and 0.86 for the assessment tools. Consequently, Prototype 2 of the Technology-Based Inquiry learning model is deemed highly feasible and viable for implementation in Indonesian language instruction at the senior high school level, and this refined version is subsequently designated as Prototype 3 to be further utilized in the one-to-one and small-group evaluations.

3.3 Discussion on the Validation Results of the Technology-Based Inquiry Learning Model

The validity results of the Technology-Based Inquiry learning model encompass the learning model book along with its support systems, namely the teacher's guide,

student workbook, and 21st-century skills assessment tools. Based on statistical calculations and feedback from the validators, it can be concluded that these products have successfully fulfilled the validity criteria. To rationalize the model, the developed Technology-Based Inquiry learning model is anchored in appropriate theories and demonstrates strong internal consistency across its pedagogical components. The following sections elaborate on the validation results based on the primary components of the learning model, including syntax, social systems, principles of reaction, support systems, and instructional and nurturant effects.

The syntax of the Technology-Based Inquiry learning model comprises the following instructional phases: planning, problem presentation, hypothesis generation, hypothesis testing, presentation, and evaluation. Validation results indicated that the average validity score for the model's syntax was 0.88, falling into the Very High validity category. This validation signifies that each phase of the Technology-Based Inquiry model represents a logical sequence of activities, possesses explicit objectives, details clear teacher and student actions, is highly practicable, supports the attainment of learning objectives, and accommodates the development of 21st-century skills.

Presenting ideas regarding a given phenomenon and providing triggering questions motivate students to beforehand study the foundational materials for the upcoming lesson. Consequently, after engaging in brainstorming, students acquire the necessary prior knowledge to face classroom instruction. Building students' prior knowledge before instruction takes place is highly critical. According to [28], students with prior knowledge are better prepared for the upcoming learning process and exhibit significantly better academic performance than students without prior knowledge. Moreover, the attainment of learning objectives through collaborative learning is heavily dependent on students' prior knowledge [29],[30].

The validation results revealed that the average validity score for the model's social system was 0.85, categorized as Very High. [31] posits that the social system is an instructional vehicle that describes the interaction between teachers and students, as well as between students and their peers. Therefore, the social system of a learning model must provide a well-structured, clear, and highly practicable relationship pattern between the teacher's role and student activities, thereby supporting the achievement of learning outcomes

The validation results showed that the average validity score for the model's principles of reaction was 0.83, within the Very High validity category. The Technology-Based Inquiry learning model aims to hone students' 21st-century skills, with a strong emphasis on collaborative, scientific, and authentic investigation processes, similar to the inquiry learning model suggested by [32],[33], [34]. The activities within the Technology-Based Inquiry model imply that the teacher's reaction during the collaborative, scientific, and authentic investigation process is to facilitate students in discovering and cooperating, rather than conducting the investigation for them.

The validation results demonstrated that the average validity score for the model's support system was 0.87, representing a Very High validity category. According to [31] the primary support system in a discovery-based learning model is a series of problems that provoke intellectual confrontation (disequilibrium/perplexity) within students. Similarly, the Technology-Based Inquiry model relies on a diverse range of instructional materials; the support system utilized to present and accommodate the discovery process is embodied in the instructional materials. These instructional materials are delivered through the student workbook. The student workbook exerts a positive effect on enhancing students' higher-order thinking skills. In addition to the student workbook, the teacher's guide and 21st-century skills assessment tools are also required to guide teachers in effectively implementing the Technology-Based Inquiry learning model and evaluating students' 21st-century skills.

The validation results indicated that the average validity score for the instructional and nurturant effects of the model was 0.88, categorized as Very High. The instructional effect of the Technology-Based Inquiry learning model is its capacity to enhance students' 21st-century skills. Students are actively engaged in observing problems, gathering information, analyzing data, discussing, collaborating, and presenting their findings. Meanwhile, the nurturant effects of the Technology-Based Inquiry model include curiosity, thoroughness, honesty, earnestness, discipline, politeness, self-confidence, and respect for others' opinions. According to [31], the nurturant effect of a self-discovery model is the development of positive attitudes resulting from the habituation of the scientific process. This is further corroborated by [35],[36] who state that the discovery process significantly impacts students' scientific

attitudes and scientific skills. who state that the discovery process significantly impacts students' scientific attitudes and scientific skills.

CONCLUSION

In conclusion, the validity of the Technology-Based Inquiry learning model products successfully met the criteria recommended in the literature, achieving a Very High validity category. This indicates that the Technology-Based Inquiry learning model is highly viable and feasible for implementation in Indonesian language subjects at the senior high school level. Consequently, the research proceeds to the subsequent phases, namely the practicality and effectiveness stages, utilizing the developed instruments in one-to-one and small-group evaluations.

Based on the peer validation results, the Technology-Based Inquiry learning model comprising the learning model book, teacher's guide, student workbook, and 21st-century skills assessment tools—fell into the Very High validity category. Specifically, the learning model book obtained an average validity score of 0.86 (Very High), the teacher's guide achieved 0.85 (Very High), the student workbook reached 0.84 (Very High), and the assessment tools yielded 0.86 (Very High). Similarly, the expert validation results from university lecturers confirmed a Very High validity category for the entire package. In the expert review, the learning model book attained an average validity score of 0.87 (Very High), the teacher's guide scored 0.85 (Very High), the student workbook obtained 0.83 (Very High), and the assessment tools reached 0.86 (Very High). Therefore, Prototype 2 of the Technology-Based Inquiry learning model is empirically deemed feasible for implementation in senior high school Indonesian language instruction. This validated version is subsequently designated as Prototype 3 to be deployed in the upcoming one-to-one and small-group evaluations.

The implications of these validation results offer significant benefits for both students and teachers, particularly in optimizing senior high school Indonesian language instruction. Furthermore, the application of this model is not strictly limited to Indonesian language subjects but holds the potential to be adapted across various other disciplines. Consequently, the Technology-Based Inquiry learning model serves as a validated framework that can be further tailored to meet specific field needs and practical utilities. To complete the scope of this study, it is highly recommended that

teachers continuously evaluate the instructional models used in Indonesian language classrooms and other subjects. Additionally, educators need to enhance their professional competencies to master diverse learning models, thereby fostering an engaging and comfortable learning environment that effectively drives the attainment of learning objectives.

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