



Validity and Reliability: Pedagogical Adaptability and Contextual Digital Learning Instrument for Teachers in the NKRI-RDTL Border Area

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ABSTRACT

Purpose - This study aimed to develop and examine the validity and reliability of pedagogical adaptability and contextual digital learning development instruments for senior high school teachers in the NKRI-RDTL border area.

Methodology - This study employed a quantitative approach using an instrument development research design. The study involved 64 senior high school teachers and four expert validators. Instrument development was carried out through the stages of theoretical construct development, indicator and item blueprint formulation, expert validation, instrument revision, field testing and validity and reliability analysis. Content validity was analyzed using Aiken's V, empirical validity was analyzed using Pearson Product-Moment correlation, and instrument reliability was analyzed using Cronbach's Alpha.

Findings - The findings showed that the developed instruments had high content validity, with Aiken's V values ranging from 0.88 to 1.00. The empirical validity test showed that most statement items were valid, while the reliability of both instruments was categorized as high to very high. These findings indicate that the developed instruments are appropriate for measuring pedagogical adaptability and contextual digital learning development in border areas.

Contribution - The novelty of this study lies in the development of instruments designed based on the characteristics of learning in border areas, particularly in relation to the demands of adaptive and contextual digital learning. The developed instruments can be used as assessment tools to map teachers' personal capacities more accurately and to support teacher competency development programs in border areas.

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INTRODUCTION

Education is an essential process that shapes the quality of life and national development (Amadi, 2023; Sele & Dewi, 2025; Zamhari et al., 2023). To support the development of an intelligent, competent and competitive Indonesian society, the government has implemented various efforts to improve the quality of national education. Through strengthening educational regulations and introducing various innovative programs, the government expects the quality of learning in schools to continue improving over time. Educational innovation is directed toward improving the quality of the learning process so that educational goals can be achieved more effectively. Among the various strategic policies introduced by the government, the implementation of the Merdeka Belajar policy has become one of the major initiatives promoting learning approaches that are more creative, flexible and relevant to the needs of students and society (Lembong et al., 2023).

The implementation of the Merdeka Belajar policy encourages teachers to develop learning processes that are contextual, adaptive and aligned with the development of science and technology (Indarta et al., 2022). One-way learning practices that position teachers as the central subject of learning can no longer be maintained because they do not provide students with opportunities to learn actively, explore ideas and interpret the learning materials they study. Teachers are therefore challenged to create meaningful learning experiences. Learning should provide students with opportunities to actively construct their own understanding and use that understanding to solve problems encountered in their daily lives.

Another demand that teachers must fulfill is the ability to integrate digital technology into the learning process. Technological development has encouraged a transformation from conventional learning patterns toward digital learning that aligns with the demands of 21st-century education and Society 5.0, which emphasizes problem-solving skills, critical thinking, communication, creativity, collaboration and digital literacy (Rahayuningsih & Muhtar, 2022). Therefore, mastery of subject content alone is no longer sufficient for teachers. Teachers also need the ability to manage technology-based learning that is relevant to students' real-life contexts.

The success of learning transformation is strongly influenced by the readiness of various parties, particularly teachers as the main facilitators of learning. Erviana (2023) explained that teachers need competencies that are aligned with current educational demands, including the ability to utilize rapidly developing information technology. Digital technology needs to be integrated into learning not only as learning media and learning resources, but also as a means of enriching students' learning experiences. Previous studies have also reinforced the importance of teacher competencies in responding to current and future educational demands. Silalahi et al. (2021) explained that teachers need adequate personal and professional competencies to effectively carry out their roles as learning facilitators. Polizzi et al. (2019) further explained that learning situations that do not always proceed according to plan require teachers to have self-confidence and flexibility in innovating. Similarly, Anif et al. (2019) emphasized that teachers need to continuously improve themselves, reflect on their teaching practices and adapt to the various changes occurring in education.

In the implementation of digital learning, one of the personal capacities that teachers need to possess is pedagogical adaptability. Pedagogical adaptability refers to teachers' ability to adjust learning strategies, learning media and instructional approaches according to students' needs and continuously changing technological developments. Teachers with strong pedagogical adaptability are more capable of adjusting learning practices to the conditions they encounter in the classroom. They are also able to select varied and appropriate learning strategies that match students' diverse needs. Granziera et al. (2019) explained that pedagogical adaptability has become a fundamental capacity that teachers need in the digital era, a period in which learning is faced with both challenges and opportunities resulting from rapid technological development and changing learning dynamics. In line with this, Chen (2023) explained that teachers with high pedagogical adaptability are better able to adjust their teaching strategies to local conditions and limitations while utilizing technology flexibly. Teachers are therefore not only able to adapt to changes in learning, but

are also able to use those changes to improve the quality of learning.

In addition to pedagogical adaptability, current learning practices also require teachers to have the ability to develop contextual digital learning. Teachers are not only encouraged to utilize and integrate technology into learning, but also to connect learning with students' real-life experiences so that the material being studied becomes more relevant and easier to understand. This type of learning encourages teachers to creatively utilize digital technology and students' real-life contexts in the learning process. Digital resources, natural resources, social resources and various phenomena closely related to students' daily lives can become learning resources that help students understand learning materials more concretely. Project-based learning activities, case studies and problem-solving activities based on real situations in the school environment are learning activities designed and implemented collaboratively by teachers and students. Garzón & Garzón (2023) explained that the integration of technology with students' real-life contexts can become a strategic effort to improve students' motivation, active engagement, conceptual understanding, critical thinking and problem-solving skills.

Nevertheless, the development of contextual digital learning still faces various challenges. Rahayuningsih & Muhtar (2022) and Sahelatua et al. (2018) explained that there are two major factors contributing to the low integration of technology in learning, namely limited facilities and infrastructure, as well as teachers' limited ability to utilize technology. Among these factors, limited facilities and infrastructure are often considered the main cause of the low quality of contextual digital learning. In border areas, in particular, the limited availability of technology-based facilities compared to other regions in Indonesia is often viewed as one of the main factors contributing to the low integration of technology into contextual learning (Nama & Tanggur, 2022).

The challenges involved in developing and implementing contextual digital learning become more complex in schools located in North Central Timor Regency, an Indonesian border area directly adjacent to Timor Leste. The geographical and social conditions of border communities are often viewed as obstacles for teachers in managing digital learning. These conditions have contributed to the less optimal implementation of digital learning that is connected to students' real-life contexts and relevant to their needs. Sele and Santiari (2025) explained that the availability of technological infrastructure, internet access and digital learning media are factors that can influence the quality of learning in the digital era. Despite these limitations, teachers are still expected to carry out learning innovations, including adjusting learning practices to the conditions and resources available in schools.

The less optimal implementation of contextual digital learning, which is often associated with limitations in facilities and infrastructure, needs serious attention because these are not the only factors contributing to the low quality of learning (Bentri et al., 2022). Other factors that may have even greater influence are teachers' personal capacities, including their knowledge, attitudes and skills in implementing contextual digital learning. Teachers have the responsibility to create effective and sustainable learning experiences (Sele & Sila, 2022). Given the more challenging conditions compared to other regions, teachers in border areas need to be equipped with pedagogical adaptability and the ability to develop contextual digital learning. These personal capacities can help teachers maintain the quality of learning while also providing meaningful learning experiences for students.

Following the growing concern regarding the importance of pedagogical adaptability and contextual digital learning development, efforts to strengthen these personal teacher capacities are needed. Sumaryanta et al. (2018) explained that one of the strategic factors determining the success of teacher capacity development programs is the implementation of appropriate and contextual assessment practices. Assessment results can serve as the basis for mapping teachers' capacities and designing capacity development programs that align with actual field needs. However, until now, there has been no instrument specifically developed to assess pedagogical adaptability or teachers' ability to design digital learning that is relevant to local contexts. Previous instruments have mainly focused on digital literacy, self-efficacy and teachers' readiness to design digital learning (Arvianto et al., 2023; Rahayu et al., 2024). Previous studies such as Paredes-Aguirre et al.

(2024) primarily discussed aspects of digital self-efficacy. Meanwhile, other studies focused more on technological readiness in general without linking it to pedagogical aspects (Garzón & Garzón, 2023; Siddiq & Scherer, 2019). These conditions indicate a research gap that still needs to be addressed. Therefore, this study focuses on developing instruments specifically designed for teachers and learning practices in border areas.

The limited availability of valid, reliable and specific instruments for measuring pedagogical adaptability and contextual digital learning development has made the mapping of teachers' personal capacities in border areas less accurate. In fact, accurate mapping is essential for designing teacher training programs and educational policies that are aligned with actual needs. Based on these considerations, this study aimed to develop and examine the validity and reliability of pedagogical adaptability and contextual digital learning development instruments for senior high school teachers in the Indonesia-Timor Leste border area. This study is expected to produce instruments that are valid, reliable and relevant to the conditions faced by teachers in border areas. In addition to research purposes, the developed instruments can also be used by stakeholders to identify teachers' competency development needs in a more accurate and contextual manner.

METHODOLOGY

Research Design

This study employed a quantitative approach using an instrument development research design. This design was selected to produce valid and reliable instruments for measuring two important aspects of digital learning, namely pedagogical adaptability and contextual digital learning development. The instrument development procedures used in this study referred to standard instrument development procedures, as presented in Figure 1. These procedures are consistent with the explanations provided by DeVellis (2017) and Taherdoost (2016), who emphasized that the implementation of standard development procedures helps ensure alignment between the constructs being measured and the resulting instruments. This approach also ensures that the developed instruments can be used not only for research purposes, but also in educational practice.

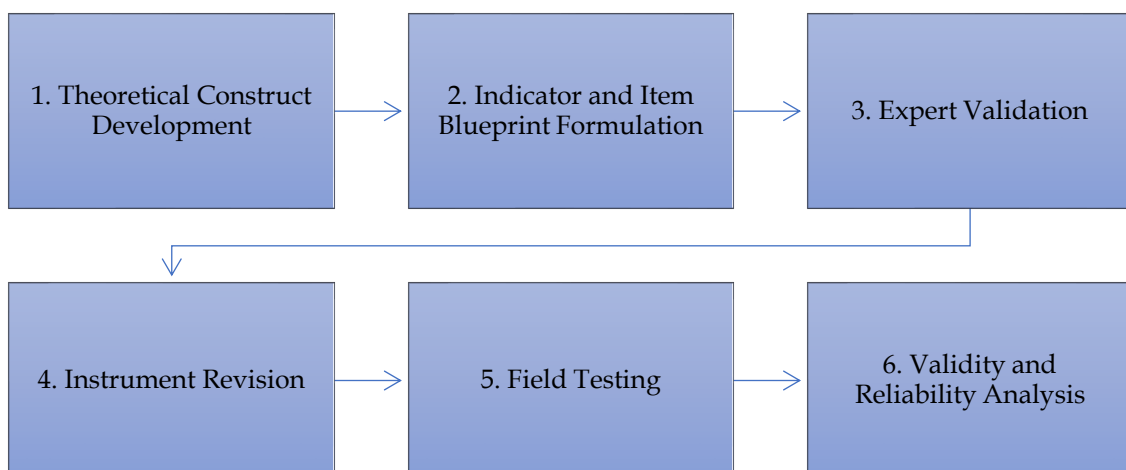


Figure 1. Stages of Instrument Development

Participants

The participants in this study were 64 senior high school teachers in North Central Timor Regency, East Nusa Tenggara Province, one of the regions directly bordering Timor Leste. To provide a more contextual description of pedagogical adaptability and contextual digital learning development in border-area schools, the participants came from various subject areas and had diverse teaching experiences, ages and gender backgrounds. Participants were selected using a simple random sampling technique to ensure that the sample

adequately represented the population of senior high school teachers in border areas. Through the use of simple random sampling, each member of the population had an equal opportunity to be selected as a participant, allowing the findings to better represent the target population (Creswell & Creswell, 2018).

In addition to involving senior high school teachers, this study also involved four validators during the instrument content validation stage. The validators were selected based on the relevance of their expertise to the constructs being developed, namely learning evaluation, digital learning development, instructional design, and instrument evaluation and development. Through their academic and practical experience, the validators played an important role in ensuring the alignment between the statement items, indicators and measured constructs. The validators also provided suggestions for improving the wording and language accuracy of each statement item in the instruments.

Data Collection

Data collection for the validity and reliability testing of the pedagogical adaptability and contextual digital learning development instruments for senior high school teachers in the Indonesia–Timor Leste border area was conducted through two main stages, namely:

Expert Content Validation

The initial draft of the instruments, which had been developed through the stages of theoretical construct development, indicator formulation and instrument blueprint preparation, was evaluated by four validators. The pedagogical adaptability instrument consisted of 22 statement items representing five indicators of pedagogical adaptability. These indicators included learning planning, flexibility in learning implementation, innovation and adaptive technology implementation, local potential-based learning, and reflection and improvement practices. Meanwhile, the contextual digital learning development instrument consisted of 16 statement items representing four indicators, namely contextual digital learning planning, contextual digital learning implementation, integration of digital and local potential in learning, and contextual digital learning evaluation. The instruments were developed using a five-point Likert scale with response options ranging from strongly agree to strongly disagree.

During the content validation stage, the validators assessed the suitability of each statement item with the indicators, including the feasibility of the instruments in terms of content, construct and language aspects. Each validator provided assessments using the prepared content validation sheets. The validators also provided comments and suggestions that became the basis for revising the instruments before the field testing stage.

Field Testing

The revised instruments, which had been improved based on the validators' suggestions, were then distributed to and completed by the participants in this study, namely 64 senior high school teachers. The instruments used a Likert scale format. After the instruments were completed, scoring and data tabulation were conducted. The field testing data were subsequently used to examine the empirical validity and reliability of the instruments.

Instruments

Two instruments were developed in this study, namely the pedagogical adaptability instrument and the contextual digital learning development instrument. Content validity was assessed using a content validation sheet. Meanwhile, empirical validity and reliability data were collected using the pedagogical adaptability instrument and the contextual digital learning development instrument that had been revised based on the validators' suggestions.

Data Analysis

Content validity was analyzed using Aiken's V based on the assessments provided by four validators. The assessment included the suitability of the statement items with the indicators, as well as the feasibility of

the instruments in terms of content, construct and language aspects. The Aiken's V value was calculated using the following formula:

$$V = \Sigma s / n(c - 1)$$

Where:

(V) = Aiken's Validity Index

(s) = the score assigned by the validator minus the lowest score in the rating category

(n) = number of validators

(c) = number of rating categories

The Aiken's V value indicates the content validity of the instruments, where values closer to 1 indicate higher levels of content validity. Furthermore, empirical validity was analyzed using Pearson Product-Moment analysis, while instrument reliability was analyzed using Cronbach's Alpha. These analyses were conducted using JASP software. For empirical validity testing, statement items were considered valid if there was a significant relationship between the item scores and the total scores, indicated by a significance value lower than 0.05. In addition to the significance value, the direction and strength of the correlation were also considered in determining item validity. Meanwhile, for reliability testing, the instruments were considered reliable if they had a Cronbach's Alpha coefficient greater than 0.70 (Taber, 2018).

FINDINGS

The initial stage in instrument development was carried out through theoretical construct development, indicator formulation and instrument blueprint preparation. This process resulted in clear and measurable construct structures. The pedagogical adaptability instrument was developed based on five main indicators, while the contextual digital learning development instrument was developed based on four indicators. Overall, the pedagogical adaptability instrument consisted of 22 statement items, whereas the contextual digital learning development instrument consisted of 16 statement items. The details of the indicators and the number of items in both instruments are presented in Table 1.

Table 1. Indicators and Number of Items of the Instrument

Instrument	Indicator	Item Numbers	Number of Items
Pedagogical Adaptability	Adaptability in Lesson Planning	1, 2, 3, 4, 5	5
	Flexibility in Learning Implementation	6, 7, 8, 9, 10	5
	Innovation and Adaptive Use of Technology	11, 12, 13, 14, 15	5
	Learning Based on Local Potential	16, 17, 18, 19	4
	Reflection and Continuous Improvement	20, 21, 22	3
	Total		22
Contextual Digital Learning Development	Planning of Contextual Digital Learning	1, 2, 3, 4	4
	Implementation of Contextual Digital Learning	5, 6, 7, 8	4
	Integration of Digital Resources and Local Potential in Learning	9, 10, 11, 12	4
	Evaluation of Contextual Digital Learning	13, 14, 15, 16	4
	Total		16

The indicators developed in both instruments were selected to represent teachers' ability to adjust learning practices to the conditions encountered in schools and to develop contextual digital learning that aligns with the characteristics of border areas. Indicators related to learning planning, learning implementation, adaptive technology integration and the integration of local potential were selected to reflect teachers' ability to respond to learning challenges in a contextual manner. The distribution of statement items was arranged proportionally to ensure that each indicator was represented comprehensively.

Content Validity

The results of the data analysis based on the assessments provided by the four validators showed that all statement items in the pedagogical adaptability and contextual digital learning development instruments were categorized as valid. The Aiken's V values of the developed instruments ranged from 0.88 to 1.00, with average values above 0.90. The detailed results of the content validation for both instruments are presented in Table 2.

Table 2. Summary of Content Validity Results of the Developed Instrument

Instrument	Range of Aiken's V	Number of Items	Average Aiken's V	Category
Pedagogical Adaptability	0.88 - 1.00	22	0.94	High
Contextual Digital Learning Development	0.88 - 1.00	16	0.936	High

The high Aiken's V values indicate that the developed statement items were well aligned with the indicators and theoretical constructs underlying the instruments. These findings also show that the validators had similar judgments regarding the relevance and appropriateness of each statement item. Therefore, both instruments were considered to have good content quality and were regarded as suitable for measuring teachers' pedagogical adaptability and contextual digital learning development, particularly in border areas. During the content validation stage, the validation process did not only produce quantitative data used to determine the Aiken's V values. Qualitative data in the form of comments and suggestions from each validator were also obtained and used as the basis for revising the statement items. The revised instruments were subsequently used in the field testing stage, and the results were analyzed to determine the empirical validity and reliability of the instruments.

Empirical Validity

Pearson correlation between item scores and total scores was used as the basis for determining the empirical validity of the two instruments developed in this study. Statement items were considered valid if there was a significant relationship between the item scores and total scores, indicated by a significance value lower than 0.05 (Hidayati et al., 2023). In addition to the significance value, the strength and direction of the correlation were also considered in determining the feasibility of each statement item. The analysis results showed that 21 out of 22 statement items in the pedagogical adaptability instrument were categorized as valid. Meanwhile, one item, namely item number 5, was categorized as invalid because it had a low and non-significant correlation. In contrast, the analysis results for the contextual digital learning development instrument showed that all statement items were categorized as valid. A complete summary of the empirical validity results for both instruments is presented in Table 3.

The data presented in Table 3 show that most statement items in the two developed instruments had a sufficiently strong relationship between item scores and total scores. This indicates that the statement items were able to represent the constructs being measured. In general, both instruments demonstrated acceptable construct consistency for measuring teachers' pedagogical adaptability and contextual digital learning development. Only one statement item was categorized as invalid and was therefore excluded from the subsequent stages of the study. The removal of this item did not significantly affect construct representation because other statement items still represented the measured indicator.

Table 3. Summary of Empirical Validity Results of the Developed Instrument

Instrument	Range of r-value	Range of p-value	Valid Items	Invalid Items	Category
Pedagogical Adaptability	-0.292 - 0.627	< 0.001 - 0.044	21	1	Valid
Contextual Digital Learning Development	0.434 - 0.849	< 0.001	16	0	Valid

Specifically, in the pedagogical adaptability instrument, two items showed negative correlation values, namely items 19 and 20. This indicates that the direction of the relationship between these items and the total score was opposite. Such conditions may occur in statement items written in a negative form and therefore require reverse scoring before interpretation. Nevertheless, both items were retained because they still showed significant relationships with the measured construct and remained theoretically relevant to the indicators of pedagogical adaptability.

Instrument Reliability

The next analysis was conducted using Cronbach's Alpha to determine the level of internal consistency of the developed instruments. The results showed that the pedagogical adaptability instrument had a reliability value of 0.797, while the contextual digital learning development instrument had a reliability value of 0.911. A complete summary of the reliability test results is presented in Table 4.

Table 4. Results of Instrument Reliability Testing

No.	Instrument	Cronbach' s Alpha	Description
1.	Pedagogical Adaptability	0.797	Reliable
2.	Contextual Digital Learning Development	0.911	Reliable

The data presented in Table 4 show that the Cronbach's Alpha values of both instruments were above 0.70, indicating that the instruments met the reliability criteria. These findings indicate that both instruments had good internal consistency and were therefore capable of producing relatively stable data when used in similar measurements. The higher reliability value of the contextual digital learning development instrument compared to the pedagogical adaptability instrument suggests stronger consistency among its statement items. The homogeneity of participants' responses and the more consistent relationships among indicators may have contributed to the difference in reliability values between the two instruments.

Overall, the fact that both instruments were categorized as reliable indicates that they are appropriate for assessing and mapping the capacities of senior high school teachers in the Indonesia-Timor Leste border area, particularly in relation to pedagogical adaptability and contextual digital learning development.

DISCUSSION

This study produced pedagogical adaptability and contextual digital learning development instruments that met the criteria of validity and reliability. The selection of indicators and statement items based on the learning conditions faced by teachers in border areas may have contributed to the high validity and reliability of the developed instruments. The developed indicators were not only focused on technology utilization, but were also related to teachers' ability to adjust learning practices to limited facilities, student characteristics and local contexts. The alignment between the indicators and teachers' real experiences in the field made the instruments more relevant to the context of border areas. These findings are consistent with the views of DeVellis (2017) and Taherdoost (2016), who explained that the quality of a developed instrument is strongly influenced by the clarity of its constructs and the alignment between indicators and statement items.

The high Aiken's V values obtained for both instruments indicate that the validators considered the statement items to be aligned with the measured indicators. The high ratings provided by the validators were likely influenced by the relevance of the indicators to the actual learning conditions encountered in border areas. The validators were able to recognize that the need for teachers in border areas to implement flexible, adaptive and contextual learning had been represented in the indicators developed in this study. These findings suggest that instrument content validity may be influenced not only by the theoretical strength of the developed constructs, but also by the alignment between the indicators and actual learning practices in the field. This finding is consistent with the studies conducted by Penfield & Giacobbi (2014) and Boateng et al. (2018), which reported that high content validity is determined by the relevance between statement items and

theoretical constructs. In addition to construct relevance, the representation of indicators in each statement item is also important to ensure that the instruments are able to comprehensively describe learning conditions.

The pedagogical adaptability indicators developed in this study included learning planning adaptability, flexibility in learning implementation, innovation and adaptive technology integration, as well as reflection and improvement practices. These indicators are supported by previous studies conducted by Collie and Martin (2016), Granziera et al. (2019), and Chen (2023), which described pedagogical adaptability as the ability to adjust learning practices in the digital era. Teachers with strong pedagogical adaptability are generally more capable of adjusting learning practices to students' needs, learning dynamics and technological developments. In border areas, in particular, this capacity is important because teachers often face conditions that are not always ideal. Amid the demands of integrating technology into learning, pedagogical adaptability enables teachers to maintain the quality of learning despite limited digital resources and diverse student characteristics. Therefore, pedagogical adaptability is not only related to technical skills in using technology, but also to teachers' ability to sustain the quality of learning.

The contextual digital learning development instrument also demonstrated high content validity. This indicates that the formulated indicators were aligned with the concept of contextual digital learning, which emphasizes the integration of digital technology with students' real-life experiences. This finding is consistent with Redecker (2017) and Garzón & Garzón (2023), who explained that the effectiveness of digital learning is determined not only by the quality of technology utilization, but also by teachers' ability to integrate students' real experiences into the learning process. In learning practices in border areas, teachers need to integrate digital media, available local resources and students' real-life experiences to strengthen the quality of learning. Such conditions can provide meaningful learning experiences for students, allowing them to understand learning materials in ways that are more closely connected to their daily lives.

In addition to the content validity results, the instrument validation process also produced suggestions from the validators regarding the wording and clarity of the statement items. This process was important to ensure that the statement items were more communicative and easier for respondents to understand. Polit & Beck (2017) explained that a good content validation process should not rely solely on quantitative approaches, but should also incorporate qualitative approaches. In this study, the validators' suggestions became particularly important because differences in school conditions and teachers' experiences in border areas may influence how teachers interpret each statement item. Revisions based on the validators' suggestions were therefore conducted to ensure that the instruments were aligned with teachers' actual experiences in the field.

The empirical validity results showed that 21 out of 22 statement items in the pedagogical adaptability instrument were categorized as valid, while all statement items in the contextual digital learning development instrument were categorized as valid. The alignment between teachers' empirical experiences and the statement items in the instruments may have contributed to the high number of valid items. Statement items developed based on actual learning practices tend to be easier for teachers to understand. These findings indicate that the relevance of local contexts in developing indicators and statement items may influence the empirical validity of an instrument. The more relevant the statement items are to respondents' experiences, the greater the likelihood that respondents will provide responses that are consistent with the measured constructs. These findings are consistent with the studies conducted by Garzón & Garzón (2023), Rahayuningsih & Muhtar (2022), and Siddiq & Scherer (2019), which explained that teachers are generally more capable of implementing learning practices designed in ways that are contextual and aligned with local conditions.

Theoretically, the findings of this study strengthen the discussion regarding the importance of developing contextual educational instruments, including instruments specifically designed to assess teachers' personal capacities. The instruments developed in this study are not only intended to assess teachers' ability to utilize digital technology, but also to evaluate their ability to adjust learning practices to local conditions and the challenges encountered in schools. Practically, the developed instruments can be used to map teachers' personal capacities in a more contextual and accurate manner. Such mapping can serve as the basis for

designing teacher competency development programs, including more targeted training and continuous mentoring, particularly for senior high school teachers in the Indonesia–Timor Leste border area. These findings are consistent with Bentri et al. (2022), who emphasized the importance of contextual assessment as a foundation for developing targeted and sustainable educational policies.

CONCLUSION

This study produced valid and reliable pedagogical adaptability and contextual digital learning development instruments for senior high school teachers in the Indonesia–Timor Leste border area. The novelty of this study lies in the development of instruments designed based on the characteristics of learning in border areas. The developed instruments are able to represent teachers' capacities in adjusting pedagogical practices and developing digital learning that is integrated with students' real-life contexts and local potential. In addition to being used as assessment tools to map teachers' personal capacities in a more contextual and accurate manner, these instruments can also support the development of teacher competency improvement programs and the formulation of educational policies that are more aligned with the needs of border areas.

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REFERENCES

- Amadi, A. S. M. (2023). Pendidikan di Era Global: Persiapan Siswa untuk Menghadapi Dunia yang Semakin Kompetitif. *Education*, 17(2), 153–164. <https://doi.org/10.29408/edc.v17i2.9439>
- Anif, S., Utama, Prayitno, H. J., & Idrus, N. B. M. (2019). Effectiveness of Pedagogical Competence: A Development Model Through Association of Biology Teachers' Forum. *Jurnal Pendidikan IPA Indonesia*, 8(1), 22–31. <https://doi.org/10.15294/jpii.v8i1.17176>
- Arvianto, F., Slamet, S. Y., & Andayani, A. (2023). Designing an Instrument to Measure Digital Literacy Competence Using the 4D Model. *International Journal of Instruction*, 16(4), 845–860.
- Bentri, A., Hidayati, A., & Kristiawan, M. (2022). Factors supporting digital pedagogical competence of primary education teachers in Indonesia. *Frontiers in Education*, 7, 1–9.
- Boateng, G. O., Neilands, T. B., Frongillo, E. A., Melgar-Quiñonez, H. R., & Young, S. L. (2018). Best practices for developing and validating scales for health, social, and behavioral research: A primer. *Frontiers in Public Health*, 6, 149. <https://doi.org/10.3389/fpubh.2018.00149>
- Chen, J. J. (2023). Pedagogical adaptability as an essential capacity: Reflective practice of applying theory. *Journal of Early Childhood Teacher Education*, 44(4), 723–746.
- Collie, R.J., & Martin, A.J. (2016). Adaptability: An important capacity for effective teachers. *Educational Practice and Theory*, 38, 27–39. DOI: 10.7459/ept/38.1.03.
- Creswell, J. W., & Creswell, J. D. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches* (5th ed.). Thousand Oaks, CA: SAGE Publications.
- DeVellis, R. F. (2017). *Scale development: Theory and applications* (4th ed.). Thousand Oaks, CA: SAGE Publications.
- Erviana, V.Y., Ghufroon A, Haryanto., & Retnawati, H. (2023). Validity and Reliability of IoJEPD Model Instruments to Improve Elementary School Teacher Competence. *Pegem Journal of Education and Instruction*, 13 (2), 200–206, Doi: 10.47750/pegegog.13.02.24
- Garzón, E., & Garzón, C. (2023). Teacher digital competence and educational innovation: A systematic review. *Education Sciences*, 13(3), 303.

- Granziera, H., Collie, R.J., & Martin AJ. Adaptability: An important capacity to cultivate among pre-service teachers in teacher education programmes. *Psychology Teaching Review*, 25(1), 60–66.
- Hidayati, R., Kusmato, A.S., & Kiswanto, A. (2023). Development and Construct Validation of Indonesian Students Self-Confidence Scale Using Pearson Product Moment. *Pegem Journal of Education and Instruction*, 13(3), 94-103
- Indarta, Y., Jalinus, N., Waskito, Samala, A.D., Riyanda, A.R., & Adi, N.H. (2022). Relevansi Kurikulum Merdeka Belajar dengan Model Pembelajaran Abad 21. *Edukatif*, 4(2), 3011-3024.
- Lembong, J.M., Lumapow, H.R., & Rotty, V.N.J. (2023). Implementasi Merdeka Belajar Sebagai Transformasi Kebijakan Pendidikan. *Jurnal Educatio*, 9, 765–777
- Nama, D. Y., & Tanggur, F. S. (2022). Disparitas Media Pembelajaran Pada Era Digitalisasi Pendidikan Di Wilayah Perbatasan RI-RDTL. *Jukanti*, 5(2)
- Paredes-Aguirre, M. I., Castillo-Cedeño, I., & Rodríguez-García, A. M. (2024). Digital self-efficacy of teachers: A systematic review of instruments and influencing factors. *Education and Information Technologies*, 29(1), 1201–1223.
- Penfield, R. D., & Giacobbi, P. R. (2014). Applying a score and confidence interval to Aiken's item content-relevance index. *Measurement in Physical Education and Exercise Science*, 8(4), 213–225. https://doi.org/10.1207/s15327841mpee0804_3
- Polit, D. F., & Beck, C. T. (2017). *Nursing research: Generating and assessing evidence for nursing practice* (10th ed.). Philadelphia, PA: Wolters Kluwer Health.
- Polizzi, S. J., Ofem, B., Coyle, W., Lundquist, K., & Rushton, G. T. (2019). Social Network Data From Teacher Leader Development. *Data in Brief*, 25, 104182. <https://doi.org/10.1016/j.dib.2019.104182>
- Rahayu, T., Watini, S., Hotijah, Mardiyanti, E., & Hakim, A. (2024). Kreativitas Dan Inovasi Guru Dalam Pembelajaran Berbasis Digital Dengan Media Kelas Virtual Tv Sekolah Pada Anak Usia Dini Di Paud Cinta Kasih Ibu. *Syntax Idea*. 6(3), 1-15
- Rahayuningsih, Y. S., & Muhtar, T. (2022). Pedagogik Digital Sebagai Upaya untuk Meningkatkan Kompetensi Guru Abad 21. *Basicedu*, 6(4), 6960–6966.
- Redecker, C. (2017). *European framework for the digital competence of educators: DigCompEdu*. Luxembourg: Publications Office of the European Union. <https://publications.jrc.ec.europa.eu/repository/handle/JRC107466>
- Sahelatua, L. S., Mislinawat, L., & Mislinawati. (2018). Kendala Guru Memanfaatkan Media IT Dalam Pembelajaran Di SDN 1 Pagar Air Aceh Besar. *Jurnal Ilmiah Pendidikan Guru Sekolah Dasar*, 3(2), 131–140.
- Sele, Y. & Dewi, N.P.A. (2025). Challenges and Opportunities in Preparing Prospective Teachers in the Digital Era: A Critical Study Based on Digital Literacy Profile. *Jurnal Eduscience (JES)*, 12(2), 542-552
- Sele, Y., & Sila. V.U.R. (2022). Problematika Kompetensi Pedagogik Guru dalam Pembelajaran. *Biocaster*, 2(4):230–235.
- Sele, Y., & Santiari, M. (2025). Conventional Character Empowerment: A Critical Study On Students' Environmental Care Character Profile at Noemuti State High School. *Jurnal Pembelajaran dan Biologi Nuklida*, 11(1), 103–112. <https://doi.org/10.36987/jpbn.v11i1.6454>
- Siddiq, F., & Scherer, R. (2019). Is there a gender gap? A meta-analysis of the gender differences in students' ICT literacy. *Educational Research Review*, 27, 205–217. <https://doi.org/10.1016/j.edurev.2019.03.007>
- Silalahi, L.H., Sitorus, M.M., Rajagukguk, Panggabean, N., & Nasution, J. (2021). The Effect Of Higher Order Thinking Skill In Reading Comprehension. *Ideas Journal On English Language Teaching and Learning, Linguistics and Literature*, 9(1), 109-123
- Sumaryanta, Mardapi, D., Sugiman, & Herawan, T. (2018). Assessing Teacher Competence and Its Follow-up to Support Professional Development Sustainability. *Journal of Teacher Education for Sustainability*, 20(1), 106-123.
- Taber, K. S. (2018). The use of Cronbach's alpha when developing and reporting research instruments in science education. *Research in Science Education*, 48(6), 1273–1296. <https://doi.org/10.1007/s11165-016-9602-2>

- Taherdoost, H. (2016). Validity and reliability of the research instrument; How to test the validation of a questionnaire/survey in a research. *International Journal of Academic Research in Management*, 5(3), 28–36. <https://doi.org/10.2139/ssrn.3205040>
- Zamhari, Noviani, D., & Zainuddin. (2023). Perkembangan Pendidikan di Indonesia. *Morfologi: Jurnal Ilmu Pendidikan, Bahasa, Sastra Dan Budaya*, 1(5), 01–10. <https://doi.org/10.61132/morfologi.v1i5.4>