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Development of Digital Diagnostic Test Instruments for Differentiated Learning Process in Elementary Schools

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Abstract: Developing diagnostic tests for differentiated learning in Kurikulum Merdeka is becoming increasingly important to address today's learning challenges. Diagnostic tests can help teachers more effectively identify students' needs and abilities so that they can improve learning effectiveness and better achieve learning goals in Kurikulum Merdeka. This research aims to develop a digital diagnostic test instrument for the differentiated learning process for elementary school students that is valid and suitable for use. This research is development research. The product developed is a digital diagnostic test instrument. The results of the development research produced a digital diagnostic test instrument for the differentiated learning process in elementary schools that is valid and suitable for use in measuring the learning styles of elementary school students.

Keywords: Diagnostic Tests; Differentiated Learning; Kurikulum Merdeka.

Introduction

With the issuance of the Minister of Education and Culture's Decree Number 56/M/2022 concerning Guidelines for Implementing Merdeka Curriculum in the Context of Learning Recovery, the new curriculum, called the independent curriculum, has begun to be implemented, including for elementary school level (Menteri Pendidikan Kebudayaan Riset dan Teknologi Republik Indonesia, 2022).

The Merdeka Curriculum is a refinement of the 2013 curriculum by focusing on competency-based learning which prioritizes the development of students' skills and character which is adapted to students' learning styles (Rizki & Fahkrunisa, 2022). In the competency-based learning process, the role of diagnostic tests becomes very important. Diagnostic tests are able to identify students' understanding and difficulties in understanding the concepts taught in class (Joo et al., 2022). Diagnostic tests help teachers identify students' weaknesses and deficiencies in certain concepts or skills (Diyanahesa et al., 2017) (Chakravarthy, 2013). By using diagnostic tests, teachers can measure students' initial understanding, identify conceptual errors, and determine students' level of understanding of certain concepts (I Kadek Mustika, 2022). The results of these diagnostic tests can be used to design learning experiences that better suit students' abilities and needs, allowing students to learn more effectively and improving their learning outcomes.

Apart from that, the use of diagnostic tests is also very important to develop differentiated learning. Under the educational strategy known as differentiated learning, teachers use a range of pedagogical approaches to fulfill each student's needs on an individual basis. This method is predicated on the knowledge that every student has a distinct learning style, set of skills, and set of interests. Teachers can support students' maximal

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growth and give every student an equal learning edge by implementing tactics that work for them. The four components of differentiated learning are learning environment, product, method, and content. Pupils are neither too challenged nor under-challenged during the learning process.

It's crucial to recognize that while some students may have a general comprehension of the subject, others may have a certain level of knowledge before bringing a course to the class. On the other hand, some pupils might know nothing about the subject at all. Additionally, some kids learn more quickly and effectively when they listen to audiobooks or teachers read aloud. However, some people learn best when they are actively involved in the process of learning. For certain pupils, independent reading will be necessary in order to fully understand the material. There are kids who like to study alone, but there are also kids who want to work and play in small groups.

Focusing on the "how" of individualized learning, differentiated learning is the process of adapting the approach or technique of instruction to each student's unique needs. Individualized or adaptive learning is frequently combined with differentiated instruction. Differentiated learning is a learning approach in the independent curriculum that considers individual differences between students in terms of learning styles, interests, abilities, learning speed and level of readiness. In differentiated learning, teachers try to identify the learning needs and tendencies of each student and provide learning experiences that suit these needs and tendencies (Chandra Handa Manoj, 2019). The aim is to maximize the learning potential of each student and ensure that all students can achieve the same learning goals even through different paths (Chin et al., 2021). Differentiated learning is very important to ensure that each student can achieve maximum results according to their abilities and potential. In differentiated learning, diagnostic tests become an important tool for identifying the needs and abilities of individual students, so that teachers can develop learning plans that suit the needs and abilities of students (Tumanggor & Nirmala, 2021).

This research is important to carry out because there is still no research related to digital diagnostic test instruments in the differentiated learning process in elementary schools. Existing research so far is limited to developing diagnostic instrument tests to determine students' conceptual understanding and misconceptions regarding a learning concept.

In this research, the diagnostic test developed is a test that can determine students' learning styles in the differentiated learning process. This is the novelty of this research. Apart from that, many previous diagnostic test developments were developed for secondary school level, while there are still none for elementary school level. The learning process at the elementary school level is very different from the secondary school level, so a learning style measurement process that is appropriate to the level of development of elementary school students is needed. Another novelty can be seen from the methodology and data analysis techniques used. In previous research, research related to diagnostic tests was studied using a quantitative and qualitative approach, whereas in this research it was studied using a mixed-method approach. This means that the data obtained is managed using a quantitative approach and a qualitative approach so that the data obtained can be more accountable.

Another novelty in this research also can be seen from the instruments developed. The instrument developed uses a digital system. This digital diagnostic test instrument is a representation of developments in the 4.0 era. Apart from that, this digital diagnostic test also aims to differentiate the learning process in the Merdeka curriculum. Differentiated learning is superior learning which is the main approach in the Merdeka curriculum learning process in elementary schools. This research is also in accordance with the Samudra University Research RIP on the themes of social and human development, education, arts and culture as well as the theme of integrated and innovative learning development. By developing this research, it is hoped that it will be able to achieve the superior target of Samudra University's research RIP.

The research problem can be defined as how is the construct of a digital diagnostic test instrument for the differentiated learning process in elementary school developed? How is the analysis of the results of the feasibility of digital diagnostic test instruments for the differentiated learning process in elementary school being developed? What are the characteristics of the questions from the digital diagnostic test instrument for the differentiated learning process in elementary school that was developed? How is the description of the digital diagnostic test results for the differentiated learning process in elementary school developed?

Method

This research is development research. The product developed is a digital diagnostic test instrument. The instrument development model used uses a model by Retnawati which consists of 8 stages as follows. First, we determine the purpose of preparing the test instrument, then we look for relevant theories or material coverage, develop a grid and test instrument matrix, develop test instrument items, validate content, revision based on validator input, conduct trials, conduct analysis, and assemble test instruments. Data collection instruments

are documentation of research results, observation guidelines, and interview guidelines.

Data collection techniques are documentation, observation and interviews. The data analysis technique used is the Miles and Huberman Data Analysis Technique. Validation sheets were analyzed using the Aiken formula. The data is then categorized based on the Aiken index value.

Construct validity was analyzed using exploratory factor analysis (CFA) with the help of SPSS 26. Unidimensional test using factor analysis assisted by SPSS 26. The parameter invariance assumption test was carried out by tabulating the data by estimating the parameters for difficulty level items in different test groups. Estimation of item suitability was carried out with the QUEST program. Items are said to fit the PCM model if the asterisk (*) is within the INFIT MNSQ value path. Likewise, if the INFIT MNSQ value is outside the path, the item is categorized as not matching the PCM model.

Result and Discussion

Result

After carrying out the research, the following research results were obtained according to the stages of the planned research flow.

Determine the purpose of preparing the instrument.

At this stage, the purpose of preparing the instrument is determined. The purpose of preparing this digital diagnostic instrument is to determine student learning styles for a differentiated learning process. Determining the purpose of preparing this digital diagnostic instrument is important in designing an effective tool for identifying student learning styles in the context of differentiated learning. The following is a further explanation:

First, Identifying Student Learning Styles. The main aim of this digital diagnostic instrument is to identify individual student learning styles. Every student has different preferences in how they learn and understand information. By knowing their learning styles, teachers can adapt teaching methods and learning materials to better suit each student's needs. *Second*, Facilitate Differentiated Learning. Differentiated learning is an approach where teachers accommodate different learning styles in the classroom. By knowing students' learning styles, this digital diagnostic instrument can help teachers plan more responsive and effective teaching. For example, more visual students can be given material with more illustrations or diagrams, while auditory students can be directed to participate in group discussions.

Third, Increase Student Involvement and Understanding. By accommodating student learning styles, this digital diagnostic instrument can increase student engagement in the learning process. When students feel that the learning method suits their learning style, they tend to be more engaged and have a better understanding of the subject matter. *Fourth*, Encouraging Students' Self-Understanding. These diagnostic instruments can also provide students with the opportunity to better understand their own learning styles. By becoming aware of how they learn more effectively, students can develop better learning strategies in the future, helping them become more independent and efficient learners.

Arrange the grid and test instrument items

The diagnostic instrument developed was based on three learning styles, namely visual, audio and kinesthetic according to the version of De Porter & Hernacki (Csapó & Molnár, 2019).

Validating content.

These three instruments have been developed and validated both in content and construct. Content validation involved 3 experts, namely child development experts, language experts and elementary school experts. The development expert is Mrs. Yosi Molina, M.Psi (psychologist), the linguist expert is Mrs. Dr. Rizky Amelia, M.Pd., and an elementary school expert, namely Dr. Reza Rachmadtullah, S.Pd., M.Pd. From these three calculations, it can be concluded that the experts agree that the learning style instrument is valid and suitable for use.

Conduct trials.

The learning style instrument that was declared valid was then tested in three schools, namely SDN 02 Seulalah, SD 05 Langsa and SDN 13 Langsa.

Conduct analysis.

Sample adequacy test. Before conducting construct validity and IRT analysis, data from product trial results are evaluated to check whether the trial sample is adequate or representative of the population. This evaluation aims to answer whether the trial sample covers the population by checking the Kaiser-Mayer-Olkin Measure of Sampling Adequacy (KMO-MSA) value which should be more than 0.5 (>0.5). This assessment also includes the Bartlett test to see the correlation between variables, with a value criterion of less than 0.05 (<0.05). The results of the KMO-MSA test and Bartlett's test of the visual learning style diagnostic test based on analysis using SPSS 26 software. The KMO-MSA value for the visual learning style diagnostic test, the auditory learning style and the kinesthetic learning

style exceeds 0.05, and the significance of Bartlett's Test of Sphericity is 0.000 or less than 0.05. Therefore, it is sufficient to proceed to factor analysis.

The assumption of unidimensionality is met when the instrument used only measures one dominant dimension. Verification of this assumption is in line with Exploratory Factor Analysis (EFA) by considering eigenvalues and scree appearance. Unidimensional classification is carried out if the percentage of variation in the first eigenvalue exceeds 20% (Reckase, 1979:228). This test was applied to three sets of tests to measure student learning styles. The accumulative percentage of eigen values in the first factor reaches 80.862%, exceeding the threshold of 20%. This proves that the visual learning style diagnostic test instrument only covers one dominating factor or one dimension (unidimensional). The accumulative percentage of eigenvalues in the first factor, reaches 55.770%, exceeding the 20% threshold. This proves that the visual learning style diagnostic test instrument only covers one dominating factor or one dimension (unidimensional). The accumulative percentage of eigenvalues in the first factor, as recorded in Table 15, reaches 54.279%, exceeding the 20% threshold. This proves that the kinesthetic learning style diagnostic test instrument only covers one dominating factor or one dimension (unidimensional).

Test the Local Independence Assumption.

Apart from unidimensionality, the test items must also meet local independence, which means that the test participant's answer or response to one question item is not influenced by the test participant's response to other test items. According to De Mars (Retnawati, 2016a: 14), unidimensionality and local independence are in line, meaning that if the unidimensionality assumption is met, then the local independence assumption is also fulfilled. Based on this concept, the test questions for computational thinking skills in mathematics in package 1 and package 2 have fulfilled the assumption of local independence, because they previously met the assumption of unidimensionality.

Construct Validity.

A total of 182 questionnaire statement items (including talk quic*kly*, good long-term planner and organizer, pay attention to details, prioritize appearance, both in terms of clothing and presentation, good spellers and can see the actual words in their mind, remember what you see rather than what you hear, remembering by visual association, usually not bothered by noise, etc) were declared valid. In addition to the visual learning style grid, an auditory learning style grid was also developed. A total of 182 questionnaire statement items (including easily distracted by noise, move their lips and pronounce the words in the book when reading, enjoy reading aloud and listening, can repeat and imitate the tone, find it difficult to write, but great at telling stories, speak in a patterned rhythm, usually a fluent speaker, prefers music to art, learn by listening and remembering what is discussed rather than what is seen, etc) were declared valid for the auditory learning style questionnaire. Apart from the auditory learning style grid, there is also a kinesthetic learning style grid. A total of 267 questionnaire statement items developed were declared valid for kinesthetic instruments (including touching people to get their attention, stand close when talking to people, always physically oriented and move a lot, has early development of large muscles, learn through manipulation and practice, memorize by walking and seeing, using fingers as a guide when reading, etc).

Reliability Test

Apart from carrying out validity tests, reliability tests are also carried out for each instrument being developed. The results of the visual learning style reliability test in the Guttman Split-Half Coefficient section obtained a value of 0.925, which means the reliability level of the diagnostic test is in the high category. The results of the auditory learning style reliability test in the Guttman Split-Half Coefficient section obtained a value of 0.924, which means the reliability level of the diagnostic test is in the high category. The results of the kinesthetic learning style reliability test in the Guttman Split-Half Coefficient section obtained a value of 0.943, which means the diagnostic test reliability level is in the high category. So it can be concluded that the three learning style diagnostic instruments have high category reliability.

Item Difficulty Level. The item difficulty level test is a method of validating research instruments, mainly used in creating questionnaires to measure respondents' level of knowledge. The difficulty level of an item is an important parameter used to assess how difficult or easy an item is in a questionnaire. The purpose of testing the level of difficulty of the items is to ensure that each question in the questionnaire has a level of difficulty that is appropriate to the level of knowledge or ability of the intended respondent. Questions that are too easy or too difficult can produce inaccurate information about the respondent's knowledge. In this context, the difficulty level of questions helps in classifying questions into categories such as easy, medium, or difficult. Questions that are relatively easy are more likely to be answered correctly by the majority of respondents. Questions that are classified as difficult, on the other hand, will challenge respondents and may only be answered correctly by respondents with a higher level of knowledge. Therefore, testing the level of difficulty of

the items allows researchers to adjust the level of difficulty of the items so that they suit the research objectives and characteristics of the respondents. This will support more accurate and meaningful data collection in research using questionnaires. From the measurement results using SPSS 26, it was found that the question items got a score above 0.70. This indicates that the difficulty level of the questions is in the easy category. This is in line with the aim of developing the questions, namely to make it easier for students to identify learning styles. The calculation results can be seen at the following link https://shorturl.at/aKLS5 .

Assemble test instruments. The results of the content validity, construct and level of difficulty of the learning style items are suitable or categorized as good for further assembly of the questions. The questions that have been assembled into 3 packages and tested have the same arrangement of question items, because all the question items meet the suitability of the PCM IRT model and fulfill feasibility in terms of content validity, construct and level of item difficulty. The questions that have been analyzed are then corrected and reassembled as a test that is ready to be used to collect research data. Researchers need to pay attention to the appearance of the test when assembling it, such as question sequence numbers, layout and so on. This is done to prepare tests that are reliable, valid and have a good appearance for students to take.

Discussion

Elementary school students are a very important group in the use of diagnostic tests. Diagnostic tests are specifically designed to gather information about an individual student's abilities and needs (Aulia et al., 2023) (Rizki & Fahkrunisa, 2022). This test can help identify students' level of understanding, strengths and weaknesses in various subjects, including mathematics, Indonesian, science and others (Van Hooijdonk et al., 2023). By using diagnostic tests, teachers can get a clearer picture of students' abilities and their level of understanding of learning material (Tumanggor & Nirmala, 2021)(Acosta-Gonzaga & Ramirez-Arellano, 2021).

This information is very valuable in teaching planning, because teachers can adapt the learning approach and material delivered to suit students' needs and level of understanding. Teachers can identify gaps in students' understanding, recognize the difficulties they face, and adapt effective learning methods and strategies (Van der Kleij et al., 2015) (Yankovskaya & Semenov, 2013). In this way, teachers can design learning experiences that are more relevant, interesting and appropriate to students' level of understanding. A clearer understanding of students' abilities through diagnostic testing also allows teachers to provide more appropriate support and guidance. Teachers can adjust assignments, provide additional help, or provide enrichment materials according to students' individual needs (Diyanahesa et al., 2017) (Kurniawan et al., 2023) (Sholikhah & Alyani, 2022). This aims to ensure that students can reach an optimal level of understanding and overcome any learning difficulties they may face.

Diagnostic tests also help identify students' weaknesses and difficulties in learning (Fitzmaurice et al., 2021)(Mutlu & Sesen, 2015). For example, if a student shows low comprehension in mathematics, diagnostic testing can assist teachers in identifying areas that need strengthening and providing appropriate intervention. By understanding students' needs and potential, teachers can develop appropriate learning strategies to help students overcome learning difficulties and achieve better progress (Amali et al., 2023).

The importance of identifying student weaknesses and difficulties through diagnostic testing is to prevent the accumulation of gaps in understanding and ensure that students get the necessary help early on. With appropriate interventions, students have a greater opportunity to overcome their learning barriers and make better progress. In this case, diagnostic tests serve as an important tool for teachers in detecting students' weaknesses and difficulties, directing their teaching, and providing the necessary assistance to ensure that each student can learn successfully (Frasnyaigu et al., 2023) (Baghdady et al., 2014).

In addition, diagnostic tests can also help direct students' self-development programs (Amali et al., 2023) (Bakhri et al., 2023) (Prayitno & Hidayati, 2022). Test results can provide information about certain interests, talents or potential that students have. This can be used as a basis for developing extracurricular programs or career guidance that suit students' interests and potential. Diagnostic tests can also help in identifying students who have special needs or require additional support in learning (Amali et al., 2023) (Saat et al., 2016) (Van der Kleij et al., 2015). By using diagnostic tests as a tool to direct students' self-development programs, schools can provide a more holistic approach to education. Diagnostic tests help reveal students' interests, talents, and potential that may not be visible in regular learning contexts (Kurniawan et al., 2023) (Saat et al., 2016). In this way, schools can develop programs that utilize students' interests and potential more effectively, thereby providing a more varied and satisfying learning experience for elementary school students (Bakhri et al., 2023) (Rosmiati et al., 2022).

By using diagnostic tests effectively, elementary school students can experience significant benefits in their learning process. These tests help personalize students' learning experiences, promote optimal growth and development, and assist in identifying areas for improvement (Shim et al., 2017) (Xia et al., 2022)

(Hermita et al., 2017). Thus, diagnostic tests are an important tool in supporting effective learning and providing a deep understanding of the needs of elementary school students. This is the basis for supporting the need to develop diagnostic tests for elementary school students.

Conclusion

From the research results, it is stated that a digital diagnostic test instrument has been developed for the differentiated learning process in elementary schools that is valid and suitable for use in measuring the learning styles of elementary school students. This research suggests that research can be continued regarding differentiated learning models so that the instruments developed can be more useful.

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Conflicts of Interest
The authors declare that there is no conflict of interest regarding the publication of this paper

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