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Measures Teachers' Perceptions of Differentiated Instruction : A Combination of Guttman Scale and Item Response Theory

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Abstract: This study aims to develop an instrument for teachers' perceptions of differentiated instruction by adopting Oriondo and Antonio's instrument development model. This study involves three stages of development: instrument planning, pilot testing, and measurement. The respondents involved were 152 subject teachers at the secondary school level. The instrument developed contains differentiated instruction principles: learning environment, quality curriculum, responsive teaching, continuous assessment, and leadership and routines. A combination of the Guttman Scale and Item Response Theory was used to measure teachers' perceptions, which gave significant results. The analysis results show that most instrument items follow the model used, but some items require adjustment. The implication of this study is the importance of developing valid and reliable instruments to measure teachers' perceptions of differentiated instruction. The findings can contribute to improving classroom learning practices and student learning outcomes. Thus, this study provides a strong foundation for the development of teacher professionalism and the overall improvement of education quality.

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Introduction

Learner diversity is an unavoidable reality. Each learner's social and cultural diversity (Harris & Lee, 2019), creates a rich learning experience in the classroom environment. Aspects such as ethnicity, culture, religion, background, socio-economic conditions, and learning styles and abilities contribute to this diversity (Harris & Lee, 2019). Each learner brings uniqueness to the classroom, creating a varied learning environment. Student can optimize their potential by learning according to their intelligence while also benefiting from the advantages of their classmates.

The Independent Curriculum in Indonesia views the diversity of learners' needs as one of the main focuses, reflected in the implementation of differentiated instruction and assessment. Previous studies (Breaux & Magee, 2013; Catherine Coubergs et al., 2017; Lavrijsen et al., 2021; Puzio et al., 2020; Tomlinson & Moon, 2013) have shown that differentiated learning is effective in supporting teachers to design learning that meets the diverse learning needs of learners. Although this approach has been proven effective, there

are challenges in its implementation. These include inadequate resources (varied teaching materials, supporting technology, and teacher training), classroom management, evaluation and assessment, and so on (Lavrijsen et al., 2021; Puzio et al., 2020).

Implementing differentiated instruction in the Independent Curriculum in Indonesia faces several teacher challenges. These challenges include the lack of teachers' ability to develop teaching tools that elaborate learning objectives from learning outcomes, difficulties in understanding and adjusting learning methods and media to the learning needs of each learner, and the complexity of compiling relevant diagnostic assessment questions and analyze assessment results quickly and accurately (Kurniati & Kusumawati, 2023). To overcome these challenges, efforts are needed to improve teachers' conceptual understanding of the Merdeka Curriculum, develop differentiated instruction skills, and provide adequate resources and support to support a diverse and sustainable learning process for all learners.

The development of differentiated instruction skills is essential to improve the quality of education. A comprehensive initial diagnosis is necessary to provide teachers with appropriate differentiated instruction skills. This diagnosis can be in the form of measuring teachers' perceptions of differentiated learning. Although an instrument for teachers' perception of differentiated instruction has been developed previously (Coubergs, 2017), an instrument that genuinely fits the characteristics and context of Indonesian teachers still needs to be made available. Therefore, developing an instrument specifically designed to reflect the conditions, needs, and challenges teachers face in Indonesia is imperative. The development of these instruments should involve an in-depth understanding of Indonesian culture, curriculum, and classroom dynamics so that the diagnosis results can provide an accurate picture and help design practical training and intervention programs. Thus, teachers can be better prepared and skilled in implementing differentiated instruction, improving student learning outcomes across Indonesia.

Research Method

The research on developing teacher perception instruments towards differentiated instruction adopted the Oriondo and Antonio (1984) instrument development model. This development model consists of three stages: instrument planning, testing, and measurement (Aristiawan & Istiyono, 2020; Oriondo & Dallo-Antonio, 1984). The planning stage involves setting the measurement objectives and preparing the instrument grid. The instrument contains five principles of differentiated instruction (Mumpuniarti et al., 2023), namely, learning environment (LE), quality curriculum (QC), responsive teaching (RT), continuous assessment (CA), and leadership and routines (LR). These five principles are then referred to as the aspects to be measured. The lattice of the instrument for teachers ' perceptions of differentiated instruction is shown in Table 1. The instrument was designed using a Guttman scale (Fidia et al., 2022), with two answer options: "yes" and "no".

Table 1. Blue Print of Teacher Perception of Differentiated Instruction Instrument

Aspect	Indicator	Item
Learning Environment (LE)	Teachers' perceptions of the influence of the learning environment on students' thinking skills.	1, 2, 3, 4, 5
Quality Curriculum (QC)	Teachers' views on the implementation of the school curriculum used.	6, 7, 8, 9, 10
Responsive Teaching (RT)	Flexible grouping and peer-to-peer learning.	11, 12, 13, 14, 15
Continuous Assessment (CA)	Teachers' steps in providing assessment in learning.	16, 17, 18, 19
Leadership And	Teachers' actions in organizing classroom activities	20, 21, 22, 23 24

Aspect	Indicator	Item
Routines (LR)	follow the differentiated instruction approach.	

The pilot testing stage began with validating the instrument content with experts to reassemble the instrument with quality items. Nine experts reviewed the draft instrument and made qualitative suggestions while calculating the content validity coefficient of each instrument item. The content validity coefficient will be analyzed using the introduced CVR (Content Validity Ratio) equation. Items are declared valid if the CVR value is greater than or equal to 0.78 (CVR ≥ 0.78) Lawshe (Azwar, 2023).

Items that meet these content validity criteria are then compiled and tested on a small scale (40 respondents). The results are then analyzed so that they can follow the rules of the Scalogram (Guttman scale) by identifying the Guttman error that occurs (Fitria et al., 2021; Merta et al., 2022). The suitability of the instrument with the Guttman Scale is analyzed using the coefficient of reproducibility (CR) equation with criteria that must be met at 0.90 (Fidia et al., 2022; Kurinta et al., 2021). The results of this analysis are then used as a reference in ranking and compiling instruments to be tested on a large scale.

The respondents involved in the large-scale trial were the same as in the previous trial: subject teachers at the secondary level. One hundred fifty-two respondents were involved in this pilot test, spread from various regions in Indonesia. The test results were then analyzed for item parameters using the Item Response Theory approach (Djidu et al., 2022; Retnawati, 2014). The goal is to get quality items that genuinely measure teachers' perceptions of differentiated learning. Items that do not fit the model used in IRT will be dropped, and the rest will be rearranged to produce an instrument that genuinely measures teacher perceptions of differentiated learning.

Results and Discussion

The instrument for teachers' perceptions of differentiated learning underwent a series of development stages. Following the development method, the stages passed are test planning, testing, and measurement. It has been explained previously that this instrument aims to measure teacher perceptions of differentiated learning. Teachers' perceptions can be known through their understanding of the five principles of differentiated learning, namely Learning Environment (LE), Quality Curriculum (QC), Responsive Teaching (RT), Continuous Assessment (CA), and Leadership and Routines (LR). Based on these five principles, 24 statement items were developed to measure teachers' perceptions of differentiated learning. Education, measurement, evaluation, and language experts then reviewed the items. The results of this instrument review were then analyzed to determine the validity coefficient of each item. The coefficient of validity of the instrument item content is in the range of 0.78 to 1.00. Following Lawshe's recommendation, by involving nine experts, the item is declared content valid if it has a validity coefficient ≥ 0.78 (Azwar, 2022). The analysis results in Table 2 provide information that 7 items on the instrument have a validity coefficient of 0.78 and 17 other items of 1.00. Thus, all items of the instrument of teachers' perceptions of differentiated learning have met the criteria of content validity.

Table 2. CVR Analysis Result

CVR	Item Code	Total
0.78	LE1, LE2, LE3, LE4, QC1, CA2, LR1	7
1.00	LE5, QC2, QC3, QC4, QC5, RT1, RT2, RT3, RT4, RT5, CA1, CA3, CA4, LR2, LR3, LR4, LR5	17

Items that met the content validity were tested on 40 respondents who were subject teachers at secondary schools. The data from this small-scale pilot test was analyzed to fit the scale used in measuring teacher perceptions, the Guttman Scale (Table 3). Initially, 24 items were included in the analysis to determine the appropriate item order. The analysis showed that 331 Guttman errors occurred. Based on this data, a Coefficient of Reproducibility (CR) of 0.655 was obtained. This indicates that the scale's accuracy is only 65.5% (Kurinta et al., 2021; Michellia, 2023). Therefore, it needs to be modified by dropping items unsuitable for measuring teacher perceptions using this Guttman scale (Wilson et al., 2023). 12 items were dropped, leaving 12 other items that were re-analyzed. The analysis results with the same respondents found 44 Guttman errors that occurred, with the Coefficient of Reproducibility (CR) obtained of 0.908 (Fidia et al., 2022). It means that the accuracy of the Guttman scale in measuring teacher perceptions using 12 items is 90.8%. Following the criteria, these 12 items can be used for large-scale trials.

Table 3. Scalogram Analysis Results on the Guttman Scale

Item	N	Error Guttman	Coefficient of Reproducibility (CR)
24	40	331	0.655
12	40	44	0.908

The large-scale pilot involved 152 respondents from various regions in Indonesia. All of them are subject teachers at the secondary level. The data from the large-scale trial were analyzed using the Item Response Theory (IRT) approach (Effatpanah et al., 2024; Istiyono et al., 2018; Retnawati, 2014). The aim is to determine item parameters, such as difficulty level (b) and distinguishing power (a). Previously, the data was tested for model fit in IRT. Because the data is a Guttman scale, which is dichotomous data, it was tested for fit with the 1PL, 2PL, and 3PL models. It should be noted that the best-fit model has the smallest AIC, SABIC, HQ, and BIC (Clairmont et al., 2021; Firestone et al., 2021; Istiyono et al., 2018). Table 4 shows that the most suitable model is the 2PL model, with AIC = 1589.161, SABIC = 1580.929, HQ = 1623.705, and BIC = 1655.891. Thus, the next stage will use the 2PL model to analyze the item parameters.

Table 4. Model Fit Analysis Results

Model	AIC	SABIC	HQ	BIC
1PL	1627.124	1625.374	1643.127	1666.520
2PL	1589.161	1580.929	1623.705	1655.891
3PL	1591.924	1587.077	1636.240	1701.020

Table 5 presents the order of the items corresponding to the Guttman scale. It can be seen from the item codes presented that all five principles of differentiated learning can be measured using the items analyzed. The items' overall distinguishing power (a) ranged from -0.307 to 4.552. Items with an excellent discriminating power index have a criterion of ≥ 0.3 (Maratin & Shodikin, 2022; Risdiana et al., 2022). However, the analysis results show that four items have low differentiating power. These four items cannot distinguish high and low-ability groups well. Furthermore, the difficulty level (b) of each item obtained ranged from -2.561 to 2.971. The criteria must be met for an item to be declared good if the difficulty level ranges from -2 to 2 (Hambelton & Swaminathan, 1985; Retnawati, 2014). Thus, from the analysis, two items do not meet this criterion. Finally, based on the model's fit, 2 items do not fit this 2PL model.

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Table 5. Results of Item Parameter Analysis and Model Fit (N=152)

Item Code	Item	a	b	p.S_X2	Note
LE1	Despite their learning potential, teachers as educators cannot change students' thinking.	0.619	-0.356	0.711	Fit
QC4	Government supervision of curriculum implementation limits freedom as a professional teacher.	4.552	-1.400	0.139	Fit
QC5	The current curriculum implementation needs to provide more support for a teacher in implementing differentiated learning.	2.747	-1.188	0.989	Fit
QC1	Various government policies towards learning make performances as a teacher less qualified.	1.233	-1.005	0.039	Not Fit
CA3	I guide learners in responding to feedback.	2.075	-1.416	0.100	Fit
QC2	The current curriculum contains too much learning material, so learning objectives should focus more on quantity rather than deep understanding.	1.642	-0.866	0.010	Not Fit
RT4	In class, each learner can choose the task they want to do.	0.071	0.732	0.382	Fit
LR5	Give learners space to choose learning content and methods.	0.223	0.751	0.102	Fit
LR3	Learners are given tasks with difficulty levels adjusted to their abilities in class.	-0.206	0.910	0.338	Fit
RT3	Ensure each learner has a defined role in the learning.	0.160	0.817	0.254	Fit
LE2	Teachers' belief in learners' competence can influence their thinking.	0.395	2.971	0.554	Fit
LE3	Success in the classroom environment, such as learners achieving high grades, can impact their thinking skills.	-0.307	-2.561	0.179	Fit

The characteristics of each item can be seen through the Item Characteristic Curve (ICC), while the reliability of information on each item is seen through the Item Information Function (IIF). Figure 1 shows the IIC and IIF on item KB5, which measure perceptions of quality curriculum. The ICC in Figure 1(a) forms a slope that can provide information about the item's difficulty level. It can be seen that the centre point of the slope is between -2 and 0. If a straight line is drawn down, the item's difficulty level is around the -1 scale. It follows the results in Table 5, which show that this item's difficulty level is -1.188, which is in the easy category. Each item should be able to provide accurate information when measuring the specified variable. The information on item KB5 is shown in Figure 1(b), with the peak point around 1.8. It indicates that this item provides good information.

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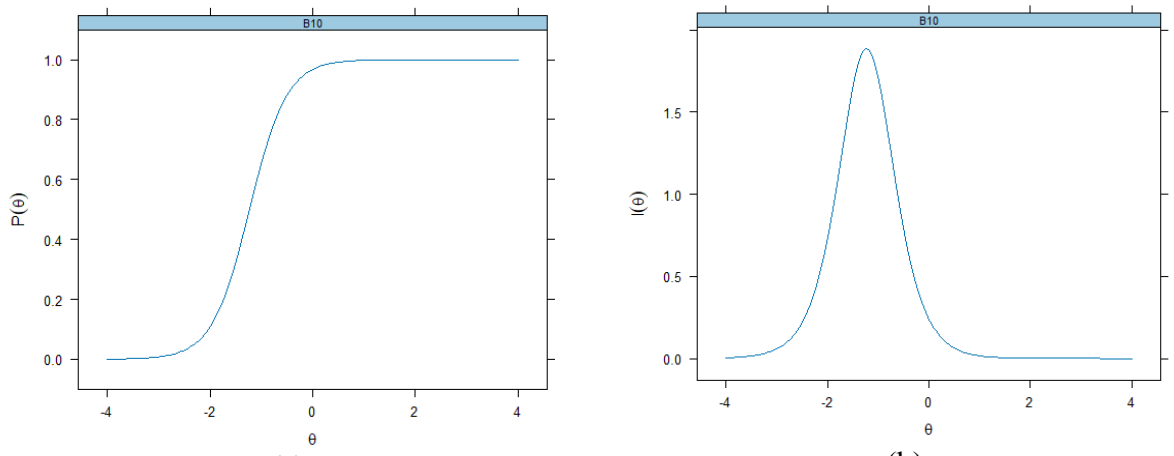


(a) (b)

Figure 1. (a) *Item Characteristic Curve* on KB5; (b) *Item Information Function* on KB5

The collection of each IIF then forms a graph called the Information Function (IF). A good instrument has a high Information Function (IF) value and a small Standard Error Measurement (SEM). Figure 2 shows a combination of the IF and SEM graphs. The highest peak of the IF graph is around 9.2, while the SEM valley is around 0.2 at ability -1. The obtained SEM value indicates a small error in the instrument of teachers' perceptions of differentiated learning.

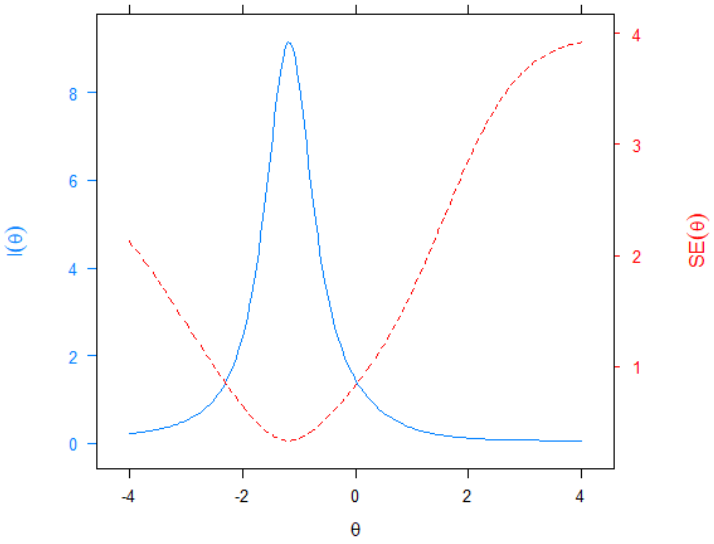
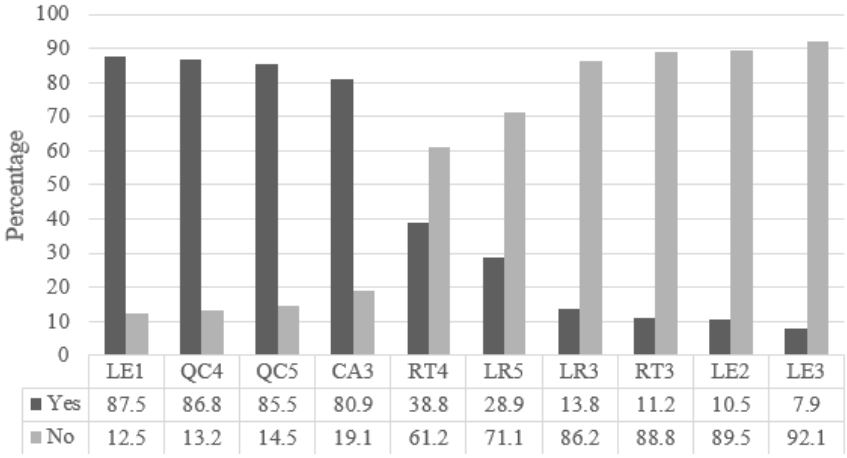


Figure 2. The Intersection of The Information Function and SEM Graphs

If these two graphs are combined, there will be an intersection between the two graphs. This intersection is the limit of ability that can be measured using the instrument. Figure 2 shows the intersection of the information function graph and SEM at -2.4 to 0.1. It means that the instrument of teacher perceptions of differentiated learning is well applied to respondents with a range of abilities from -2.4 to 0.1. Following Hambelton & Swaminathan's (1985) opinion that a suitable instrument is an instrument that can measure abilities in the range of -2 to 2, the teacher's perceptions of differentiated instruction instruments meet these criteria (Djidu et al., 2022; Retnawati, 2014; Sari et al., 2024). However, it can only measure respondents' ability in the "medium" and "low" categories.

Following its purpose, this instrument was designed to identify teachers' perceptions of differentiated learning. The identification results are presented as percentages of teachers' answers as shown in Figure 3.



	LE1	QC4	QC5	CA3	RT4	LR5	LR3	RT3	LE2	LE3
Yes	87.5	86.8	85.5	80.9	38.8	28.9	13.8	11.2	10.5	7.9
No	12.5	13.2	14.5	19.1	61.2	71.1	86.2	88.8	89.5	92.1

Figure 3. Distribution of Teacher Responses

Teacher responses show that teachers' perceptions of differentiated instruction vary, with most teachers expressing disagreement with some important aspects of this approach. For example, the majority of teachers disagreed that students should have the freedom to choose the tasks they want to do (RT4), reflecting concerns about control and structure in the learning process. On the other hand, although many teachers agree that they have an important role in guiding students to respond to feedback (CA3), few believe that their belief in students' competence can influence the way students think (LE3). This suggests a gap between the recognition of the importance of feedback and the belief in the influence of teacher expectations (Shoshi Dorfberger & Eyal, 2023; Wan, 2020). Overall, the profile of teachers' perceptions of differentiated instruction appears to be influenced by concerns about classroom control, as well as a more pessimistic view of their ability to influence student development (Merawi, 2018; Sr & Luard, 2018).

This profile was constructed from a combination of teachers' personal experiences, educational backgrounds and possibly the influence of broader education policies. Uncertainty and lack of support in implementing differentiated learning can inhibit teachers from adopting approaches that are more flexible and responsive to student's needs (Sr & Luard, 2018). Therefore, it is important to provide adequate training and resources so that teachers can be more confident in implementing differentiated learning and understand the positive impact their beliefs have on students (S Dorfberger, 2023; Merawi, 2018).

This study has significant conceptual and practical implications. Conceptually, this study enriches the literature by providing a valid instrument to measure teachers' perceptions of differentiated learning, allowing for a deeper exploration of their understanding and attitudes towards this approach. Practically, this instrument can be used by educators and policymakers to assess teachers' readiness and understanding of the implementation of differentiated learning and to design more appropriate training or interventions to improve the effectiveness of implementation in the field.

Conclusion

Based on this study, using a combination of the Guttman Scale and Item Response Theory in measuring teacher perceptions of differentiated instruction provides significant results. The

planning stage, instrument development, pilot test, and item parameter analysis were carefully conducted to ensure the validity and quality of the instrument. The results indicate that although the instrument items are aligned with the model used, some items do not meet the criteria for difficulty or the model fit. The implication highlights the need for valid and reliable instruments to measure teachers' perceptions of differentiated instruction. The findings can contribute to improving classroom learning practices and student learning outcomes. Thus, this study provides a strong foundation for the development of teacher professionalism and the overall improvement of education quality.

Recommendation

The research product, the instrument about teachers' perception of differentiated instruction, is recommended for measuring the teachers' perspectives on differentiated instruction. Teachers' perspectives are specifically on aspects of the learning environment, quality curriculum, responsive teaching, continuous assessment, and leadership and routines. The outcome of the measurement using this instrument can be the evidence for designing training on differentiated instruction, which is more focused and tailored to the specific needs of teachers. Additionally, the outcome of using this instrument can provide valuable data to improve collaboration between teachers in designing more effective teaching strategies. A regular evaluation using this instrument can also help in identifying areas for improvement and provide constructive feedback to teachers. Therefore, the implementation of the instrument regarding teachers' perceptions of differentiated instruction not only improves teachers' understanding but also contributes to improving the quality of learning in the classroom.

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