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Adaptive Diagnostic Assessment Design through Google Form Optimization and jMetric to Detect Students' Mathematics Learning Difficulty Levels

Desain Asesmen Diagnostik Adaptif melalui Optimalisasi Google Form dan jMetric untuk Mendeteksi Level Kesulitan Belajar Matematika Siswa

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ABSTRACT

The level of mathematics learning difficulties experienced by students can facilitate teachers in designing learning that suits students' abilities and fosters a climate of independent learning. Google form and jMetric can be used as alternative software to construct adaptive assessments to detect students' level of mathematics learning difficulties that are precise and easy to apply. The development of google form-based adaptive assessment that has been carried out, known results from validators At the trial stage of the question, the readability of the assessment was obtained at 80%, some items were revised to suit the language development of students, and at the trial stage the assessment model and user responses were declared valid in the aspect of website attractiveness and website convenience on average 64.5%.

INFO ARTIKEL

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ABSTRAK

Level kesulitan belajar matematika yang dialami oleh siswa dapat memudahkan guru dalam merancang pembelajaran yang sesuai dengan kemampuan siswa dan menumbuhkan iklim merdeka belajar. Google form dan jMetric dapat dijadikan sebagai software alternatif untuk mengkonstruksi asesmen adaptif pendeteksi level kesulitan belajar matematika siswa yang presisi dan mudah diaplikasikan. Pengembangan asesmen adaptif berbasis google form yang telah dilakukan, diketahui hasil dari validator Pada tahap uji coba soal, diperoleh keterbacaan asesmen sebesar 80%, beberapa item direvisi agar sesuai dengan perkembangan bahasa peserta didik, dan pada tahap uji coba model asesmen serta respon pengguna dinyatakan valid secara aspek ketertarikan website dan kemudahan website rata – rata 64,5 %.

Introduction

This research is motivated by the occurrence of *learning loss* after the COVID-19 pandemic, the implementation of Merdeka Curriculum in schools, and the advancement of *Artificial Intelligence (AI)* technology. In line with these conditions, learning needs to be presented by considering the level of achievement and ability of students. On the other hand, AI can be utilized to create software that facilitates learning (Chen et al., 2022; Popenici & Kerr, 2017; Roll & Wylie, 2016). The scale of student ability is also reflected in the learning difficulties they experience so that it needs to be used as a reference in learning design (Elastika & Dewanto, 2021; Mutflu & Akgün, 2019a). In Merdeka Curriculum, students' abilities are measured by diagnostic assessments. Diagnostic assessments can map students' learning potential, one of which is able to detect student learning difficulties (Inayati, 2022; Septiani, 2022). Mathematics, as one of the sciences that is perceived as difficult, also creates learning difficulties for students (Sibaen et al., 2023; Uegatani et al., 2024; Žakelj, 2014).

However, the diagnosis of mathematics learning difficulties carried out so far is only a description of certain criteria without describing the level of student difficulties. Whereas the level of learning difficulty expressed in the level of mathematics learning difficulty, can make it easier for teachers to design learning that is in accordance with the abilities of their students (Aikenhead, 2021; Samawati, 2021; Wandari & Fardillah, 2021). In addition, the *test* mechanism carried out is not able to provide sufficient information to differentiate *the testee's* ability scale (test participants) (Abdullah et al., 2015; Wijaya et al., 2014). The test items given are not differentiated for each testee with certain mathematical abilities. This indicates that the diagnostic assessment developed is not sufficient with the principle of fairness in the Merdeka curriculum. Test characteristics that are in accordance with the above principles can be adaptive tests. Adaptive tests allow *testees* to obtain test items different from other testees according to the responses (answers) given previously but these differences have been adjusted to the ability level of each *testee*. Such a test mechanism can be developed using a *google form* based on the results of question calibration using jMetric. Google form can be utilized as an instrument to conduct diagnostic assessment because it has features that are easy to operate (Haddad & Kalaani, 2014; Rinaldi et al., 2022). The algorithm constructed on *Google Form* makes *testees* with high ability levels will get more difficult items compared to testees who have low ability levels and vice versa. Meanwhile, jMetric will calibrate the questions so that good items can be determined and built into a question bank that will be adapted to Google Form (Aksu et al., 2019). Therefore, google form applied with jmetric is expected to be an adaptive diagnostic assessment that is able to detect students' level of mathematical difficulty with precision.

Based on the above background, the formulation of the problem to be studied is how the design and analysis of the *google form-based* adaptive diagnostic assessment design based on jMetric in detecting students' level of mathematics learning difficulties. The problem- solving approach will be carried out, first by developing a frame of reference for each level of mathematics learning difficulties through identifying patterns of errors made by students in solving math problems. So far, the classification of learning difficulties does not appear *hierarchical* (Nelson & Powell, 2018; Yuberta et al., 2022). Second, developing an adaptive framework by calibrating questions using the RASCH Model so that it is expected to select the level of difficulty of the *testee*. Third, conduct a comprehensive assessment test to provide an overview related to the consistency of the developed test form in detecting the level of difficulty in learning mathematics.

Several studies have conducted research related to the diagnosis of students' mathematics learning difficulties. Researchers highlight some of the main research that is used as a foothold, such as the most commonly used way to diagnose student learning difficulties is tests (Hasan & Fraser, 2015; Ishak et al., 2021; Wijaya et al., 2019). In line with that, research that has been conducted by the research team (Anggara, 2020; Anggara & Solahudin, 2022; Anggara & Wandari, 2021; Wandari & Anggara, 2021) and several previous researchers (Liu et al., 2023; Powell et al., 2021) in identifying the form of students' mathematics learning difficulties by giving classic tests (meaning that each testee gets the same questions as other testees). In the end, many of the students sometimes leave the answers blank because they think the questions given are too difficult. All of the research that has been done relies on classic tests through descriptive data presentation on certain criteria without describing the hierarchy of each difficulty that occurs.

Meanwhile, *test* mechanisms that rely on the principle of equality in seeing the ability of *testees*, according to some research, will produce measurement errors that have an impact on the validity and reliability of the test (Langoban & Langoban, 2020; Santoso et al., 2017). On the other hand, students'

abilities need to be grouped based on certain levels so that they describe the hierarchy of students' thinking processes (Akhter & Akhter, 2018; Kleden et al., n.d.). The level of student ability will be used as a reference in developing relevant learning programs, (Harsela et al., 2021; Hasanah et al., 2023; Pramesti & Prasetya, 2021). The level of students' mathematical ability has an influence on the level of difficulty in learning mathematics, where students with high mathematical ability will produce a low difficulty and vice versa (Fuchs et al., 2019; Mutflu & Akgün, 2019b). It can be said that the level of difficulty in learning mathematics has a negative effect on students' ability to master mathematical concepts.

Based on the description of the theoretical studies and research results previously described, there are two things that concern researchers. First, it is necessary to diagnose the level of students' mathematics learning difficulties because descriptive studies with partial explanations are not sufficient to describe the hierarchy of students' thinking processes. Second, a more adaptive test approach is needed in diagnosing the level of mathematics learning difficulties because in classical tests the level of difficulty and distinguishing power of each question is inconsistent if applied to different subjects. Therefore, this research specifically wants to utilize Google Form as a tool for a series of tests while jMetric calibrates the questions so that the design of diagnostic assessments will be adaptive in detecting students' level of mathematics learning difficulties.

In the test system, each *testee* only gets items that match their abilities so that measurement errors will be smaller (Cetin-Berber et al., 2019; Ebenbeck & Gebhardt, 2022; Hula et al., 2015; Istiyono et al., 2020; Kaplan et al., 2015). So far, several studies have concluded that the *test* system provides enough information to differentiate *testee* ability scales (Martin & Lazendic, 2018; Samsudin et al., 2019). Meanwhile, the RASCH Model will work to select items according to their difficulty level based on previous responses (answers) (Azmi et al., 2019). Thus, the diagnostic assessment will be adaptive and have the ability to select student difficulties based on their level systemically.

Google forms as an online service from *Google* that is useful for creating online forms, collecting data, and comments, which are then compiled using spreadsheets (Rinaldi et al., 2022; Whittaker et al., 2012). This service is usually used to conduct surveys, manage registrations, create tests, or quizzes online. In the world of education, *Google forms* have several functions, including creating online exams or assessments, collecting opinions, collecting teacher and student data, creating registration forms, and distributing questionnaires online (Sari et al., 2020). The advantages of *Google forms* include ease of operation, economical, free from space and time constraints, responsive, and easy to share. These reasons motivate the selection of *Google Form* as an instrument for adaptive assessment of number concepts.

Google form-assisted adaptive assessment design has many advantages over paper-based formative assessment testing. It accurately shows students' ability levels, is very effective for teachers in assessment (Hadianti et al., 2021), the calibrated question pool means that it can be used throughout the year as long as there are no curriculum changes, provides immediate feedback to students after taking the test, can be easily implemented for online assessment and is suitable for use in offline and online learning.

Meanwhile, jMetric itself is an easy-to-use software, designed to facilitate working in a production environment and to enable any researcher to use advanced psychometric procedures (Aksu et al., 2019; Loh & Lee, 2008; Rajnish, 2014; Stroulia & Kapoor, 2001). Compared to similar software products, jMetric provides a more integrated system in terms of performing psychometric analyses for research and operational purposes at no cost, unlike some other psychometric software. jMetric provides comprehensive statistical and psychometric procedures such as descriptive statistics, IRT parameter estimation, scale linking, and score equating (Gusev & Armenski, 2013; Özyurt et al., 2012). In addition, jMetrics helps to create various graphs and tables for data visualization. The structure of the software's graphical user interface is intuitive and easy to learn. In addition, the scale is customized to the user's experience. New users can run psychometric procedures through pop-up menus with signs, while experienced users can use jMetric commands to automate analyses.

Thus, this research is considered important to do because there is a level of novelty in the development of the test adaptive assessment model by utilizing *Google Form* and using *Jmetri software* to calibrate questions and using the RASCH Model. So that it can be used independently (*self-directed*), as needed (*self-contained*), easy to use (*usable*) and can be adapted to technological developments.

Method

The research method used in this study is a qualitative research method with a research design in the form of Plomp model design research. The research data collection and analysis techniques refer to data triangulation in the validation test process of qualitative data by conducting interviews, observations, and *Focus Group Discussions (FGD)* (Belkhatir et al., 2013). The research stages include, preliminary stage, prototype stage, and assessment stage (Plomp, 2013). The preliminary stage is to develop a frame of reference for the level of mathematics learning difficulties and their attributes. The prototype stage is to design an adaptive diagnostic assessment of mathematics learning difficulties based on the RASCH Model. The assessment stage in the form of accuracy analysis refers to the modified test development model and formative evaluation using *self-evaluation* (Plomp, 2013; Tessmer, 2013).

In the preliminary stage, researchers have compiled a rubric for students' mathematics learning difficulty patterns referring to several studies conducted by the research team in the last five years (Anggara, 2020; Anggara & Solahudin, 2022; Anggara & Wandari, 2021; Wandari & Anggara, 2021). Then observations and testing of questions will be carried out on research subjects to obtain a frame of reference along with symptoms that can be used as attributes in the level of students' mathematics learning difficulties. At this stage, the subjects were 26 students of class X from one of the high schools in Majalengka Regency who were selected using the *snowball sampling* technique. The instruments used in this stage are several PISA 2018 questions. Then the students' error patterns were mapped and the learning difficulty value was calculated. The error values obtained from each student were analyzed to obtain error patterns that would be used as a benchmark reference frame.

The next stage is the prototype stage of the diagnostic assessment design using the Algorithm on the RASCH Model to detect the level of mathematics learning difficulties in terms of mathematical principles, namely mathematical knowledge, strategic knowledge, and communication. Test items are compiled from junior high school level mathematics material to see the extent of mastery of prerequisite material for grade X high school students. The test design is in the form of *clustering* so that the logic system built in this computer-based test is able to think, make the right decisions and act like humans do (Yang et al., 2022). The RASCH Model will make the level of difficulty of test items, the differentiation of test items, and *the testee's* answer response as the basis for decision making to determine the right test items given to the *testee*. The logic in describing the *testee's* ability uses monotonous reasoning so that a level of certainty will be obtained regarding the level of difficulty in learning student mathematics based on the responses given during the *testing* process.

The classification of test item difficulty levels in this study is divided into three groups: high, medium and easy difficulty levels. Therefore, the number of test items that qualify to be used as a question bank must include these three groups. If the number of items to be tested is 10 items, then the item bank must have at least 30 test items, with details of 10 high difficulty test items, 10 medium difficulty test items, and 10 low difficulty test items. Good test items should have difficulty and power parameters in the range of 0.3 to 0.8 (classically) and -3 to 3 for modern tests.

Next, the assessment stage includes test trials using a formative evaluation approach. First, an expert *review* of the diagnostic assessment design that has been developed is carried out to 10 mathematics education lecturers, 2 informatics engineering lecturers, and 10 mathematics teachers. Then after making revisions from expert notes, a *one-to-one evaluation* will be carried out involving 10 grade X students from different schools in Majalengka district to conduct a *review*. This is important to do in order to obtain some information related to content suitability, assessment design, accuracy of use, and content quality. Then, a *small group evaluation* was conducted on 3 grade X students from different schools to evaluate the diagnostic assessment design. The information to be obtained from this step is related to effectiveness, efficiency, implementation, content, and test design. Finally, a *field test* was conducted with 200 grade X students in Majalengka district using *snowball sampling* to obtain an overview related to *implementability*, *sustainability*, effectiveness, suitability, and *acceptance & attractiveness*. At this stage, a screening test will be obtained that is able to measure students' level of difficulty in learning mathematics in detail.

Test measurements are conducted to obtain an overview of the effectiveness and efficiency of the diagnostic assessment design that has been designed. The implementation of this diagnostic assessment design will obtain qualitative data and quantitative data to be analyzed and grouped based on the level of mathematics learning difficulties of the *testees*. This is done to obtain a comprehensive picture of students' mathematics learning difficulties.

This research will run according to the stages that have been planned with a team of lecturers to foster a spirit of collaboration in equalizing the quality of research and in accordance with the required areas of expertise. The team is also supported by members from practitioners in the field of computer engineering so as to support the design of effective and efficient diagnostic assessments. In addition, this research also involves five students who will assist the research team in carrying out the research.

Results and Discussion

In the needs assessment stage, a literature study and field observations were conducted to identify potential or problems. The literature includes theories, concepts, and studies that highlight effective development models. The field study is an initial research activity aimed at collecting basic data for further development. The data collected includes a description of the ongoing learning conditions, including administrative completeness, learning media, and infrastructure facilities.

Based on the results of the analysis conducted by the teacher and the researcher, class X students are taken, where class X students can represent the mathematical abilities of students at the X grade level, and based on the characteristics of students in class X who have easy, medium and difficult abilities in other words, heterogeneous. Assessments that are still widely used are non-adaptive and use paper and pencil (PGP test). Therefore, a new assessment model is needed such as an adaptive assessment model with the use of google forms that can assess the ability of students at a certain level allowing to measure their achievement more accurately. Assessments that are structured according to learners' abilities have the advantage of measuring because they are able to adjust to their individual ability levels.

At the curriculum analysis stage, researchers analyzed various applicable curriculum tools. This analysis aims to formulate indicators and learning outcomes that apply at grade X SMA level. The formulation of indicators based on learning outcomes is as follows.

Table 1 Learning Outcomes and Learning Indicators

Learning Outcomes	Learning Achievement Indicators
By the end of phase E, learners can generalize the properties of power numbers, root forms and logarithms (including fractional powers).	Writing down the power form.
	Convert negative to positive powers and determine the result
	Simplifying power numbers and solving them
	Simplifying the properties of power number
	Find the value of the root form
	Simplify the shape of a fraction with a power
	Transforming the root form of a word and solving it
	Converting power form to logarithm form
	Writing logarithmic numbers
	Determine the properties of logarithms

Table 1 shows some indicators of learning achievement on number materials in the independent curriculum. The indicators are designed to assess students' ability to think critically and logically when solving problems related to numbers. So that researchers make a grid of test instruments tailored to these indicators. Analyzing the characteristics of students is a stage used by researchers to find out the characteristics of students which are the basis for researchers to develop adaptive assessment models. Based on this analysis, the adaptive assessment model can be applied to students and is expected to improve student learning outcomes.

At this stage, the process of correcting or validation by experts on the questions that have been prepared is carried out. The expert validators consist of lecturers of Mathematics Education at Sindang Kasih University and mathematics subject teachers at the high school level. The instrument validation stage is carried out by providing a validation instrument consisting of 30 multiple choice questions, question indicators and answer keys. In addition, there are criticisms and suggestions on each item and also in general. Validators are also expected to provide conclusions from the validated test instrument, and state the feasibility of the test instrument before being tested on students. If it is declared not feasible, then revise the questions according to the suggestions of each validator. The validation results can be seen in the following table.

Table 2 Expert Validation Results

Question Number	Notes and Revisions
1	In question number one, the context of the question was improved and the indicators of the question were improved to match the learning outcomes of the number concept.
5	In question number five, the context of the question was improved and the indicators of the question were improved to match the learning outcomes of the number concept
29	In question number twenty nine, the context of the question was improved and the indicators of the question were improved to match the learning outcomes of the number concept.

Based on the results of validation by experts, it was found that the items required revision based on suggestions such as improving the context of the questions and adjusted to the indicators. The next step is validation and calibration. This calibration is a process to determine the characteristics of the items. The calibration process is carried out with the help of Jmetrik Software.

As for the calibration results, good items can be determined and built into a question bank that will be adapted to Google Forms.

FINAL JMLE ITEM STATISTICS						
Item	Difficulty	Std. Error	WMS	Std. WMS	UMS	Std. UMS
in1	-2.43	0.64	0.98	0.10	0.86	-0.14
in2	0.13	0.50	1.08	0.48	1.08	0.43
in3	-1.76	0.53	0.83	-0.62	0.76	-0.79
in4	-2.07	0.57	0.95	-0.04	0.85	-0.28
in5	0.40	0.53	1.10	0.48	1.14	0.54
in6	-1.02	0.48	1.02	0.18	1.01	0.13
in7	-0.12	0.49	0.97	-0.15	0.96	-0.16
in8	2.30	1.03	1.03	0.33	1.03	0.37
in9	1.54	0.76	1.05	0.27	1.02	0.25
in10	-1.50	0.50	1.01	0.14	1.16	0.75
in11	1.06	0.64	1.11	0.40	1.27	0.66
in12	-0.57	0.47	0.96	-0.33	0.96	-0.34
in13	3.55	1.84	0.02	-0.64	0.02	-0.46
in14	1.06	0.64	0.90	-0.11	0.94	0.03
in15	-0.12	0.49	1.20	1.26	1.19	1.05
in16	3.55	1.84	0.02	-0.64	0.02	-0.46
in17	2.30	1.03	1.08	0.38	1.89	1.03
in18	-1.76	0.53	0.91	-0.30	0.85	-0.43
in19	0.70	0.57	0.92	-0.15	0.94	-0.03
in20	-0.35	0.48	0.97	-0.21	0.96	-0.25
in21	2.30	1.03	1.03	0.33	1.03	0.37
in22	0.13	0.50	1.14	0.73	1.10	0.51
in23	-0.57	0.47	0.92	-0.75	0.91	-0.76
in24	-1.50	0.50	0.99	0.02	0.94	-0.19
in25	-0.35	0.48	1.12	1.00	1.17	1.23
in26	0.40	0.53	1.12	0.54	1.20	0.74
in27	-0.57	0.47	0.79	-2.18	0.77	-2.11
in28	-0.35	0.48	0.90	-0.82	0.94	-0.40
in29	0.40	0.53	0.96	-0.06	1.12	0.48
in30	2.30	1.03	0.91	0.20	0.50	-0.26

Figure 1 Problem Bank Calibration Results

Figure 1 above shows the results of the calibration of the level of difficulty test that will be adapted to *google form*. The initial development of the question bank produced 3 (three) packages, each package consisting of 10 (ten) items. The calibration method used is the *RASCH model*. The results of calibration

with the RASCH model have a normal range of values seen in the *difficulty* column, namely from (-3 to +3) then, if the value of the more mines the question is declared easier and vice versa if the value of the more plus the question is declared more difficult. At this stage, the results of the difficulty level test are as follows.

SCALE QUALITY STATISTICS		
Statistic	Items	Persons
Observed Variance	1.7905	0.2205
Observed Std. Dev.	1.3381	0.4696
Mean Square Error	0.4001	0.2066
Root MSE	0.6325	0.4546
Adjusted Variance	1.3904	0.0138
Adjusted Std. Dev.	1.1792	0.1177
Separation Index	1.8643	0.2588
Number of Strata	2.8190	0.6784
Reliability	0.7766	0.0628

Elapsed time: 1 secs, 470 msec

Data Variables freq1 descriptives2 item3 rasch4 rasch5 x

Figure 2 *Scale Quality Statistic* of the tested questions

In Figure 2 regarding the question instrument, we can see the description of the output below. The person reliability value is 0.06 and the item reliability value is 0.77. This shows that the consistency of answers from our subjects is still weak, but the quality of the items in the instrument in terms of reliability is quite good. The Person Starata value is 0.67 and the item starata value is 2.81 which shows the quality of the instrument as well as the quality of our subjects. The greater the Strata value the better because it can identify a wider group of subjects (able - unable) and groups of items (difficult - easy). *Criteria* in the *Rating Scale Instrument Quality Criteria* column where there are *poor* that explain the items that have been calibrated must be revised, *Fair* items are valid but there are some items that must be revised, *Good*, *Verry Good*, *Excellent* items are valid and suitable for testing.

Following the calibration, storing and securing the items is important. The results of the instrument content calibration show that the overall instrument has a good category with a stratum of 2.81. This means that theoretically, the question bank instruments are calibrated, and can be continued with testing in the next process.

The product developed is an adaptive assessment on the concept of number by utilizing *google form*. Software design, or the process of creating software used for adaptive testing, is carried out in stages according to the stages of the RASCH model of software development. The first stage is the analysis of the needs in the development of the software to be made. The next stage is the design stage which includes application design, database design and required interface design. Then the third stage is the software coding stage, and the last stage is testing the software.

Then the instruments used in this research are questionnaires and tests. This questionnaire is used to assess the quality or attractiveness of this evaluation model through media expert validation, *assessment* and user response. This questionnaire or questionnaire was developed from the assessment model evaluation criteria based on several experts. This questionnaire or questionnaire was given to the validators of the development model and material experts, namely lecturers and teachers who were used to determine the feasibility of developing the assessment model and also given to class teachers to find out the response to the use of the assessment model.

Then to find out the feasibility and results of the development, a test is given to students. All questionnaires in this study used a Likert scale questionnaire to measure the opinions, attitudes and perceptions of a person or group of people towards this development (Sugiyono, 2016).

Pertanyaan	Jawaban	63	Setelan	Poin total: 20
Pertanyaan yang sering terlewatkan ?				
Pertanyaan	Jawaban yang benar			
	14 / 63			
	15 / 62			
	21 / 65			
	13 / 44			
	8 / 51			
	12 / 55			
	21 / 57			
	2 / 47			
	2 / 16			
	3 / 43			
	7 / 18			
	0 / 1			
	14 / 34			
	10 / 22			

Figure 3 User Response Display of Missed Questions

In Figure 3, it can be concluded that the development of the *google form-based* adaptive assessment model has been adjusted to the level of ability of each learner. The advantage of using adaptive tests is that the time used in the exam is shorter, learners ask questions individually. This means that the questions asked by each learner are different, reducing opportunities for collaboration.

At this stage, the researcher conducted a trial directly to the field of test instruments that had gone through the expert validation stage and made revisions based on suggestions. The test trial was conducted on class X students consisting of 26 students. The trial was carried out according to the schedule given by the school in the implementation of face-to-face teaching and learning activities. The trial was conducted twice a meeting for 90 minutes during math class time, precisely on Tuesday, June 4, 2024 and Tuesday, June 11, 2024. The trial implementation was carried out in 2 meetings.

- Meeting 1 on Tuesday, June 4, 2024 started at 08.00 WIB. The first trial was a trial to see the level of ability of students using non-adaptive tests.
- Meeting 2 on Tuesday, June 11, 2024 starts at 08.00 WIB. The second trial was a trial of the adaptive assessment model test in the form of a *google form* link.

After working on the test instrument, students are given an adaptive test instrument questionnaire to see feedback from the perspective of students. Furthermore, the researcher analyzed the results of the implementation of the adaptive test instrument to class X students. This stage aims to determine the quality or feasibility of the test instrument. Details of the test analysis are described as follows.

Table 3 Recap of Expert Validation Assessment Results

Validator	Number of Aspects	Yield (%)	Category
1	3	80%	Valid

Based on the results of the development of *google form-based* adaptive assessments that have been carried out, it is known that the results of the validator on the results obtained are 80%. So that from the results of the validator referring to the conversion table, it can be concluded that the assessment developed is feasible to use or can be tested on students and needs to be revised by researchers

Table 4 User Response Validation Results

No	Aspects	Indicator	Yield (%)	Category
1	Website Interest	Convenience in using the website	61,8 %	Valid
		Level of trust in using the website	56,4 %	Firly Valid
		Website appearance and performance	76,4 %	Valid
2	Ease of Website	Ease of the use of the website	67,3 %	Valid
		Seeking information on using the website	56, 4 %	Fairly Valid
		Website Fungtion and Capacity	69,1 %	Valid

Based on the data above, it can be seen that the overall average is 64.5% with Valid criteria. thus the development of an adaptive assessment model on the concept of number by utilizing google forms is declared valid and does not need to be revised.

The research conducted is a type of Adaptive Assessment development research on the concept of number based on google form class X SMK. The development of this assessment refers to the ADDIE model development procedure developed by (Haddad & Kalaani, 2014; Rinaldi et al., 2022). Stage Two is the design of the initial product. This includes the selection of materials that match learner characteristics and competency demands, the learning strategies applied, and the forms and methods of evaluation used (Gusev & Armenski, 2013; Yang et al., 2022). In this context, you want to refer to the Mathematics textbook for grade X semester two of the independent curriculum to collect references on number material. The preparation of the question grids must cover all the indicators and learning outcomes set.

The third step includes several activities, namely entering the questions that have been made into the *Google Form* website, making instructions for working on the questions, setting points on each question, compiling an answer key for each question, and coding. The last step is to prepare the questions that have been made in *Google Drive*. The fourth stage involves copying the Google Form link containing the adaptive number material questions to be distributed to students. One of the obstacles of the third stage is the variation in the ability of learners in one class who often have different background knowledge. Therefore, choosing materials that are appropriate for all learners and designing questions that are challenging but not too difficult can be a challenge.

The third stage is the development of question instruments that are expected to be used for evaluation, especially for class X students in number material. In the validation process by media experts, there are several comments from each validator that need to be corrected so that the instrument is more suitable for use by students. The instrument has been improved in accordance with the comments from the validator. The results of the material validation process show that there are several comments that need to be corrected to make it better and suitable for use by students. The instrument that has been improved is in accordance with the comments of the validator. The material expert gave an average percentage value of 80% in the "very good" category to the Google Form-based question instrument, which indicates that the instrument is suitable for use and testing. This is in line with the view of (Reiser & Dempsey, 2012; Sari et al., 2020; Stroulia & Kapoor, 2001), which states that a development product is considered effective if it achieves the learning objectives set for learner learning outcomes. Barriers at this stage include managing and analyzing the assessment results from Google Forms, especially when the number of respondents is very large. While Google Sheets can help, more in-depth analysis may require additional expertise in using spreadsheets or other data analysis tools. Stage four involves piloting the Google Forms-based adaptive question instrument with learners. After learners completed the instrument, the results were then validated and calibrated as follows.

Based on the results of the validity and calibration analysis, using Jmetrik Software, information was obtained that the item validity test showed a variety of difficulty levels. Of the 30 items tested, there were 10 items with a "medium" level of difficulty, 10 items with an "easy" level of difficulty, and 10 items with a "difficult" level of difficulty. Thus, from these 30 items, we can represent the ability of students by

looking at the assessment score of the adaptive assessment model used.

From the analysis results obtained from the table, it can be concluded that all 30 items are classified in the good category, which indicates that these questions have good differentiating power. Thus, based on the results of the reliability test, difficulty level, and question differentiation, the question instrument used for this test can be considered good. This is in accordance with the opinion (Belkhatir et al., 2013; Gusev & Armenski, 2013) that the validity of test development logically shows the test is very valid. In addition, from the reliability, difficulty level, and differentiating power tests conducted, this test has been assessed as good to use. Based on the results of data analysis, the effectiveness of the distractor or the power of the question instrument can be measured. It was found that there were 5 items that had distractors that functioned properly. These distractors are not just a complement to the answer choices, but are designed to mislead students not to choose the answer key. To achieve this goal, distractors must be designed to resemble the answer key as accurately as possible (Aksu et al., 2019; Whittaker et al., 2012). The bottleneck in stage four is the question testing process, which requires sufficient time to ensure that the questions can accurately measure learners' abilities. Time constraints are often a major challenge in this regard.

In the evaluation stage, an assessment is carried out from the beginning of the process, namely needs analysis, curriculum analysis, and analysis of learner characteristics, as well as the design and development stages that have been passed. After passing the validation process by validators, consisting of expert lecturers and material lecturers, this evaluation stage can provide an overview of how feasible the assessment questions that have been developed in terms of validity.

Conclusion

Adaptively prepared assessments can improve the ability of learners at a certain level with moderate, difficult and easy (heterogeneous) categories. The ability of students can be seen from the number of students who get the most scores seen from the results of the assessment model that has been developed. The development of this adaptive assessment was responded well by students. This is partly because the assessments used are still non-adaptive and use *paper and pencil (P&P test)*. Based on the results of the development of *google form-based* adaptive assessments that have been carried out, it is known that the results of the validator at the question trial stage, obtained the readability of the assessment of 80%, some items were revised to suit the language development of students, and at the trial stage the assessment model and user response were declared valid in the aspect of website attractiveness and website convenience on average 64.5%. Thus, the adaptive assessment developed has met the criteria for development products, namely valid, practical, effective, and showing added value.

In applying this adaptive assessment, teachers or researchers are advised to check students' concept knowledge. Checking students' concept mastery is done to find out the relationship between students' concept mastery and the character being assessed. For further research, it is better to first make observations and collect as much data and information as possible on the subject and the environment that will be assessed for character. All information will be very useful as a consideration in the preparation of indicators and the development of a question grid that will be compiled as a character assessment tool. The development of an adaptive assessment model on the concept of number by utilizing *google form* can be done for the development of further assessment models. Teachers or researchers can make assessments with other materials or lessons.

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Adaptive Diagnostic Assessment Design through Google Form Optimization and jMetric to Detect Students' Mathematics Learning Difficulty Levels

Desain Asesmen Diagnostik Adaptif melalui Optimalisasi Google Form dan jMetric untuk Mendeteksi Level Kesulitan Belajar Matematika Siswa

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ABSTRACT

The level of mathematics learning difficulties experienced by students can facilitate teachers in designing learning that suits students' abilities and fosters a climate of independent learning. Google form and jMetric can be used as alternative software to construct adaptive assessments to detect students' level of mathematics learning difficulties that are precise and easy to apply. The development of google form-based adaptive assessment that has been carried out, known results from validators At the trial stage of the question, the readability of the assessment was obtained at 80%, some items were revised to suit the language development of students, and at the trial stage the assessment model and user responses were declared valid in the aspect of website attractiveness and website convenience on average 64.5%.

INFO ARTIKEL

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ABSTRAK

Level kesulitan belajar matematika yang dialami oleh siswa dapat memudahkan guru dalam merancang pembelajaran yang sesuai dengan kemampuan siswa dan menumbuhkan iklim merdeka belajar. Google form dan jMetric dapat dijadikan sebagai software alternatif untuk mengkonstruksi asesmen adaptif pendeteksi level kesulitan belajar matematika siswa yang presisi dan mudah diaplikasikan. Pengembangan asesmen adaptif berbasis google form yang telah dilakukan, diketahui hasil dari validator Pada tahap uji coba soal, diperoleh keterbacaan asesmen sebesar 80%, beberapa item direvisi agar sesuai dengan perkembangan bahasa peserta didik, dan pada tahap uji coba model asesmen serta respon pengguna dinyatakan valid secara aspek ketertarikan website dan kemudahan website rata – rata 64,5 %.

Dikomentari [FA1]: Paparkan secara utuh hubungan Gform, jMetric, RASCH, model ADDIE, *paper and pencil (P&P test)*

Dikomentari [FA2R1]: Munculkan novelty dan pembeda penelitian relevan dalam pendahuluan

Introduction

This research is motivated by the occurrence of *learning loss* after the COVID-19 pandemic, the implementation of Merdeka Curriculum in schools, and the advancement of *Artificial Intelligence (AI)* technology. In line with these conditions, learning needs to be presented by considering the level of achievement and ability of students. On the other hand, AI can be utilized to create software that facilitates learning (Chen et al., 2022; Popenici & Kerr, 2017; Roll & Wylie, 2016). The scale of student ability is also reflected in the learning difficulties they experience so that it needs to be used as a reference in learning design (Elastika & Dewanto, 2021; Mutflu & Akgün, 2019a). In Merdeka Curriculum, students' abilities are measured by diagnostic assessments. Diagnostic assessments can map students' learning potential, one of which is able to detect student learning difficulties (Inayati, 2022; Septiani, 2022). Mathematics, as one of the sciences that is perceived as difficult, also creates learning difficulties for students (Sibaen et al., 2023; Uegatani et al., 2024; Žakelj, 2014).

However, the diagnosis of mathematics learning difficulties carried out so far is only a description of certain criteria without describing the level of student difficulties. Whereas the level of learning difficulty expressed in the level of mathematics learning difficulty, can make it easier for teachers to design learning that is in accordance with the abilities of their students (Aikenhead, 2021; Samawati, 2021; Wandari & Fardillah, 2021). In addition, the *test* mechanism carried out is not able to provide sufficient information to differentiate the *testee's* ability scale (test participants) (Abdullah et al., 2015; Wijaya et al., 2014). The test items given are not differentiated for each testee with certain mathematical abilities. This indicates that the diagnostic assessment developed is not sufficient with the principle of fairness in the Merdeka curriculum. Test characteristics that are in accordance with the above principles can be adaptive tests. Adaptive tests allow *testees* to obtain test items different from other testees according to the responses (answers) given previously but these differences have been adjusted to the ability level of each *testee*. Such a test mechanism can be developed using a *google form* based on the results of question calibration using jMetric. Google form can be utilized as an instrument to conduct diagnostic assessment because it has features that are easy to operate (Haddad & Kalaani, 2014; Rinaldi et al., 2022). The algorithm constructed on *Google Form* makes *testees* with high ability levels will get more difficult items compared to testees who have low ability levels and vice versa. Meanwhile, jMetric will calibrate the questions so that good items can be determined and built into a question bank that will be adapted to Google Form (Aksu et al., 2019). Therefore, google form applied with jmetric is expected to be an adaptive diagnostic assessment that is able to detect students' level of mathematical difficulty with precision.

Based on the above background, **the formulation of the problem to be studied is how the design and analysis of the google form-based adaptive diagnostic assessment design based on jMetric in detecting students' level of mathematics learning difficulties.** The problem-solving approach will be carried out, first by developing a frame of reference for each level of mathematics learning difficulties through identifying patterns of errors made by students in solving math problems. So far, the classification of learning difficulties does not appear *hierarchical* (Nelson & Powell, 2018; Yuberta et al., 2022). Second, developing an adaptive framework by calibrating questions using the RASCH Model so that it is expected to select the level of difficulty of the *testee*. Third, conduct a comprehensive assessment test to provide an overview related to the consistency of the developed test form in detecting the level of difficulty in learning mathematics.

Several studies have conducted research related to the diagnosis of students' mathematics learning difficulties. Researchers highlight some of the main research that is used as a foothold, such as the most commonly used way to diagnose student learning difficulties is tests (Hasan & Fraser, 2015; Ishak et al., 2021; Wijaya et al., 2019). In line with that, research that has been conducted by the research team (Anggara, 2020; Anggara & Solahudin, 2022; Anggara & Wandari, 2021; Wandari & Anggara, 2021) and several previous researchers (Liu et al., 2023; Powell et al., 2021) in identifying the form of students' mathematics learning difficulties by giving classic tests (meaning that each testee gets the same questions as other testees). In the end, many of the students sometimes leave the answers blank because they think the questions given are too difficult. All of the research that has been done relies on classic tests through descriptive data presentation on certain criteria without describing the hierarchy of each difficulty that occurs.

Meanwhile, *test* mechanisms that rely on the principle of equality in seeing the ability of *testees*, according to some research, will produce measurement errors that have an impact on the validity and reliability of the test (Langoban & Langoban, 2020; Santoso et al., 2017). On the other hand, students'

Memformat: Warna font: Merah

Dikomentari [FA3]: Paparkan detail hubungan Gform dan jMetric

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abilities need to be grouped based on certain levels so that they describe the hierarchy of students' thinking processes (Akhter & Akhter, 2018; Kleden et al., n.d.). The level of student ability will be used as a reference in developing relevant learning programs, (Harsela et al., 2021; Hasanah et al., 2023; Pramesti & Prasetya, 2021). The level of students' mathematical ability has an influence on the level of difficulty in learning mathematics, where students with high mathematical ability will produce a low difficulty and vice versa (Fuchs et al., 2019; Mutflu & Akgün, 2019b). It can be said that the level of difficulty in learning mathematics has a negative effect on students' ability to master mathematical concepts.

Based on the description of the theoretical studies and research results previously described, there are two things that concern researchers. First, it is necessary to diagnose the level of students' mathematics learning difficulties because descriptive studies with partial explanations are not sufficient to describe the hierarchy of students' thinking processes. Second, a more adaptive test approach is needed in diagnosing the level of mathematics learning difficulties because in classical tests the level of difficulty and distinguishing power of each question is inconsistent if applied to different subjects. **Therefore, this research specifically wants to utilize Google Form as a tool for a series of tests while jMetric calibrates the questions so that the design of diagnostic assessments will be adaptive in detecting students' level of mathematics learning difficulties.**

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In the test system, each *testee* only gets items that match their abilities so that measurement errors will be smaller (Cetin-Berber et al., 2019; Ebenbeck & Gebhardt, 2022; Hula et al., 2015; Istiyono et al., 2020; Kaplan et al., 2015). So far, several studies have concluded that the *test* system provides enough information to differentiate *testee* ability scales (Martin & Lazendic, 2018; Samsudin et al., 2019). Meanwhile, the RASCH Model will work to select items according to their difficulty level based on previous responses (answers) (Azmi et al., 2019). Thus, the diagnostic assessment will be adaptive and have the ability to select student difficulties based on their level systemically.

Google forms as an online service from *Google* that is useful for creating online forms, collecting data, and comments, which are then compiled using spreadsheets (Rinaldi et al., 2022; Whittaker et al., 2012). This service is usually used to conduct surveys, manage registrations, create tests, or quizzes online. In the world of education, *Google forms* have several functions, including creating online exams or assessments, collecting opinions, collecting teacher and student data, creating registration forms, and distributing questionnaires online (Sari et al., 2020). The advantages of *Google forms* include ease of operation, economical, free from space and time constraints, responsive, and easy to share. These reasons motivate the selection of *Google Form* as an instrument for adaptive assessment of number concepts.

Google form-assisted adaptive assessment design has many advantages over paper-based formative assessment testing. It accurately shows students' ability levels, is very effective for teachers in assessment (Hadianti et al., 2021), the calibrated question pool means that it can be used throughout the year as long as there are no curriculum changes, provides immediate feedback to students after taking the test, can be easily implemented for online assessment and is suitable for use in offline and online learning.

Meanwhile, jMetrik itself is an easy-to-use software, designed to facilitate working in a production environment and to enable any researcher to use advanced psychometric procedures (Aksu et al., 2019; Loh & Lee, 2008; Rajnish, 2014; Stroulia & Kapoor, 2001). Compared to similar software products, jMetrik provides a more integrated system in terms of performing psychometric analyses for research and operational purposes at no cost, unlike some other psychometric software. jMetrik provides comprehensive statistical and psychometric procedures such as descriptive statistics, IRT parameter estimation, scale linking, and score equating (Gusev & Armenski, 2013; Özyurt et al., 2012). In addition, jMetrics helps to create various graphs and tables for data visualization. The structure of the software's graphical user interface is intuitive and easy to learn. In addition, the scale is customized to the user's experience. New users can run psychometric procedures through pop-up menus with signs, while experienced users can use jMetrik commands to automate analyses.

Thus, this research is considered important to do because there is a level of novelty in the development of the test adaptive assessment model by utilizing *Google Form* and using *Jmetri software* to calibrate questions and using the RASCH Model. So that it can be used independently (*self-directed*), as needed (*self-contained*), easy to use (*usable*) and can be adapted to technological developments.

Method

The research method used in this study is a qualitative research method with a research design in the form of Plomp model design research. The research data collection and analysis techniques refer to data triangulation in the validation test process of qualitative data by conducting interviews, observations, and *Focus Group Discussions (FGD)* (Belkhatir et al., 2013). The research stages include, preliminary stage, prototype stage, and assessment stage (Plomp, 2013). The preliminary stage is to develop a frame of reference for the level of mathematics learning difficulties and their attributes. The prototype stage is to design an adaptive diagnostic assessment of mathematics learning difficulties based on the RASCH Model. The assessment stage in the form of accuracy analysis refers to the modified test development model and formative evaluation using *self-evaluation* (Plomp, 2013; Tessmer, 2013).

In the preliminary stage, researchers have compiled a rubric for students' mathematics learning difficulty patterns referring to several studies conducted by the research team in the last five years (Anggara, 2020; Anggara & Solahudin, 2022; Anggara & Wandari, 2021; Wandari & Anggara, 2021). Then observations and testing of questions will be carried out on research subjects to obtain a frame of reference along with symptoms that can be used as attributes in the level of students' mathematics learning difficulties. At this stage, the subjects were 26 students of class X from one of the high schools in Majalengka Regency who were selected using the *snowball sampling* technique. The instruments used in this stage are several PISA 2018 questions. Then the students' error patterns were mapped and the learning difficulty value was calculated. The error values obtained from each student were analyzed to obtain error patterns that would be used as a benchmark reference frame.

The next stage is the prototype stage of the diagnostic assessment design using the Algorithm on the RASCH Model to detect the level of mathematics learning difficulties in terms of mathematical principles, namely mathematical knowledge, strategic knowledge, and communication. Test items are compiled from junior high school level mathematics material to see the extent of mastery of prerequisite material for grade X high school students. The test design is in the form of *clustering* so that the logic system built in this computer-based test is able to think, make the right decisions and act like humans do (Yang et al., 2022). The RASCH Model will make the level of difficulty of test items, the differentiation of test items, and the *testee's* answer response as the basis for decision making to determine the right test items given to the *testee*. The logic in describing the *testee's* ability uses monotonous reasoning so that a level of certainty will be obtained regarding the level of difficulty in learning student mathematics based on the responses given during the *testing* process.

The classification of test item difficulty levels in this study is divided into three groups: high, medium and easy difficulty levels. Therefore, the number of test items that qualify to be used as a question bank must include these three groups. If the number of items to be tested is 10 items, then the item bank must have at least 30 test items, with details of 10 high difficulty test items, 10 medium difficulty test items, and 10 low difficulty test items. Good test items should have difficulty and power parameters in the range of 0.3 to 0.8 (classically) and -3 to 3 for modern tests.

Next, the assessment stage includes test trials using a formative evaluation approach. First, an expert review of the diagnostic assessment design that has been developed is carried out to 10 mathematics education lecturers, 2 informatics engineering lecturers, and 10 mathematics teachers. Then after making revisions from expert notes, a *one-to-one evaluation* will be carried out involving 10 grade X students from different schools in Majalengka district to conduct a *review*. This is important to do in order to obtain some information related to content suitability, assessment design, accuracy of use, and content quality. Then, a *small group evaluation* was conducted on 3 grade X students from different schools to evaluate the diagnostic assessment design. The information to be obtained from this step is related to effectiveness, efficiency, implementation, content, and test design. Finally, a *field test* was conducted with 200 grade X students in Majalengka district using *snowball sampling* to obtain an overview related to *implementability*, *sustainability*, effectiveness, suitability, and *acceptance & attractiveness*. At this stage, a screening test will be obtained that is able to measure students' level of difficulty in learning mathematics in detail.

Test measurements are conducted to obtain an overview of the effectiveness and efficiency of the diagnostic assessment design that has been designed. The implementation of this diagnostic assessment design will obtain qualitative data and quantitative data to be analyzed and grouped based on the level of mathematics learning difficulties of the *testees*. This is done to obtain a comprehensive picture of students' mathematics learning difficulties.

Dikomentari [FA4]: Rancangan setiap model diagnostik yang digunakan dalam bentuk prosedural gambar

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This research will run according to the stages that have been planned with a team of lecturers to foster a spirit of collaboration in equalizing the quality of research and in accordance with the required areas of expertise. The team is also supported by members from practitioners in the field of computer engineering so as to support the design of effective and efficient diagnostic assessments. In addition, this research also involves five students who will assist the research team in carrying out the research.

Dikomentari [FA5]: Tidak perlu, bukan bagian substantif penelitian

Results and Discussion

In the needs assessment stage, a literature study and field observations were conducted to identify potential or problems. The literature includes theories, concepts, and studies that highlight effective development models. The field study is an initial research activity aimed at collecting basic data for further development. The data collected includes a description of the ongoing learning conditions, including administrative completeness, learning media, and infrastructure facilities.

Based on the results of the analysis conducted by the teacher and the researcher, class X students are taken, where class X students can represent the mathematical abilities of students at the X grade level, and based on the characteristics of students in class X who have easy, medium and difficult abilities in other words, heterogeneous. Assessments that are still widely used are non-adaptive and use paper and pencil (PGP test). Therefore, a new assessment model is needed such as an adaptive assessment model with the use of google forms that can assess the ability of students at a certain level allowing to measure their achievement more accurately. Assessments that are structured according to learners' abilities have the advantage of measuring because they are able to adjust to their individual ability levels.

At the curriculum analysis stage, researchers analyzed various applicable curriculum tools. This analysis aims to formulate indicators and learning outcomes that apply at grade X SMA level. The formulation of indicators based on learning outcomes is as follows.

Table 1 Learning Outcomes and Learning Indicators

Learning Outcomes	Learning Achievement Indicators
By the end of phase E, learners can generalize the properties of power numbers, root forms and logarithms (including fractional powers).	Writing down the power form.
	Convert negative to positive powers and determine the result
	Simplifying power numbers and solving them
	Simplifying the properties of power number
	Find the value of the root form
	Simplify the shape of a fraction with a power
	Transforming the root form of a word and solving it
	Converting power form to logarithm form
	Writing logarithmic numbers
	Determine the properties of logarithms

Table 1 shows some indicators of learning achievement on number materials in the independent curriculum. The indicators are designed to assess students' ability to think critically and logically when solving problems related to numbers. So that researchers make a grid of test instruments tailored to these indicators. Analyzing the characteristics of students is a stage used by researchers to find out the characteristics of students which are the basis for researchers to develop adaptive assessment models. Based on this analysis, the adaptive assessment model can be applied to students and is expected to improve student learning outcomes.

At this stage, the process of correcting or validation by experts on the questions that have been prepared is carried out. The expert validators consist of lecturers of Mathematics Education at Sindang Kasih University and mathematics subject teachers at the high school level. The instrument validation stage is carried out by providing a validation instrument consisting of 30 multiple choice questions, question indicators and answer keys. In addition, there are criticisms and suggestions on each item and also in general. Validators are also expected to provide conclusions from the validated test instrument, and state the feasibility of the test instrument before being tested on students. If it is declared not feasible, then revise the questions according to the suggestions of each validator. The validation results can be seen in the following table.

Table 2 Expert Validation Results

Question Number	Notes and Revisions
1	In question number one, the context of the question was improved and the indicators of the question were improved to match the learning outcomes of the number concept.
5	In question number five, the context of the question was improved and the indicators of the question were improved to match the learning outcomes of the number concept
29	In question number twenty nine, the context of the question was improved and the indicators of the question were improved to match the learningoutcomes of thenumber concept.

Based on the results of validation by experts, it was found that the items required revision based on suggestions such as improving the context of the questions and adjusted to the indicators. The next step is validation and calibration. This calibration is a process to determine the characteristics of the items. The calibration process is carried out with the help of Jmetrik Software.

As for the calibration results, good items can be determined and built into a question bank that will be adapted to Google Forms.

FINAL JMETRIK ITEM STATISTICS						
Item	Difficulty	Std. Error	WMS	Std. WMS	WMS	Std. WMS
in1	-2.43	0.64	0.98	0.10	0.86	-0.14
in2	0.13	0.50	1.08	0.48	1.08	0.43
in3	-1.76	0.53	0.83	-0.62	0.76	-0.79
in4	-2.07	0.57	0.85	-0.04	0.85	-0.28
in5	0.40	0.53	1.10	0.48	1.14	0.84
in6	-1.02	0.48	1.02	0.18	1.01	0.13
in7	-0.12	0.49	0.97	-0.15	0.96	-0.16
in8	2.30	1.03	1.03	0.33	1.03	0.37
in9	1.54	0.76	1.05	0.27	1.02	0.25
in10	-1.50	0.50	1.01	0.14	1.16	0.75
in11	1.06	0.64	1.11	0.40	1.27	0.66
in12	-0.57	0.47	0.96	-0.33	0.96	-0.34
in13	3.55	1.84	0.62	-0.64	0.02	-0.46
in14	1.06	0.64	0.90	-0.11	0.94	0.03
in15	-0.12	0.49	1.20	1.24	1.19	1.05
in16	3.55	1.84	0.02	-0.64	0.02	-0.46
in17	2.30	1.03	1.08	0.38	1.89	1.03
in18	-1.76	0.53	0.91	-0.30	0.85	-0.43
in19	0.70	0.57	0.92	-0.15	0.94	-0.03
in20	-0.35	0.48	0.97	-0.21	0.96	-0.25
in21	2.30	1.03	1.03	0.33	1.03	0.37
in22	0.13	0.50	1.14	0.73	1.10	0.51
in23	-0.57	0.47	0.92	-0.75	0.91	-0.76
in24	-1.50	0.50	0.89	0.02	0.94	-0.19
in25	-0.35	0.48	1.12	1.00	1.17	1.23
in26	0.40	0.53	1.12	0.54	1.20	0.74
in27	-0.57	0.47	0.79	-2.18	0.77	-2.11
in28	-0.35	0.48	0.90	-0.82	0.94	-0.40
in29	0.40	0.53	0.96	-0.06	1.12	0.48
in30	2.30	1.03	0.91	0.20	0.50	-0.26

Figure 1 Problem Bank Calibration Results

Figure 1 above shows the results of the calibration of the level of difficulty test that will be adapted to google form. The initial development of the question bank produced 3 (three) packages, each package consisting of 10 (ten) items. The calibration method used is the *RASCH model*. The results of calibration

with the RASCH model have a normal range of values seen in the *difficulty* column, namely from (-3 to +3) then, if the value of the more mines the question is declared easier and vice versa if the value of the more plus the question is declared more difficult. At this stage, the results of the difficulty level test are as follows.

SCALE QUALITY STATISTICS		
Statistic	Items	Persons
Observed Variance	1.7905	0.2205
Observed Std. Dev.	1.3381	0.4696
Mean Square Error	0.4001	0.2066
Root MSE	0.6325	0.4546
Adjusted Variance	1.3904	0.0138
Adjusted Std. Dev.	1.1792	0.1177
Separation Index	1.8643	0.2588
Number of Strata	2.8190	0.6784
Reliability	0.7766	0.0628

Elapsed time: 1 secs, 470 msec

Data

Variables

freq1

descriptives2

item3

rasch4

rasch5 x

Figure 2 *Scale Quality Statistic* of the tested questions

In Figure 2 regarding the question instrument, we can see the description of the output below. The person reliability value is 0.06 and the item reliability value is 0.77. This shows that the consistency of answers from our subjects is still weak, but the quality of the items in the instrument in terms of reliability is quite good. The Person Starata value is 0.67 and the item starata value is 2.81 which shows the quality of the instrument as well as the quality of our subjects. The greater the Strata value the better because it can identify a wider group of subjects (able - unable) and groups of items (difficult - easy). *Criteria* in the *Rating Scale Instrument Quality Criteria* column where there are *poor* that explain the items that have been calibrated must be revised, *Fair* items are valid but there are some items that must be revised, *Good*, *Very Good*, *Excellent* items are valid and suitable for testing.

Following the calibration, storing and securing the items is important. The results of the instrument content calibration show that the overall instrument has a good category with a stratum of 2.81. This means that theoretically, the question bank instruments are calibrated, and can be continued with testing in the next process.

The product developed is an adaptive assessment on the concept of number by utilizing *google form*. Software design, or the process of creating software used for adaptive testing, is carried out in stages according to the stages of the RASCH model of software development. The first stage is the analysis of the needs in the development of the software to be made. The next stage is the design stage which includes application design, database design and required interface design. Then the third stage is the software coding stage, and the last stage is testing the software.

Then the instruments used in this research are questionnaires and tests. This questionnaire is used to assess the quality or attractiveness of this evaluation model through media expert validation, *assessment* and user response. This questionnaire or questionnaire was developed from the assessment model evaluation criteria based on several experts. This questionnaire or questionnaire was given to the validators of the development model and material experts, namely lecturers and teachers who were used to determine the feasibility of developing the assessment model and also given to class teachers to find out the response to the use of the assessment model.

Then to find out the feasibility and results of the development, a test is given to students. All questionnaires in this study used a Likert scale questionnaire to measure the opinions, attitudes and perceptions of a person or group of people towards this development (Sugiyono, 2016).

Pertanyaan	Jawaban	Setelah	Poin total: 20
Pertanyaan yang sering terlewatkan			
Pertanyaan	Jawaban yang benar		
	14 / 63		
	15 / 62		
	21 / 65		
	13 / 44		
	8 / 51		
	12 / 55		
	21 / 57		
	2 / 47		
	2 / 16		
	3 / 43		
	7 / 18		
	0 / 1		
	14 / 34		
	10 / 22		

Figure 3 User Response Display of Missed Questions

Dikomentari [FA6]: Selain hasil, munculkan contoh pertanyaan pada Gform untuk penggunaan/kejelasan jMetriknya

In Figure 3, it can be concluded that the development of the *google form-based* adaptive assessment model has been adjusted to the level of ability of each learner. The advantage of using adaptive tests is that the time used in the exam is shorter, learners ask questions individually. This means that the questions asked by each learner are different, reducing opportunities for collaboration.

At this stage, the researcher conducted a trial directly to the field of test instruments that had gone through the expert validation stage and made revisions based on suggestions. The test trial was conducted on class X students consisting of 26 students. The trial was carried out according to the schedule given by the school in the implementation of face-to-face teaching and learning activities. The trial was conducted twice a meeting for 90 minutes during math class time, precisely on Tuesday, June 4, 2024 and Tuesday, June 11, 2024. The trial implementation was carried out in 2 meetings.

- Meeting 1 on Tuesday, June 4, 2024 started at 08.00 WIB. The first trial was a trial to see the level of ability of students using non-adaptive tests.
- Meeting 2 on Tuesday, June 11, 2024 starts at 08.00 WIB. The second trial was a trial of the adaptive assessment model test in the form of a *google form* link.

After working on the test instrument, students are given an adaptive test instrument questionnaire to see feedback from the perspective of students. Furthermore, the researcher analyzed the results of the implementation of the adaptive test instrument to class X students. This stage aims to determine the quality or feasibility of the test instrument. Details of the test analysis are described as follows.

Table 3 Recap of Expert Validation Assessment Results

Validator	Number of Aspects	Yield (%)	Category
1	3	80%	Valid

Based on the results of the development of *google form-based* adaptive assessments that have been carried out, it is known that the results of the validator on the results obtained are 80%. So that from the results of the validator referring to the conversion table, it can be concluded that the assessment developed is feasible to use or can be tested on students and needs to be revised by researchers

Table 4 User Response Validation Results

No	Aspects	Indicator	Yield (%)	Category
1	Website Interest	Convenience in using the website	61,8 %	Valid
		Level of trust in using the website	56,4 %	Firly Valid
		Website appearance and performance	76,4 %	Valid
2	Ease of Website	Ease of the use of the website	67,3 %	Valid
		Seeking information on using the website	56,4 %	Fairly Valid
		Website Function and Capacity	69,1 %	Valid

Based on the data above, it can be seen that the overall average is 64.5% with Valid criteria. thus the development of an adaptive assessment model on the concept of number by utilizing google forms is declared valid and does not need to be revised.

The research conducted is a type of Adaptive Assessment development research on the concept of number based on google form class X SMK. The development of this assessment refers to the ADDIE model development procedure developed by (Haddad & Kalaani, 2014; Rinaldi et al., 2022). Stage Two is the design of the initial product. This includes the selection of materials that match learner characteristics and competency demands, the learning strategies applied, and the forms and methods of evaluation used (Gusev & Armenski, 2013; Yang et al., 2022). In this context, you want to refer to the Mathematics textbook for grade X semester two of the independent curriculum to collect references on number material. The preparation of the question grids must cover all the indicators and learning outcomes set.

The third step includes several activities, namely entering the questions that have been made into the *Google Form* website, making instructions for working on the questions, setting points on each question, compiling an answer key for each question, and coding. The last step is to prepare the questions that have been made in *Google Drive*. The fourth stage involves copying the Google Form link containing the adaptive number material questions to be distributed to students. One of the obstacles of the third stage is the variation in the ability of learners in one class who often have different background knowledge. Therefore, choosing materials that are appropriate for all learners and designing questions that are challenging but not too difficult can be a challenge.

The third stage is the development of question instruments that are expected to be used for evaluation, especially for class X students in number material. In the validation process by media experts, there are several comments from each validator that need to be corrected so that the instrument is more suitable for use by students. The instrument has been improved in accordance with the comments from the validator. The results of the material validation process show that there are several comments that need to be corrected to make it better and suitable for use by students. The instrument that has been improved is in accordance with the comments of the validator. The material expert gave an average percentage value of 80% in the "very good" category to the Google Form-based question instrument, which indicates that the instrument is suitable for use and testing. This is in line with the view of (Reiser & Dempsey, 2012; Sari et al., 2020; Stroulia & Kapoor, 2001), which states that a development product is considered effective if it achieves the learning objectives set for learner learning outcomes. Barriers at this stage include managing and analyzing the assessment results from Google Forms, especially when the number of respondents is very large. While Google Sheets can help, more in-depth analysis may require additional expertise in using spreadsheets or other data analysis tools. Stage four involves piloting the Google Forms-based adaptive question instrument with learners. After learners completed the instrument, the results were then validated and calibrated as follows.

Based on the results of the validity and calibration analysis, using Jmetrik Software, information was obtained that the item validity test showed a variety of difficulty levels. Of the 30 items tested, there were 10 items with a "medium" level of difficulty, 10 items with an "easy" level of difficulty, and 10 items with a "difficult" level of difficulty. Thus, from these 30 items, we can represent the ability of students by

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looking at the assessment score of the adaptive assessment model used.

From the analysis results obtained from the table, it can be concluded that all 30 items are classified in the good category, which indicates that these questions have good differentiating power. Thus, based on the results of the reliability test, difficulty level, and question differentiation, the question instrument used for this test can be considered good. This is in accordance with the opinion (Belkhatir et al., 2013; Gusev & Armenski, 2013) that the validity of test development logically shows the test is very valid. In addition, from the reliability, difficulty level, and differentiating power tests conducted, this test has been assessed as good to use. Based on the results of data analysis, the effectiveness of the distractor or the power of the question instrument can be measured. It was found that there were 5 items that had distractors that functioned properly. These distractors are not just a complement to the answer choices, but are designed to mislead students not to choose the answer key. To achieve this goal, distractors must be designed to resemble the answer key as accurately as possible (Aksu et al., 2019; Whittaker et al., 2012). The bottleneck in stage four is the question testing process, which requires sufficient time to ensure that the questions can accurately measure learners' abilities. Time constraints are often a major challenge in this regard.

In the evaluation stage, an assessment is carried out from the beginning of the process, namely needs analysis, curriculum analysis, and analysis of learner characteristics, as well as the design and development stages that have been passed. After passing the validation process by validators, consisting of expert lecturers and material lecturers, this evaluation stage can provide an overview of how feasible the assessment questions that have been developed in terms of validity.

Conclusion

Adaptively prepared assessments can improve the ability of learners at a certain level with moderate, difficult and easy (heterogeneous) categories. The ability of students can be seen from the number of students who get the most scores seen from the results of the assessment model that has been developed. The development of this adaptive assessment was responded well by students. This is partly because the assessments used are still non-adaptive and use *paper and pencil (P&P test)*. Based on the results of the development of *google form-based* adaptive assessments that have been carried out, it is known that the results of the validator at the question trial stage, obtained the readability of the assessment of 80%, some items were revised to suit the language development of students, and at the trial stage the assessment model and user response were declared valid in the aspect of website attractiveness and website convenience on average 64.5%. Thus, the adaptive assessment developed has met the criteria for development products, namely valid, practical, effective, and showing added value.

In applying this adaptive assessment, teachers or researchers are advised to check students' concept knowledge. Checking students' concept mastery is done to find out the relationship between students' concept mastery and the character being assessed. For further research, it is better to first make observations and collect as much data and information as possible on the subject and the environment that will be assessed for character. All information will be very useful as a consideration in the preparation of indicators and the development of a question grid that will be compiled as a character assessment tool. The development of an adaptive assessment model on the concept of number by utilizing *google form* can be done for the development of further assessment models. Teachers or researchers can make assessments with other materials or lessons.

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Adaptive Diagnostic Assessment Design through Google Form Optimization and jMetric to Detect Students' Mathematics Learning Difficulty Levels

Desain Asesmen Diagnostik Adaptif melalui Optimalisasi Google Form dan jMetric untuk Mendeteksi Level Kesulitan Belajar Matematika Siswa

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ABSTRACT

The level of mathematics learning difficulties experienced by students can facilitate teachers in designing learning that suits students' abilities and fosters a climate of independent learning. Google form and jMetric can be used as alternative software to construct adaptive assessments to detect students' level of mathematics learning difficulties that are precise and easy to apply. The development of google form-based adaptive assessment that has been carried out, known results from validators At the trial stage of the question, the readability of the assessment was obtained at 80%, some items were revised to suit the language development of students, and at the trial stage the assessment model and user responses were declared valid in the aspect of website attractiveness and website convenience on average 64.5%.

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ABSTRAK

Level kesulitan belajar matematika yang dialami oleh siswa dapat memudahkan guru dalam merancang pembelajaran yang sesuai dengan kemampuan siswa dan menumbuhkan iklim merdeka belajar. Google form dan jMetric dapat dijadikan sebagai software alternatif untuk mengkonstruksi asesmen adaptif pendeteksi level kesulitan belajar matematika siswa yang presisi dan mudah diaplikasikan. Pengembangan asesmen adaptif berbasis google form yang telah dilakukan, diketahui hasil dari validator Pada tahap uji coba soal, diperoleh keterbacaan asesmen sebesar 80%, beberapa item direvisi agar sesuai dengan perkembangan bahasa peserta didik, dan pada tahap uji coba model asesmen serta respon pengguna dinyatakan valid secara aspek ketertarikan website dan kemudahan website rata – rata 64,5 %.

Dikomentari [WW1]: please explain the sample of this research

Introduction

This research is motivated by the occurrence of *learning loss* after the COVID-19 pandemic, the implementation of Merdeka Curriculum in schools, and the advancement of *Artificial Intelligence (AI)* technology. In line with these conditions, learning needs to be presented by considering the level of achievement and ability of students. On the other hand, AI can be utilized to create software that facilitates learning (Chen et al., 2022; Popenici & Kerr, 2017; Roll & Wylie, 2016). The scale of student ability is also reflected in the learning difficulties they experience so that it needs to be used as a reference in learning design (Elastika & Dewanto, 2021; Mutflu & Akgün, 2019a). In Merdeka Curriculum, students' abilities are measured by diagnostic assessments. Diagnostic assessments can map students' learning potential, one of which is able to detect student learning difficulties (Inayati, 2022; Septiani, 2022). Mathematics, as one of the sciences that is perceived as difficult, also creates learning difficulties for students (Sibaen et al., 2023; Uegatani et al., 2024; Žakelj, 2014).

However, the diagnosis of mathematics learning difficulties carried out so far is only a description of certain criteria without describing the level of student difficulties. Whereas the level of learning difficulty expressed in the level of mathematics learning difficulty, can make it easier for teachers to design learning that is in accordance with the abilities of their students (Aikenhead, 2021; Samawati, 2021; Wandari & Fardillah, 2021). In addition, the *test* mechanism carried out is not able to provide sufficient information to differentiate the *testee's* ability scale (test participants) (Abdullah et al., 2015; Wijaya et al., 2014). The test items given are not differentiated for each testee with certain mathematical abilities. This indicates that the diagnostic assessment developed is not sufficient with the principle of fairness in the Merdeka curriculum. Test characteristics that are in accordance with the above principles can be adaptive tests. Adaptive tests allow *testees* to obtain test items different from other testees according to the responses (answers) given previously but these differences have been adjusted to the ability level of each *testee*. Such a test mechanism can be developed using a *google form* based on the results of question calibration using jMetric. Google form can be utilized as an instrument to conduct diagnostic assessment because it has features that are easy to operate (Haddad & Kalaani, 2014; Rinaldi et al., 2022). The algorithm constructed on *Google Form* makes *testees* with high ability levels will get more difficult items compared to testees who have low ability levels and vice versa. Meanwhile, jMetric will calibrate the questions so that good items can be determined and built into a question bank that will be adapted to Google Form (Aksu et al., 2019). Therefore, google form applied with jmetric is expected to be an adaptive diagnostic assessment that is able to detect students' level of mathematical difficulty with precision.

Based on the above background, the formulation of the problem to be studied is how the design and analysis of the *google form-based* adaptive diagnostic assessment design based on jMetric in detecting students' level of mathematics learning difficulties. The problem-solving approach will be carried out, first by developing a frame of reference for each level of mathematics learning difficulties through identifying patterns of errors made by students in solving math problems. So far, the classification of learning difficulties does not appear *hierarchical* (Nelson & Powell, 2018; Yuberta et al., 2022). Second, developing an adaptive framework by calibrating questions using the RASCH Model so that it is expected to select the level of difficulty of the *testee*. Third, conduct a comprehensive assessment test to provide an overview related to the consistency of the developed test form in detecting the level of difficulty in learning mathematics.

Several studies have conducted research related to the diagnosis of students' mathematics learning difficulties. Researchers highlight some of the main research that is used as a foothold, such as the most commonly used way to diagnose student learning difficulties is tests (Hasan & Fraser, 2015; Ishak et al., 2021; Wijaya et al., 2019). In line with that, research that has been conducted by the research team (Anggara, 2020; Anggara & Solahudin, 2022; Anggara & Wandari, 2021; Wandari & Anggara, 2021) and several previous researchers (Liu et al., 2023; Powell et al., 2021) in identifying the form of students' mathematics learning difficulties by giving classic tests (meaning that each testee gets the same questions as other testees). In the end, many of the students sometimes leave the answers blank because they think the questions given are too difficult. All of the research that has been done relies on classic tests through descriptive data presentation on certain criteria without describing the hierarchy of each difficulty that occurs.

Meanwhile, *test* mechanisms that rely on the principle of equality in seeing the ability of *testees*, according to some research, will produce measurement errors that have an impact on the validity and reliability of the test (Langoban & Langoban, 2020; Santoso et al., 2017). On the other hand, students'

Dikomentari [WW2]: Can you describe what mathematical material is in this jmetric? And increase the number of similar articles regarding this research

abilities need to be grouped based on certain levels so that they describe the hierarchy of students' thinking processes (Akhter & Akhter, 2018; Kleden et al., n.d.). The level of student ability will be used as a reference in developing relevant learning programs, (Harsela et al., 2021; Hasanah et al., 2023; Pramesti & Prasetya, 2021). The level of students' mathematical ability has an influence on the level of difficulty in learning mathematics, where students with high mathematical ability will produce a low difficulty and vice versa (Fuchs et al., 2019; Mutflu & Akgün, 2019b). It can be said that the level of difficulty in learning mathematics has a negative effect on students' ability to master mathematical concepts.

Based on the description of the theoretical studies and research results previously described, there are two things that concern researchers. First, it is necessary to diagnose the level of students' mathematics learning difficulties because descriptive studies with partial explanations are not sufficient to describe the hierarchy of students' thinking processes. Second, a more adaptive test approach is needed in diagnosing the level of mathematics learning difficulties because in classical tests the level of difficulty and distinguishing power of each question is inconsistent if applied to different subjects. Therefore, this research specifically wants to utilize Google Form as a tool for a series of tests while jMetric calibrates the questions so that the design of diagnostic assessments will be adaptive in detecting students' level of mathematics learning difficulties.

In the test system, each *testee* only gets items that match their abilities so that measurement errors will be smaller (Cetin-Berber et al., 2019; Ebenbeck & Gebhardt, 2022; Hula et al., 2015; Istiyono et al., 2020; Kaplan et al., 2015). So far, several studies have concluded that the *test* system provides enough information to differentiate *testee* ability scales (Martin & Lazendic, 2018; Samsudin et al., 2019). Meanwhile, the RASCH Model will work to select items according to their difficulty level based on previous responses (answers) (Azmi et al., 2019). Thus, the diagnostic assessment will be adaptive and have the ability to select student difficulties based on their level systemically.

Google forms as an online service from *Google* that is useful for creating online forms, collecting data, and comments, which are then compiled using spreadsheets (Rinaldi et al., 2022; Whittaker et al., 2012). This service is usually used to conduct surveys, manage registrations, create tests, or quizzes online. In the world of education, *Google forms* have several functions, including creating online exams or assessments, collecting opinions, collecting teacher and student data, creating registration forms, and distributing questionnaires online (Sari et al., 2020). The advantages of *Google forms* include ease of operation, economical, free from space and time constraints, responsive, and easy to share. These reasons motivate the selection of *Google Form* as an instrument for adaptive assessment of number concepts.

Google form-assisted adaptive assessment design has many advantages over paper-based formative assessment testing. It accurately shows students' ability levels, is very effective for teachers in assessment (Hadianti et al., 2021), the calibrated question pool means that it can be used throughout the year as long as there are no curriculum changes, provides immediate feedback to students after taking the test, can be easily implemented for online assessment and is suitable for use in offline and online learning.

Meanwhile, jMetrik itself is an easy-to-use software, designed to facilitate working in a production environment and to enable any researcher to use advanced psychometric procedures (Aksu et al., 2019; Loh & Lee, 2008; Rajnish, 2014; Stroulia & Kapoor, 2001). Compared to similar software products, jMetrik provides a more integrated system in terms of performing psychometric analyses for research and operational purposes at no cost, unlike some other psychometric software. jMetrik provides comprehensive statistical and psychometric procedures such as descriptive statistics, IRT parameter estimation, scale linking, and score equating (Gusev & Armenski, 2013; Özyurt et al., 2012). In addition, jMetrics helps to create various graphs and tables for data visualization. The structure of the software's graphical user interface is intuitive and easy to learn. In addition, the scale is customized to the user's experience. New users can run psychometric procedures through pop-up menus with signs, while experienced users can use jMetrik commands to automate analyses.

Thus, this research is considered important to do because there is a level of novelty in the development of the test adaptive assessment model by utilizing *Google Form* and using *Jmetri software* to calibrate questions and using the RASCH Model. So that it can be used independently (*self-directed*), as needed (*self-contained*), easy to use (*usable*) and can be adapted to technological developments.

Dikomentari [WW3]: Add relevant research to strengthen the position of this research or state of the art and novelty

Method

The research method used in this study is a qualitative research method with a research design in the form of Plomp model design research. The research data collection and analysis techniques refer to data triangulation in the validation test process of qualitative data by conducting interviews, observations, and *Focus Group Discussions (FGD)* (Belkhatir et al., 2013). The research stages include, preliminary stage, prototype stage, and assessment stage (Plomp, 2013). The preliminary stage is to develop a frame of reference for the level of mathematics learning difficulties and their attributes. The prototype stage is to design an adaptive diagnostic assessment of mathematics learning difficulties based on the RASCH Model. The assessment stage in the form of accuracy analysis refers to the modified test development model and formative evaluation using *self-evaluation* (Plomp, 2013; Tessmer, 2013).

In the preliminary stage, researchers have compiled a rubric for students' mathematics learning difficulty patterns referring to several studies conducted by the research team in the last five years (Anggara, 2020; Anggara & Solahudin, 2022; Anggara & Wandari, 2021; Wandari & Anggara, 2021). Then observations and testing of questions will be carried out on research subjects to obtain a frame of reference along with symptoms that can be used as attributes in the level of students' mathematics learning difficulties. At this stage, the subjects were 26 students of class X from one of the high schools in Majalengka Regency who were selected using the *snowball sampling* technique. The instruments used in this stage are several PISA 2018 questions. Then the students' error patterns were mapped and the learning difficulty value was calculated. The error values obtained from each student were analyzed to obtain error patterns that would be used as a benchmark reference frame.

The next stage is the prototype stage of the diagnostic assessment design using the Algorithm on the RASCH Model to detect the level of mathematics learning difficulties in terms of mathematical principles, namely mathematical knowledge, strategic knowledge, and communication. Test items are compiled from junior high school level mathematics material to see the extent of mastery of prerequisite material for grade X high school students. The test design is in the form of *clustering* so that the logic system built in this computer-based test is able to think, make the right decisions and act like humans do (Yang et al., 2022). The RASCH Model will make the level of difficulty of test items, the differentiation of test items, and the *testee's* answer response as the basis for decision making to determine the right test items given to the *testee*. The logic in describing the *testee's* ability uses monotonous reasoning so that a level of certainty will be obtained regarding the level of difficulty in learning student mathematics based on the responses given during the *testing* process.

The classification of test item difficulty levels in this study is divided into three groups: high, medium and easy difficulty levels. Therefore, the number of test items that qualify to be used as a question bank must include these three groups. If the number of items to be tested is 10 items, then the item bank must have at least 30 test items, with details of 10 high difficulty test items, 10 medium difficulty test items, and 10 low difficulty test items. Good test items should have difficulty and power parameters in the range of 0.3 to 0.8 (classically) and -3 to 3 for modern tests.

Next, the assessment stage includes test trials using a formative evaluation approach. First, an expert review of the diagnostic assessment design that has been developed is carried out to 10 mathematics education lecturers, 2 informatics engineering lecturers, and 10 mathematics teachers. Then after making revisions from expert notes, a *one-to-one evaluation* will be carried out involving 10 grade X students from different schools in Majalengka district to conduct a *review*. This is important to do in order to obtain some information related to content suitability, assessment design, accuracy of use, and content quality. Then, a *small group evaluation* was conducted on 3 grade X students from different schools to evaluate the diagnostic assessment design. The information to be obtained from this step is related to effectiveness, efficiency, implementation, content, and test design. Finally, a *field test* was conducted with 200 grade X students in Majalengka district using *snowball sampling* to obtain an overview related to *implementability*, *sustainability*, effectiveness, suitability, and *acceptance & attractiveness*. At this stage, a screening test will be obtained that is able to measure students' level of difficulty in learning mathematics in detail.

Test measurements are conducted to obtain an overview of the effectiveness and efficiency of the diagnostic assessment design that has been designed. The implementation of this diagnostic assessment design will obtain qualitative data and quantitative data to be analyzed and grouped based on the level of mathematics learning difficulties of the *testees*. This is done to obtain a comprehensive picture of students' mathematics learning difficulties.

This research will run according to the stages that have been planned with a team of lecturers to foster a spirit of collaboration in equalizing the quality of research and in accordance with the required areas of expertise. The team is also supported by members from practitioners in the field of computer engineering so as to support the design of effective and efficient diagnostic assessments. In addition, this research also involves five students who will assist the research team in carrying out the research.

Results and Discussion

In the needs assessment stage, a literature study and field observations were conducted to identify potential or problems. The literature includes theories, concepts, and studies that highlight effective development models. The field study is an initial research activity aimed at collecting basic data for further development. The data collected includes a description of the ongoing learning conditions, including administrative completeness, learning media, and infrastructure facilities.

Based on the results of the analysis conducted by the teacher and the researcher, class X students are taken, where class X students can represent the mathematical abilities of students at the X grade level, and based on the characteristics of students in class X who have easy, medium and difficult abilities in other words, heterogeneous. Assessments that are still widely used are non-adaptive and use paper and pencil (PGP test). Therefore, a new assessment model is needed such as an adaptive assessment model with the use of google forms that can assess the ability of students at a certain level allowing to measure their achievement more accurately. Assessments that are structured according to learners' abilities have the advantage of measuring because they are able to adjust to their individual ability levels.

At the curriculum analysis stage, researchers analyzed various applicable curriculum tools. This analysis aims to formulate indicators and learning outcomes that apply at grade X SMA level. The formulation of indicators based on learning outcomes is as follows.

Table 1 Learning Outcomes and Learning Indicators

Learning Outcomes	Learning Achievement Indicators
By the end of phase E, learners can generalize the properties of power numbers, root forms and logarithms (including fractional powers).	Writing down the power form.
	Convert negative to positive powers and determine the result
	Simplifying power numbers and solving them
	Simplifying the properties of power number
	Find the value of the root form
	Simplify the shape of a fraction with a power
	Transforming the root form of a word and solving it
	Converting power form to logarithm form
	Writing logarithmic numbers
	Determine the properties of logarithms

Table 1 shows some indicators of learning achievement on number materials in the independent curriculum. The indicators are designed to assess students' ability to think critically and logically when solving problems related to numbers. So that researchers make a grid of test instruments tailored to these indicators. Analyzing the characteristics of students is a stage used by researchers to find out the characteristics of students which are the basis for researchers to develop adaptive assessment models. Based on this analysis, the adaptive assessment model can be applied to students and is expected to improve student learning outcomes.

Dikomentari [WW4]: Perhaps, it can be explained in more detail regarding the indicators and their components so that conclusions can be drawn to assess critical and logical thinking skills.

At this stage, the process of correcting or validation by experts on the questions that have been prepared is carried out. The expert validators consist of lecturers of Mathematics Education at Sindang Kasih University and mathematics subject teachers at the high school level. The instrument validation stage is carried out by providing a validation instrument consisting of 30 multiple choice questions, question indicators and answer keys. In addition, there are criticisms and suggestions on each item and also in general. Validators are also expected to provide conclusions from the validated test instrument, and state the feasibility of the test instrument before being tested on students. If it is declared not feasible, then revise the questions according to the suggestions of each validator. The validation results can be seen in the following table.

Table 2 Expert Validation Results

Question Number	Notes and Revisions
1	In question number one, the context of the question was improved and the indicators of the question were improved to match the learning outcomes of the number concept.
5	In question number five, the context of the question was improved and the indicators of the question were improved to match the learning outcomes of the number concept
29	In question number twenty nine, the context of the question was improved and the indicators of the question were improved to match the learning outcomes of the number concept.

Based on the results of validation by experts, it was found that the items required revision based on suggestions such as improving the context of the questions and adjusted to the indicators. The next step is validation and calibration. This calibration is a process to determine the characteristics of the items. The calibration process is carried out with the help of Jmetrik Software.

As for the calibration results, good items can be determined and built into a question bank that will be adapted to Google Forms.

FINAL JMETRIK ITEM STATISTICS						
Item	Difficulty	Std. Error	WMS	Std. WMS	WMS	Std. WMS
in1	-2.43	0.64	0.98	0.10	0.86	-0.14
in2	0.13	0.50	1.08	0.48	1.08	0.43
in3	-1.76	0.53	0.83	-0.62	0.76	-0.79
in4	-2.07	0.57	0.85	-0.04	0.85	-0.28
in5	0.40	0.53	1.10	0.48	1.14	0.54
in6	-1.02	0.48	1.02	0.18	1.01	0.13
in7	-0.12	0.49	0.97	-0.15	0.96	-0.16
in8	2.30	1.03	1.03	0.33	1.03	0.37
in9	1.54	0.76	1.05	0.27	1.02	0.25
in10	-1.50	0.50	1.01	0.14	1.16	0.75
in11	1.06	0.64	1.11	0.40	1.27	0.66
in12	-0.57	0.47	0.96	-0.33	0.96	-0.34
in13	3.55	1.84	0.62	-0.64	0.02	-0.46
in14	1.06	0.64	0.90	-0.11	0.94	0.03
in15	-0.12	0.49	1.20	1.24	1.19	1.05
in16	3.55	1.84	0.02	-0.64	0.02	-0.46
in17	2.30	1.03	1.08	0.38	1.89	1.03
in18	-1.76	0.53	0.91	-0.30	0.85	-0.43
in19	0.70	0.57	0.92	-0.15	0.94	-0.03
in20	-0.35	0.48	0.97	-0.21	0.96	-0.25
in21	2.30	1.03	1.03	0.33	1.03	0.37
in22	0.13	0.50	1.14	0.73	1.10	0.51
in23	-0.57	0.47	0.92	-0.75	0.91	-0.76
in24	-1.50	0.50	0.89	0.02	0.94	-0.19
in25	-0.35	0.48	1.12	1.00	1.17	1.23
in26	0.40	0.53	1.12	0.54	1.20	0.74
in27	-0.57	0.47	0.79	-2.18	0.77	-2.11
in28	-0.35	0.48	0.90	-0.82	0.94	-0.40
in29	0.40	0.53	0.96	-0.06	1.12	0.48
in30	2.30	1.03	0.91	0.20	0.50	-0.26

Figure 1 Problem Bank Calibration Results

Figure 1 above shows the results of the calibration of the level of difficulty test that will be adapted to google form. The initial development of the question bank produced 3 (three) packages, each package consisting of 10 (ten) items. The calibration method used is the *RASCH model*. The results of calibration

with the RASCH model have a normal range of values seen in the *difficulty* column, namely from (-3 to +3) then, if the value of the more mines the question is declared easier and vice versa if the value of the more plus the question is declared more difficult. At this stage, the results of the difficulty level test are as follows.

SCALE QUALITY STATISTICS		
Statistic	Items	Persons
Observed Variance	1.7905	0.2205
Observed Std. Dev.	1.3381	0.4696
Mean Square Error	0.4001	0.2066
Root MSE	0.6325	0.4546
Adjusted Variance	1.3904	0.0138
Adjusted Std. Dev.	1.1792	0.1177
Separation Index	1.8643	0.2588
Number of Strata	2.8190	0.6784
Reliability	0.7766	0.0628

Elapsed time: 1 secs, 470 msec

Data

Variables

freq1

descriptives2

item3

rasch4

rasch5

Figure 2 *Scale Quality Statistic* of the tested questions

In Figure 2 regarding the question instrument, we can see the description of the output below. The person reliability value is 0.06 and the item reliability value is 0.77. This shows that the consistency of answers from our subjects is still weak, but the quality of the items in the instrument in terms of reliability is quite good. The Person Starata value is 0.67 and the item starata value is 2.81 which shows the quality of the instrument as well as the quality of our subjects. The greater the Strata value the better because it can identify a wider group of subjects (able - unable) and groups of items (difficult - easy). *Criteria* in the *Rating Scale Instrument Quality Criteria* column where there are *poor* that explain the items that have been calibrated must be revised, *Fair* items are valid but there are some items that must be revised, *Good*, *Very Good*, *Excellent* items are valid and suitable for testing.

Following the calibration, storing and securing the items is important. The results of the instrument content calibration show that the overall instrument has a good category with a stratum of 2.81. This means that theoretically, the question bank instruments are calibrated, and can be continued with testing in the next process.

The product developed is an adaptive assessment on the concept of number by utilizing *google form*. Software design, or the process of creating software used for adaptive testing, is carried out in stages according to the stages of the RASCH model of software development. The first stage is the analysis of the needs in the development of the software to be made. The next stage is the design stage which includes application design, database design and required interface design. Then the third stage is the software coding stage, and the last stage is testing the software.

Then the instruments used in this research are questionnaires and tests. This questionnaire is used to assess the quality or attractiveness of this evaluation model through media expert validation, *assessment* and user response. This questionnaire or questionnaire was developed from the assessment model evaluation criteria based on several experts. This questionnaire or questionnaire was given to the validators of the development model and material experts, namely lecturers and teachers who were used to determine the feasibility of developing the assessment model and also given to class teachers to find out the response to the use of the assessment model.

Then to find out the feasibility and results of the development, a test is given to students. All questionnaires in this study used a Likert scale questionnaire to measure the opinions, attitudes and perceptions of a person or group of people towards this development (Sugiyono, 2016).

Dikomentari [WW5]: Maybe it could be deleted so as not to confuse the research instrument (this article) or the instrument that is used as the object of the research.

Pertanyaan	Jawaban	Setelah	Poin total: 20
Pertanyaan yang sering terlewatkan			
Pertanyaan	Jawaban yang benar		
	14 / 63		
	15 / 62		
	21 / 65		
	13 / 44		
	8 / 51		
	12 / 55		
	21 / 57		
	2 / 47		
	2 / 16		
	3 / 43		
	7 / 18		
	0 / 1		
	14 / 34		
	10 / 22		

Figure 3 User Response Display of Missed Questions

In Figure 3, it can be concluded that the development of the *google form-based* adaptive assessment model has been adjusted to the level of ability of each learner. The advantage of using adaptive tests is that the time used in the exam is shorter, learners ask questions individually. This means that the questions asked by each learner are different, reducing opportunities for collaboration.

At this stage, the researcher conducted a trial directly to the field of test instruments that had gone through the expert validation stage and made revisions based on suggestions. The test trial was conducted on class X students consisting of 26 students. The trial was carried out according to the schedule given by the school in the implementation of face-to-face teaching and learning activities. The trial was conducted twice a meeting for 90 minutes during math class time, precisely on Tuesday, June 4, 2024 and Tuesday, June 11, 2024. The trial implementation was carried out in 2 meetings.

- Meeting 1 on Tuesday, June 4, 2024 started at 08.00 WIB. The first trial was a trial to see the level of ability of students using non-adaptive tests.
- Meeting 2 on Tuesday, June 11, 2024 starts at 08.00 WIB. The second trial was a trial of the adaptive assessment model test in the form of a *google form* link.

After working on the test instrument, students are given an adaptive test instrument questionnaire to see feedback from the perspective of students. Furthermore, the researcher analyzed the results of the implementation of the adaptive test instrument to class X students. This stage aims to determine the quality or feasibility of the test instrument. Details of the test analysis are described as follows.

Table 3 Recap of Expert Validation Assessment Results

Validator	Number of Aspects	Yield (%)	Category
1	3	80%	Valid

Based on the results of the development of *google form-based* adaptive assessments that have been carried out, it is known that the results of the validator on the results obtained are 80%. So that from the results of the validator referring to the conversion table, it can be concluded that the assessment developed is feasible to use or can be tested on students and needs to be revised by researchers

Table 4 User Response Validation Results

No	Aspects	Indicator	Yield (%)	Category
1	Website Interest	Convenience in using the website	61,8 %	Valid
		Level of trust in using the website	56,4 %	Firly Valid
		Website appearance and performance	76,4 %	Valid
2	Ease of Website	Ease of the use of the website	67,3 %	Valid
		Seeking information on using the website	56, 4 %	Fairly Valid
		Website Fungtion and Capacity	69,1 %	Valid

Based on the data above, it can be seen that the overall average is 64.5% with Valid criteria. thus the development of an adaptive assessment model on the concept of number by utilizing google forms is declared valid and does not need to be revised.

The research conducted is a type of Adaptive Assessment development research on the concept of number based on google form class X SMK. The development of this assessment refers to the ADDIE model development procedure developed by (Haddad & Kalaani, 2014; Rinaldi et al., 2022). Stage Two is the design of the initial product. This includes the selection of materials that match learner characteristics and competency demands, the learning strategies applied, and the forms and methods of evaluation used (Gusev & Armenski, 2013; Yang et al., 2022). In this context, you want to refer to the Mathematics textbook for grade X semester two of the independent curriculum to collect references on number material. The preparation of the question grids must cover all the indicators and learning outcomes set.

The third step includes several activities, namely entering the questions that have been made into the *Google Form* website, making instructions for working on the questions, setting points on each question, compiling an answer key for each question, and coding. The last step is to prepare the questions that have been made in *Google Drive*. The fourth stage involves copying the Google Form link containing the adaptive number material questions to be distributed to students. One of the obstacles of the third stage is the variation in the ability of learners in one class who often have different background knowledge. Therefore, choosing materials that are appropriate for all learners and designing questions that are challenging but not too difficult can be a challenge.

The third stage is the development of question instruments that are expected to be used for evaluation, especially for class X students in number material. In the validation process by media experts, there are several comments from each validator that need to be corrected so that the instrument is more suitable for use by students. The instrument has been improved in accordance with the comments from the validator. The results of the material validation process show that there are several comments that need to be corrected to make it better and suitable for use by students. The instrument that has been improved is in accordance with the comments of the validator. The material expert gave an average percentage value of 80% in the "very good" category to the Google Form-based question instrument, which indicates that the instrument is suitable for use and testing. This is in line with the view of (Reiser & Dempsey, 2012; Sari et al., 2020; Stroulia & Kapoor, 2001), which states that a development product is considered effective if it achieves the learning objectives set for learner learning outcomes. Barriers at this stage include managing and analyzing the assessment results from Google Forms, especially when the number of respondents is very large. While Google Sheets can help, more in-depth analysis may require additional expertise in using spreadsheets or other data analysis tools. Stage four involves piloting the Google Forms-based adaptive question instrument with learners. After learners completed the instrument, the results were then validated and calibrated as follows.

Based on the results of the validity and calibration analysis, using Jmetrik Software, information was obtained that the item validity test showed a variety of difficulty levels. Of the 30 items tested, there were 10 items with a "medium" level of difficulty, 10 items with an "easy" level of difficulty, and 10 items with a "difficult" level of difficulty. Thus, from these 30 items, we can represent the ability of students by

looking at the assessment score of the adaptive assessment model used.

From the analysis results obtained from the table, it can be concluded that all 30 items are classified in the good category, which indicates that these questions have good differentiating power. Thus, based on the results of the reliability test, difficulty level, and question differentiation, the question instrument used for this test can be considered good. This is in accordance with the opinion (Belkhatir et al., 2013; Gusev & Armenski, 2013) that the validity of test development logically shows the test is very valid. In addition, from the reliability, difficulty level, and differentiating power tests conducted, this test has been assessed as good to use. Based on the results of data analysis, the effectiveness of the distractor or the power of the question instrument can be measured. It was found that there were 5 items that had distractors that functioned properly. These distractors are not just a complement to the answer choices, but are designed to mislead students not to choose the answer key. To achieve this goal, distractors must be designed to resemble the answer key as accurately as possible (Aksu et al., 2019; Whittaker et al., 2012). The bottleneck in stage four is the question testing process, which requires sufficient time to ensure that the questions can accurately measure learners' abilities. Time constraints are often a major challenge in this regard.

In the evaluation stage, an assessment is carried out from the beginning of the process, namely needs analysis, curriculum analysis, and analysis of learner characteristics, as well as the design and development stages that have been passed. After passing the validation process by validators, consisting of expert lecturers and material lecturers, this evaluation stage can provide an overview of how feasible the assessment questions that have been developed in terms of validity.

Conclusion

Adaptively prepared assessments can improve the ability of learners at a certain level with moderate, difficult and easy (heterogeneous) categories. The ability of students can be seen from the number of students who get the most scores seen from the results of the assessment model that has been developed. The development of this adaptive assessment was responded well by students. This is partly because the assessments used are still non-adaptive and use *paper and pencil (P&P test)*. Based on the results of the development of *google form-based* adaptive assessments that have been carried out, it is known that the results of the validator at the question trial stage, obtained the readability of the assessment of 80%, some items were revised to suit the language development of students, and at the trial stage the assessment model and user response were declared valid in the aspect of website attractiveness and website convenience on average 64.5%. Thus, the adaptive assessment developed has met the criteria for development products, namely valid, practical, effective, and showing added value.

In applying this adaptive assessment, teachers or researchers are advised to check students' concept knowledge. Checking students' concept mastery is done to find out the relationship between students' concept mastery and the character being assessed. For further research, it is better to first make observations and collect as much data and information as possible on the subject and the environment that will be assessed for character. All information will be very useful as a consideration in the preparation of indicators and the development of a question grid that will be compiled as a character assessment tool. The development of an adaptive assessment model on the concept of number by utilizing *google form* can be done for the development of further assessment models. Teachers or researchers can make assessments with other materials or lessons.

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**4. BUKTI KONFIRMASI SUBMIT REVISI, RESPON KEPADA REVIEWER,
DAN ARTIKEL YANG DI RESUBMIT**

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▶		91735-1 Research Results, Template Sosiotek Benny revisi.docx	June 1, 2025	Research Results
▶		91747-1 Research Results, 25248-Research Results-91735-1-15-20250601.docx	June 2, 2025	Research Results

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Name	From	Last Reply	Replies	Closed	



Adaptive Diagnostic Assessment Design through Google Form Optimization and jMetric to Detect Students' Mathematics Learning Difficulty Levels

Desain Asesmen Diagnostik Adaptif melalui Optimalisasi Google Form dan jMetric untuk Mendeteksi Level Kesulitan Belajar Matematika Siswa

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ABSTRACT

The level of mathematics learning difficulties experienced by students can facilitate teachers in designing learning that suits students' abilities and fosters a climate of independent learning. Google form and jMetric can be used as alternative software to construct adaptive assessments to detect students' level of mathematics learning difficulties that are precise and easy to apply. The development of google form-based adaptive assessment that has been carried out, known results from validators At the trial stage of the question, the readability of the assessment was obtained at 80%, some items were revised to suit the language development of students, and at the trial stage the assessment model and user responses were declared valid in the aspect of website attractiveness and website convenience on average 64.5%

INFO ARTIKEL

Kata kunci:

Desain Asesmen Diagnostik Adaptif,
Google Form, jMetric,
Level Kesulitan Belajar
Matematika

ABSTRAK

Level kesulitan belajar matematika yang dialami oleh siswa dapat memudahkan guru dalam merancang pembelajaran yang sesuai dengan kemampuan siswa dan menumbuhkan iklim merdeka belajar. Google form dan jMetric dapat dijadikan sebagai software alternatif untuk mengkonstruksi asesmen adaptif pendeteksi level kesulitan belajar matematika siswa yang presisi dan mudah diaplikasikan. Pengembangan asesmen adaptif berbasis google form yang telah dilakukan, diketahui hasil dari validator Pada tahap uji coba soal, diperoleh keterbacaan asesmen sebesar 80%, beberapa item direvisi agar sesuai dengan perkembangan bahasa peserta didik, dan pada tahap uji coba model asesmen serta respon pengguna dinyatakan valid secara aspek ketertarikan website dan kemudahan website rata – rata 64,5 %.

Introduction

This research is motivated by the occurrence of *learning loss* after the COVID-19 pandemic, the implementation of Merdeka Curriculum in schools, and the advancement of *Artificial Intelligence (AI)* technology. In line with these conditions, learning needs to be presented by considering the level of achievement and ability of students. On the other hand, AI can be utilized to create software that facilitates learning (Chen et al., 2022; Popenici & Kerr, 2017; Roll & Wylie, 2016). The scale of student ability is also reflected in the learning difficulties they experience so that it needs to be used as a reference in learning design (Elastika & Dewanto, 2021; Mutflu & Akgün, 2019a). In Merdeka Curriculum, students' abilities are measured by diagnostic assessments. Diagnostic assessments can map students' learning potential, one of which is able to detect student learning difficulties (Inayati, 2022; Septiani, 2022). Mathematics, as one of the sciences that is perceived as difficult, also creates learning difficulties for students (Sibaen et al., 2023; Uegatani et al., 2024; Žakelj, 2014).

However, the diagnosis of mathematics learning difficulties carried out so far is only a description of certain criteria without describing the level of student difficulties. Whereas the level of learning difficulty expressed in the level of mathematics learning difficulty, can make it easier for teachers to design learning that is in accordance with the abilities of their students (Aikenhead, 2021; Samawati, 2021; Wandari & Fardillah, 2021). In addition, the *test* mechanism carried out is not able to provide sufficient information to differentiate *the testee's* ability scale (test participants) (Abdullah et al., 2015; Wijaya et al., 2014). The test items given are not differentiated for each testee with certain mathematical abilities. This indicates that the diagnostic assessment developed is not sufficient with the principle of fairness in the Merdeka curriculum. Test characteristics that are in accordance with the above principles can be adaptive tests. Adaptive tests allow *testees* to obtain test items different from other testees according to the responses (answers) given previously but these differences have been adjusted to the ability level of each *testee*. Such a test mechanism can be developed using a *google form* based on the results of question calibration using jMetric. Google form can be utilized as an instrument to conduct diagnostic assessment because it has features that are easy to operate (Haddad & Kalaani, 2014; Rinaldi et al., 2022). The algorithm constructed on *Google Form* makes *testees* with high ability levels will get more difficult items compared to testees who have low ability levels and vice versa. Meanwhile, jMetric will calibrate the questions so that good items can be determined and built into a question bank that will be adapted to Google Form (Aksu et al., 2019). Therefore, google form applied with jmetric is expected to be an adaptive diagnostic assessment that is able to detect students' level of mathematical difficulty with precision.

Based on the above background, the formulation of the problem to be studied is how the design and analysis of the *google form-based* adaptive diagnostic assessment design based on jMetric in detecting students' level of mathematics learning difficulties. The problem-solving approach will be carried out, first by developing a frame of reference for each level of mathematics learning difficulties through identifying patterns of errors made by students in solving math problems. So far, the classification of learning difficulties does not appear *hierarchical* (Nelson & Powell, 2018; Yuberta et al., 2022). Second, developing an adaptive framework by calibrating questions using the RASCH Model so that it is expected to select the level of difficulty of the *testee*. Third, conduct a comprehensive assessment test to provide an overview related to the consistency of the developed test form in detecting the level of difficulty in learning mathematics.

Several studies have conducted research related to the diagnosis of students' mathematics learning difficulties. Researchers highlight some of the main research that is used as a foothold, such as the most commonly used way to diagnose student learning difficulties is tests (Hasan & Fraser, 2015; Ishak et al., 2021; Wijaya et al., 2019). In line with that, research

that has been conducted by the research team (Anggara, 2020; Anggara & Solahudin, 2022; Anggara & Wandari, 2021; Wandari & Anggara, 2021) and several previous researchers (Liu et al., 2023; Powell et al., 2021) in identifying the form of students' mathematics learning difficulties by giving classic tests (meaning that each testee gets the same questions as other testees). In the end, many of the students sometimes leave the answers blank because they think the questions given are too difficult. All of the research that has been done relies on classic tests through descriptive data presentation on certain criteria without describing the hierarchy of each difficulty that occurs.

Meanwhile, *test* mechanisms that rely on the principle of equality in seeing the ability of *testees*, according to some research, will produce measurement errors that have an impact on the validity and reliability of the test (Langoban & Langoban, 2020; Santoso et al., 2017). On the other hand, students' abilities need to be grouped based on certain levels so that they describe the hierarchy of students' thinking processes (Akhter & Akhter, 2018; Kleden et al., n.d.). The level of student ability will be used as a reference in developing relevant learning programs, (Harsela et al., 2021; Hasanah et al., 2023; Pramesti & Prasetya, 2021). The level of students' mathematical ability has an influence on the level of difficulty in learning mathematics, where students with high mathematical ability will produce a low difficulty and vice versa (Fuchs et al., 2019; Mutflu & Akgün, 2019b). It can be said that the level of difficulty in learning mathematics has a negative effect on students' ability to master mathematical concepts.

Based on the description of the theoretical studies and research results previously described, there are two things that concern researchers. First, it is necessary to diagnose the level of students' mathematics learning difficulties because descriptive studies with partial explanations are not sufficient to describe the hierarchy of students' thinking processes. Second, a more adaptive test approach is needed in diagnosing the level of mathematics learning difficulties because in classical tests the level of difficulty and distinguishing power of each question is inconsistent if applied to different subjects. Therefore, this research specifically wants to utilize Google Form as a tool for a series of tests while jMetric calibrates the questions so that the design of diagnostic assessments will be adaptive in detecting students' level of mathematics learning difficulties.

In the test system, each *testee* only gets items that match their abilities so that measurement errors will be smaller (Cetin-Berber et al., 2019; Ebenbeck & Gebhardt, 2022; Hula et al., 2015; Istiyono et al., 2020; Kaplan et al., 2015). So far, several studies have concluded that the *test* system provides enough information to differentiate *testee* ability scales (Martin & Lazendic, 2018; Samsudin et al., 2019). Meanwhile, the RASCH Model will work to select items according to their difficulty level based on previous responses (answers) (Azmi et al., 2019). Thus, the diagnostic assessment will be adaptive and have the ability to select student difficulties based on their level systemically.

Google forms as an online service from *Google* that is useful for creating online forms, collecting data, and comments, which are then compiled using spreadsheets (Rinaldi et al., 2022; Whittaker et al., 2012). This service is usually used to conduct surveys, manage registrations, create tests, or quizzes online. In the world of education, *Google forms* have several functions, including creating online exams or assessments, collecting opinions, collecting teacher and student data, creating registration forms, and distributing questionnaires online (Sari et al., 2020). The advantages of *Google forms* include ease of operation, economical, free from space and time constraints, responsive, and easy to share. These reasons motivate the selection of *Google Form* as an instrument for adaptive assessment of number concepts.

Google form-assisted adaptive assessment design has many advantages over paper-based formative assessment testing. It accurately shows students' ability levels, is very effective for teachers in assessment (Hadianti et al., 2021), the calibrated question pool means that it can be used throughout the year as long as there are no curriculum changes, provides immediate feedback to students after taking the test, can be easily implemented for online assessment and is suitable for use in offline and online learning.

Meanwhile, jMetric itself is an easy-to-use software, designed to facilitate working in a production environment and to enable any researcher to use advanced psychometric procedures (Aksu et al., 2019; Loh & Lee, 2008; Rajnish, 2014; Stroulia & Kapoor, 2001). Compared to similar software products, jMetric provides a more integrated system in terms of performing psychometric analyses for research and operational purposes at no cost, unlike some other psychometric software. jMetric provides comprehensive statistical and psychometric procedures such as descriptive statistics, IRT parameter estimation, scale linking, and score equating (Gusev & Armenski, 2013; Özyurt et al., 2012). In addition, jMetrics helps to create various graphs and tables for data visualization. The structure of the software's graphical user

interface is intuitive and easy to learn. In addition, the scale is customized to the user's experience. New users can run psychometric procedures through pop-up menus with signs, while experienced users can use jMetrik commands to automate analyses.

The integration of Google Forms, jMetrik, and the Rasch Model creates a powerful synergy in digital educational measurement, enabling an efficient workflow from mass data collection to in-depth psychometric analysis. Google Forms facilitates the accessibility and efficiency of raw data collection, which is then systematically processed by jMetrik using the Rasch Model to produce valid and reliable measurements, detect item anomalies, and provide comprehensive insights into learner abilities and instrument quality. This is a highly effective and efficient model for large-scale assessment research in the digital era, significantly reducing technical and time barriers in the instrument validation process.

Thus, this research is considered important to do because there is a level of novelty in the development of the test adaptive assessment model by utilizing *Google Form* and using *Jmetri software* to calibrate questions and using the RASCH Model. So that it can be used independently (*self-directed*), as needed (*self-contained*), easy to use (*usable*) and can be adapted to technological developments.

Method

The research method used in this study is a qualitative research method with a research design in the form of Plomp model design research. The research data collection and analysis techniques refer to data triangulation in the validation test process of qualitative data by conducting interviews, observations, and *Focus Group Discussions (FGD)* (Belkhatir et al., 2013). The research stages include, preliminary stage, prototype stage, and assessment stage (Plomp, 2013). The preliminary stage is to develop a frame of reference for the level of mathematics learning difficulties and their attributes. The prototype stage is to design an adaptive diagnostic assessment of mathematics learning difficulties based on the RASCH Model. The assessment stage in the form of accuracy analysis refers to the modified test development model and formative evaluation using *self-evaluation* (Plomp, 2013; Tessmer, 2013).

In the preliminary stage, researchers have compiled a rubric for students' mathematics learning difficulty patterns referring to several studies conducted by the research team in the last five years (Anggara, 2020; Anggara & Solahudin, 2022; Anggara & Wandari, 2021; Wandari & Anggara, 2021). Then observations and testing of questions will be carried out on research subjects to obtain a frame of reference along with symptoms that can be used as attributes in the level of students' mathematics learning difficulties. At this stage, the subjects were 26 students of class X from one of the high schools in Majalengka Regency who were selected using the *snowball sampling* technique. The instruments used in this stage are several PISA 2018 questions. Then the students' error patterns were mapped and the learning difficulty value was calculated. The error values obtained from each student were analyzed to obtain error patterns that would be used as a benchmark reference frame.

The next stage is the prototype stage of the diagnostic assessment design using the Algorithm on the RASCH Model to detect the level of mathematics learning difficulties in terms of mathematical principles, namely mathematical knowledge, strategic knowledge, and communication. Test items are compiled from junior high school level mathematics material to see the extent of mastery of prerequisite material for grade X high school students. The test design is in the form of *clustering* so that the logic system built in this computer-based test is able to think, make the right decisions and act like humans do (Yang et al., 2022). The RASCH Model will make the level of difficulty of test items, the differentiation of test items, and *the testee's* answer response as the basis for decision making to determine the right test items given to the *testee*. The logic in describing the *testee's* ability uses monotonous reasoning so that a level of certainty will be obtained regarding the level of difficulty in learning student mathematics based on the responses given during the *testing* process. based on this reference, it can be assumed that the Adaptive Test can be used as a learning outcome assessment system as shown in the following figure.

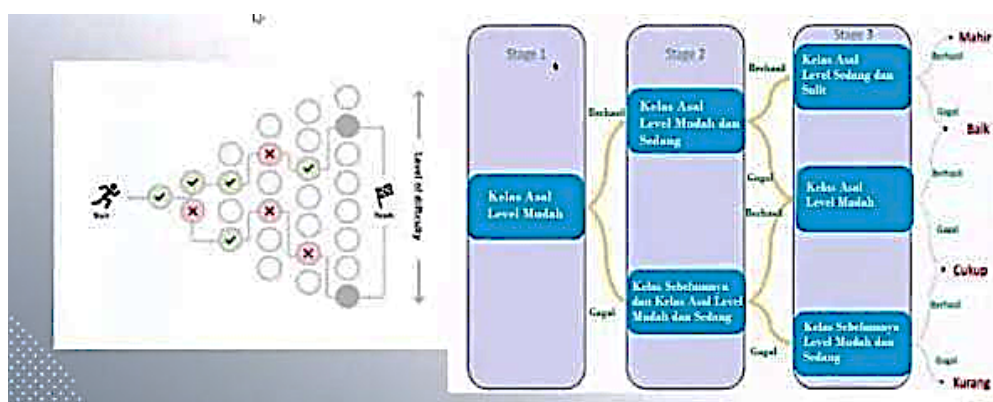


Figure 1 Adaptive Model Architecture

The classification of test item difficulty levels in this study is divided into three groups: high, medium and easy difficulty levels. Therefore, the number of test items that qualify to be used as a question bank must include these three groups. If the number of items to be tested is 10 items, then the item bank must have at least 30 test items, with details of 10 high difficulty test items, 10 medium difficulty test items, and 10 low difficulty test items. Good test items should have difficulty and power parameters in the range of 0.3 to 0.8 (classically) and -3 to 3 for modern tests.

Next, the assessment stage includes test trials using a formative evaluation approach. First, an expert review of the diagnostic assessment design that has been developed is carried out to 10 mathematics education lecturers, 2 informatics engineering lecturers, and 10 mathematics teachers. Then after making revisions from expert notes, a one-to-one evaluation will be carried out involving 10 grade X students from different schools in Majalengka district to conduct a review. This is important to do in order to obtain some information related to content suitability, assessment design, accuracy of use, and content quality. Then, a small group evaluation was conducted on 3 grade X students from different schools to evaluate the diagnostic assessment design. The information to be obtained from this step is related to effectiveness, efficiency, implementation, content, and test design. Finally, a field test was conducted with 200 grade X students in Majalengka district using snowball sampling to obtain an overview related to implementability, sustainability, effectiveness, suitability, and acceptance & attractiveness. At this stage, a screening test will be obtained that is able to measure students' level of difficulty in learning mathematics in detail.

Test measurements are conducted to obtain an overview of the effectiveness and efficiency of the diagnostic assessment design that has been designed. The implementation of this diagnostic assessment design will obtain qualitative data and quantitative data to be analyzed and grouped based on the level of mathematics learning difficulties of the testees. This is done to obtain a comprehensive picture of students' mathematics learning difficulties.

Results and Discussion

In the needs assessment stage, a literature study and field observations were conducted to identify potential or problems. The literature includes theories, concepts, and studies that highlight effective development models. The field study is an initial research activity aimed at collecting basic data for further development. The data collected includes a description of the ongoing learning conditions, including administrative completeness, learning media, and infrastructure facilities.

Based on the results of the analysis conducted by the teacher and the researcher, class X students are taken, where class X students can represent the mathematical abilities of students at the X grade level, and based on the characteristics of students in class X who have easy, medium and difficult abilities in other words, heterogeneous. Assessments that are still widely used are non-adaptive and use paper and pencil (PGP test). Therefore, a new assessment model is needed such as an adaptive assessment model with the use of google forms that can assess the ability of students at a certain level allowing to measure their achievement more accurately. Assessments that are structured according to learners' abilities have the advantage of measuring because they are able to adjust to their individual ability levels.

At the curriculum analysis stage, researchers analyzed various applicable curriculum tools. This analysis aims to formulate indicators and learning outcomes that apply at grade X SMA level. The formulation of indicators based on learning outcomes is as follows.

Table 1 Learning Outcomes and Learning Indicators

Learning Outcomes	Learning Achievement Indicators
By the end of phase E, learners can generalize the properties of power numbers, root forms and logarithms (including fractional powers).	Writing down the power form.
	Convert negative to positive powers and determine the result
	Simplifying power numbers and solving them
	Simplifying the properties of power number
	Find the value of the root form
	Simplify the shape of a fraction with a power
	Transforming the root form of a word and solving it
	Converting power form to logarithm form
	Writing logarithmic numbers
	Determine the properties of logarithms

Table 1 shows some indicators of learning achievement on number materials in the independent curriculum. The indicators are designed to assess students' ability to think critically and logically when solving problems related to numbers. So that researchers make a grid of test instruments tailored to these indicators. Analyzing the characteristics of students is a stage used by researchers to find out the characteristics of students which are the basis for researchers to develop adaptive assessment models. Based on this analysis, the adaptive assessment model can be applied to students and is expected to improve student learning outcomes.

At this stage, the process of correcting or validation by experts on the questions that have been prepared is carried out. The expert validators consist of lecturers of Mathematics Education at Sindang Kasih University and mathematics subject teachers at the high school level. The instrument validation stage is carried out by providing a validation instrument consisting of 30 multiple choice questions, question indicators and answer keys. In addition, there are criticisms and suggestions on each item and also in general. Validators are also expected to provide conclusions from the validated test instrument, and state the feasibility of the test instrument before being tested on students. If it is declared not feasible, then revise the questions according to the suggestions of each validator. The validation results can be seen in the following table.

Table 2 Expert Validation Results

Question Number	Question	Notes and Revisions
1	The simplest form of $a \times a \times a$ is ...	In question number one, the context of the question was improved and the indicators of the question were improved to match the learning outcomes of the number concept.

Question Number	Question	Notes and Revisions
5	The simplest form of $(5p^2)^3$ is ...	In question number five, the context of the question was improved and the indicators of the question were improved to match the learning outcomes of the number concept
29	The simplest form of $3 \log 18 + 3 \log 4 + 3 \log 8$ is ...	In question number twenty nine, the context of the question was improved and the indicators of the question were improved to match the learning outcomes of the number concept.

Based on the results of validation by experts, it was found that the items required revision based on suggestions such as improving the context of the questions and adjusted to the indicators. The next step is validation and calibration. This calibration is a process to determine the characteristics of the items. The calibration process is carried out with the help of Jmetrik Software.

As for the calibration results, good items can be determined and built into a question bank that will be adapted to Google Forms.

FINAL JMLE ITEM STATISTICS						
Item	Difficulty	Std. Error	WMS	Std. WMS	UMS	Std. UMS
in1	-2.43	0.64	0.98	0.10	0.86	-0.14
in2	0.13	0.50	1.08	0.48	1.08	0.43
in3	-1.76	0.53	0.83	-0.62	0.76	-0.79
in4	-2.07	0.57	0.95	-0.04	0.85	-0.28
in5	0.40	0.53	1.10	0.48	1.14	0.54
in6	-1.02	0.48	1.02	0.18	1.01	0.13
in7	-0.12	0.49	0.97	-0.15	0.96	-0.16
in8	2.30	1.03	1.03	0.33	1.03	0.37
in9	1.54	0.76	1.05	0.27	1.02	0.25
in10	-1.50	0.50	1.01	0.14	1.16	0.75
in11	1.06	0.64	1.11	0.40	1.27	0.66
in12	-0.57	0.47	0.96	-0.33	0.96	-0.34
in13	3.55	1.84	0.02	-0.64	0.02	-0.46
in14	1.06	0.64	0.90	-0.11	0.94	0.03
in15	-0.12	0.49	1.20	1.26	1.19	1.05
in16	3.55	1.84	0.02	-0.64	0.02	-0.46
in17	2.30	1.03	1.08	0.38	1.89	1.03
in18	-1.76	0.53	0.91	-0.30	0.85	-0.43
in19	0.70	0.57	0.92	-0.15	0.94	-0.03
in20	-0.35	0.48	0.97	-0.21	0.96	-0.25
in21	2.30	1.03	1.03	0.33	1.03	0.37
in22	0.13	0.50	1.14	0.73	1.10	0.51
in23	-0.57	0.47	0.92	-0.75	0.91	-0.76
in24	-1.50	0.50	0.99	0.02	0.94	-0.19
in25	-0.35	0.48	1.12	1.00	1.17	1.23
in26	0.40	0.53	1.12	0.54	1.20	0.74
in27	-0.57	0.47	0.79	-2.18	0.77	-2.11
in28	-0.35	0.48	0.90	-0.82	0.94	-0.40
in29	0.40	0.53	0.96	-0.06	1.12	0.48
in30	2.30	1.03	0.91	0.20	0.50	-0.26

Figure 2 Problem Bank Calibration Results

Figure 1 above shows the results of the calibration of the level of difficulty test that will be adapted to *google form*. The initial development of the question bank produced 3 (three) packages, each package consisting of 10 (ten) items. The calibration method used is the *RASCH model*. The results of calibration with the RASCH model have a normal range of values seen in the *difficulty* column, namely from (-3 to +3) then, if the value of the more mines the question is declared easier and vice versa if the value of the more plus the question is declared more difficult. At this stage, the results of the difficulty level test are as follows.

SCALE QUALITY STATISTICS		
Statistic	Items	Persons
Observed Variance	1.7905	0.2205
Observed Std. Dev.	1.3381	0.4696
Mean Square Error	0.4001	0.2066
Root MSE	0.6325	0.4546
Adjusted Variance	1.3904	0.0138
Adjusted Std. Dev.	1.1792	0.1177
Separation Index	1.8643	0.2588
Number of Strata	2.8190	0.6784
Reliability	0.7766	0.0628
Elapsed time: 1 secs, 470 msec		
Data	Variables	freq1 descriptives2 item3 rasch4 rasch5 x

Figure 3 *Scale Quality Statistic* of the tested questions

In Figure 2 regarding the question instrument, we can see the description of the output below. The person reliability value is 0.06 and the item reliability value is 0.77. This shows that the consistency of answers from our subjects is still weak, but the quality of the items in the instrument in terms of reliability is quite good. The Person Starata value is 0.67 and the item starata value is 2.81 which shows the quality of the instrument as well as the quality of our subjects. The greater the Strata value the better because it can identify a wider group of subjects (able - unable) and groups of items (difficult - easy). *Criteria* in the *Rating Scale Instrument Quality Criteria* column where there are *poor* that explain the items that have been calibrated must be revised, *Fair* items are valid but there are some items that must be revised, *Good*, *Verry Good*, *Excellent* items are valid and suitable for testing.

Following the calibration, storing and securing the items is important. The results of the instrument content calibration show that the overall instrument has a good category with a stratum of 2.81. This means that theoretically, the question bank instruments are calibrated, and can be continued with testing in the next process.

The product developed is an adaptive assessment on the concept of number by utilizing *google form*. Software design, or the process of creating software used for adaptive testing, is carried out in stages according to the stages of the RASCH model of software development. The first stage is the analysis of the needs in the development of the software to be made. The next stage is the design stage which includes application design, database design and required interface design. Then the third stage is the software coding stage, and the last stage is testing the software.

Then the instruments used in this research are questionnaires and tests. This questionnaire is used to assess the quality or attractiveness of this evaluation model through media expert validation, *assessment* and user response. This questionnaire or questionnaire was developed from the assessment model evaluation criteria based on several experts. This questionnaire or questionnaire was given to the validators of the development model and material experts, namely lecturers and teachers who were used to determine the feasibility of developing the assessment model and also given to class teachers to find out the response to the use of the assessment model.

Then to find out the feasibility and results of the development, a test is given to students. All questionnaires in this study used a Likert scale questionnaire to measure the opinions, attitudes and perceptions of a person or group of people towards this development (Sugiyono, 2016).

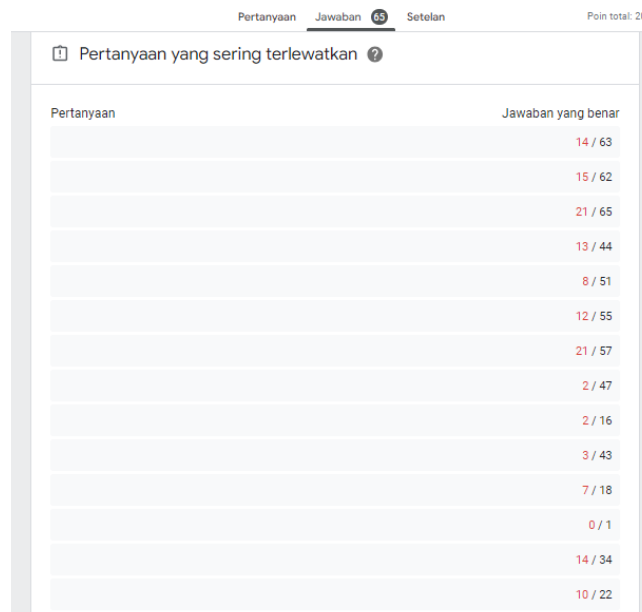


Figure 4 User Response Display of Missed Questions

In Figure 3, it can be concluded that the development of the *google form-based* adaptive assessment model has been adjusted to the level of ability of each learner. The advantage of using adaptive tests is that the time used in the exam is shorter, learners ask questions individually. This means that the questions asked by each learner are different, reducing opportunities for collaboration.

At this stage, the researcher conducted a trial directly to the field of test instruments that had gone through the expert validation stage and made revisions based on suggestions. The test trial was conducted on class X students consisting of 26 students. The trial was carried out according to the schedule given by the school in the implementation of face-to-face teaching and learning activities. The trial was conducted twice a meeting for 90 minutes during math class time, precisely on Tuesday, June 4, 2024 and Tuesday, June 11, 2024. The trial implementation was carried out in 2 meetings.

- Meeting 1 on Tuesday, June 4, 2024 started at 08.00 WIB. The first trial was a trial to see the level of ability of students using non-adaptive tests.
- Meeting 2 on Tuesday, June 11, 2024 starts at 08.00 WIB. The second trial was a trial of the adaptive assessment model test in the form of a *google* form link.

After working on the test instrument, students are given an adaptive test instrument questionnaire to see feedback from the perspective of students. Furthermore, the researcher analyzed the results of the implementation of the adaptive test instrument to class X students. This stage aims to determine the quality or feasibility of the test instrument. Details of the test analysis are described as follows.

Table 3 Recap of Expert Validation Assessment Results

Validator	Number of Aspects	Yield (%)	Category
1	3	80%	Valid

Based on the results of the development of *google form-based* adaptive assessments that have been carried out, it is known that the results of the validator on the results obtained are 80%. So that from the results of the validator referring to the conversion table, it can be concluded that the assessment developed is feasible to use or can be tested on students and needs to be revised by researchers.

Table 4 User Response Validation Results

No	Aspects	Indicator	Yield (%)	Category
1	Website Interest	Convenience in using the website	61,8 %	Valid
		Level of trust in using the website	56,4 %	Firly Valid
		Website appearance and performance	76,4 %	Valid
2	Ease of Website	Ease of the use of the website	67,3 %	Valid
		Seeking information on using the website	56, 4 %	Fairly Valid
		Website Fungtion and Capacity	69,1 %	Valid

Based on the data above, it can be seen that the overall average is 64.5% with Valid criteria. thus the development of an adaptive assessment model on the concept of number by utilizing google forms is declared valid and does not need to be revised.

The research conducted is a type of Adaptive Assessment development research on the concept of number based on google form class X SMK. The development of this assessment refers to the ADDIE model development procedure developed by (Haddad & Kalaani, 2014; Rinaldi et al., 2022). The ADDIE model serves as a strategic assessment ecosystem manager, ensuring that the selection, design, development, implementation, and evaluation of assessment instruments (both digital such as Google Forms and traditional such as P&P) are coherently integrated across the learning lifecycle. With an emphasis on continuous and comprehensive evaluation, ADDIE guides the use of assessment tools and methods to systematically monitor progress, identify areas for improvement, and validate the effectiveness of educational interventions, making it key to the development of planned, high-quality assessments. Stage Two is the design of the initial product. This includes the selection of materials that match learner characteristics and competency demands, the learning strategies applied, and the forms and methods of evaluation used (Gusev & Armenski, 2013; Yang et al., 2022). In this context, you want to refer to the Mathematics textbook for grade X semester two of the independent curriculum to collect references on number material. The preparation of the question grids must cover all the indicators and learning outcomes set.

The third step includes several activities, namely entering the questions that have been made into the *Google Form* website, making instructions for working on the questions, setting points on each question, compiling an answer key for each question, and coding. The last step is to prepare the questions that have been made in *Google Drive*. The fourth stage involves copying the Google Form link containing the adaptive number material questions to be distributed to students. One of the obstacles of the third stage is the variation in the ability of learners in one class who often have different background knowledge. Therefore, choosing materials that are appropriate for all learners and designing questions that are challenging but not too difficult can be a challenge.

The third stage is the development of question instruments that are expected to be used for evaluation, especially for class X students in number material. In the validation process by media experts, there are several comments from each validator that need to be corrected so that the instrument is more suitable for use by students. The instrument has been improved in accordance with the comments from the validator. The results of the material validation process show that there are several comments that need to be corrected to make it better and suitable for use by students. The instrument that has been improved is in accordance with the comments of the validator. The material expert gave an average percentage value of 80% in the "very good" category to the Google Form-based question instrument, which indicates that the instrument is suitable for use and testing. This is in line with the view of (Reiser & Dempsey, 2012; Sari et al., 2020; Stroulia & Kapoor, 2001), which states that a development product is considered effective if it achieves the learning objectives set for learner learning outcomes. Barriers at this stage include managing and analyzing the assessment results from Google Forms, especially when the number of respondents is very large. While Google Sheets can help, more in-depth analysis may require additional expertise in using spreadsheets or other data analysis tools. Stage four involves piloting the Google Forms-based adaptive

question instrument with learners. After learners completed the instrument, the results were then validated and calibrated as follows.

Based on the results of the validity and calibration analysis, using Jmetrik Software, information was obtained that the item validity test showed a variety of difficulty levels. Of the 30 items tested, there were 10 items with a "medium" level of difficulty, 10 items with an "easy" level of difficulty, and 10 items with a "difficult" level of difficulty. Thus, from these 30 items, we can represent the ability of students by looking at the assessment score of the adaptive assessment model used.

From the analysis results obtained from the table, it can be concluded that all 30 items are classified in the good category, which indicates that these questions have good differentiating power. Thus, based on the results of the reliability test, difficulty level, and question differentiation, the question instrument used for this test can be considered good. This is in accordance with the opinion (Belkhatir et al., 2013; Gusev & Armenski, 2013) that the validity of test development logically shows the test is very valid. In addition, from the reliability, difficulty level, and differentiating power tests conducted, this test has been assessed as good to use. Based on the results of data analysis, the effectiveness of the distractor or the power of the question instrument can be measured. It was found that there were 5 items that had distractors that functioned properly. These distractors are not just a complement to the answer choices, but are designed to mislead students not to choose the answer key. To achieve this goal, distractors must be designed to resemble the answer key as accurately as possible (Aksu et al., 2019; Whittaker et al., 2012). The bottleneck in stage four is the question testing process, which requires sufficient time to ensure that the questions can accurately measure learners' abilities. Time constraints are often a major challenge in this regard.

In the evaluation stage, an assessment is carried out from the beginning of the process, namely needs analysis, curriculum analysis, and analysis of learner characteristics, as well as the design and development stages that have been passed. After passing the validation process by validators, consisting of expert lecturers and material lecturers, this evaluation stage can provide an overview of how feasible the assessment questions that have been developed in terms of validity.

Conclusion

Adaptively prepared assessments can improve the ability of learners at a certain level with moderate, difficult and easy (heterogeneous) categories. The ability of students can be seen from the number of students who get the most scores seen from the results of the assessment model that has been developed. The development of this adaptive assessment was responded well by students. This is partly because the assessments used are still non-adaptive and use *paper and pencil (P&P test)*. Based on the results of the development of *google form-based* adaptive assessments that have been carried out, it is known that the results of the validator at the question trial stage, obtained the readability of the assessment of 80%, some items were revised to suit the language development of students, and at the trial stage the assessment model and user response were declared valid in the aspect of website attractiveness and website convenience on average 64.5%. Thus, the adaptive assessment developed has met the criteria for development products, namely valid, practical, effective, and showing added value.

In applying this adaptive assessment, teachers or researchers are advised to check students' concept knowledge. Checking students' concept mastery is done to find out the relationship between students' concept mastery and the character being assessed. For further research, it is better to first make observations and collect as much data and information as possible on the subject and the environment that will be assessed for character. All information will be very useful as a consideration in the preparation of indicators and the development of a question grid that will be compiled as a character assessment tool. The development of an adaptive assessment model on the concept of number by utilizing *google form* can be done for the development of further assessment models. Teachers or researchers can make assessments with other materials or lessons.

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Letter of Acceptance (LoA) of Article Submission to Jurnal Sosioteknologi

Dear Benny Anggara, Wily Wandari, Atika Nuril Huda, and Arip Amin

This is to inform you that your article entitled **Adaptive Diagnostic Assessment Design Throught Google Form Optimization and jMetric to Detect Students' Mathematics Learning Difficulty Levels** has been accepted for publication in Journal of Sociotechnology period in the July 2025.

Thank you very much for your submission.

Sincerely.

Dr. Harry Nuriman
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Adaptive Diagnostic Assessment Design through Google Forms Optimization and Jmetric to Detect Students' Mathematics Learning Difficulty Levels

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Adaptive Diagnostic Assessment Design through Google Forms Optimization and Jmetric to Detect Students' Mathematics Learning Difficulty Levels

Desain Asesmen Diagnostik Adaptif melalui Optimalisasi Google Forms dan Jmetric untuk Mendeteksi Tingkat Kesulitan Belajar Matematika Siswa

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ABSTRACT

The level of difficulty students experience in learning mathematics can help teachers design learning activities that are appropriate for students' abilities and foster an independent learning environment. Google Forms and jMetric can be used as alternative software to construct adaptive assessments that accurately detect students' level of difficulty in learning mathematics and are easy to apply. The results of calibrating the content of the instrument with jMetric show that the overall instrument is in the "fairly good" category with a stratum of 2.81. Meanwhile, the development of adaptive assessments based on Google Forms is deemed valid in terms of website appeal and ease of use, with an average of 64.5%.

INFO ARTIKEL

Kata kunci:

desain asesmen diagnostik adaptif, Google Forms, jMetric, level kesulitan belajar matematika

ABSTRAK

Tingkat kesulitan belajar Matematika yang dialami oleh siswa dapat memudahkan guru dalam merancang pembelajaran yang sesuai dengan kemampuan siswa dan menumbuhkan iklim merdeka belajar. Google Forms dan jMetric dapat dijadikan sebagai software alternatif untuk mengonstruksi asesmen adaptif pendeteksi level kesulitan belajar Matematika siswa yang presisi dan mudah diaplikasikan. Hasil kalibrasi isi instrumen dengan jMetric menunjukkan keseluruhan instrumen mempunyai kategori cukup baik dengan strata 2.81, sedangkan pengembangan asesmen adaptif berbasis Google Forms yang telah dilakukan dinyatakan valid secara aspek ketertarikan website dan kemudahan website dengan rata – rata 64,5 %.

Introduction

This research is motivated by the occurrence of learning loss after the COVID-19 pandemic, the implementation of the Kurikulum Merdeka (freedom curriculum) in schools, and the advancement of artificial intelligence (AI) technology. In line with these conditions, learning needs to be presented by considering the level of achievement and ability of students. On the other hand, AI can be utilized to create software that facilitates learning (Chen et al., 2022; Popenici & Kerr, 2017; Roll & Wylie, 2016). The scale of student ability is also reflected in the learning difficulties they experience so that it needs to be used as a reference in learning design (Elastika & Dewanto, 2021; Mutflu & Akgün, 2019a). In the Kurikulum Merdeka, students' abilities are measured by diagnostic assessments. Diagnostic assessments can map students' learning potential, one of which is able to detect student learning difficulties (Inayati, 2022; Septiani, 2022). Mathematics, as one of the sciences that is perceived as difficult, also creates learning difficulties for students (Sibaen et al., 2023; Uegatani et al., 2024; Žakelj, 2014).

However, the current diagnosis of mathematics learning difficulties only provides a description of certain criteria and does not indicate the level of difficulty experienced by students. The level of mathematics learning difficulty can help teachers design learning that aligns with their students' abilities (Aikenhead, 2021; Samawati, 2021; Wandari & Fardillah, 2021). In addition, the test mechanism conducted is not able to provide sufficient information to differentiate the testee's ability scale (test participants) (Abdullah et al., 2015; Wijaya et al., 2014). The test items given are not differentiated for each testee with certain mathematical abilities. This lack of differentiation indicates that the diagnostic assessment developed is not sufficient with the principle of fairness in the Kurikulum Merdeka. Test characteristics that are in accordance with the above principles can be adaptive tests. Adaptive tests allow testees to obtain test items different from other testees according to the responses (answers) given previously, but these differences have been adjusted to the ability level of each testee. Such a test mechanism can be developed using a Google Forms based on the results of question calibration using jMetric. Google Forms can be utilized as an instrument to conduct diagnostic assessments because it has features that are easy to operate (Haddad & Kalaani, 2014; Rinaldi et al., 2022). The algorithm constructed on Google Forms makes testees with high ability levels get more difficult items compared to testees who have low ability levels, and vice versa. Meanwhile, jMetric will calibrate the questions so that good items can be determined and built into a question bank that will be adapted to Google Forms (Aksu et al., 2019). Therefore, Google Forms applied with jMetric is expected to be an adaptive diagnostic assessment that is able to detect students' level of mathematical difficulty with precision.

Based on the background provided, this study examines how a Google Form-based adaptive diagnostic assessment using jMetric can effectively detect students' levels of mathematics learning difficulties. The problem-solving approach involves three key phases. First, we will develop a reference framework for each level of mathematics learning difficulty by identifying error patterns in students' mathematical problem-solving processes. Current research indicates that learning difficulty classifications lack hierarchical structure (Nelson & Powell, 2018; Yuberta et al., 2022). Second, we will create an adaptive framework by calibrating questions using the RASCH model to appropriately select difficulty levels for individual test-takers. Third, we will conduct comprehensive assessment testing to evaluate the consistency of the developed test instrument in detecting mathematics learning difficulty levels.

Several studies have investigated methods for diagnosing students' mathematics learning difficulties. Research consistently shows that tests are the most commonly used diagnostic tool for identifying student learning difficulties (Hasan & Fraser, 2015; Ishak et al., 2021; Wijaya et al., 2019). Building on this foundation, studies conducted by our research team (Anggara, 2020; Anggara & Solahudin, 2022; Anggara & Wandari, 2021; Wandari & Anggara, 2021) and other researchers (Liu et al., 2023; Powell et al., 2021) have used classical tests to identify forms of students' mathematics learning difficulties. In classical testing, all students receive identical questions. However, this approach often results in students leaving answers blank when they perceive questions as too difficult. Furthermore, existing research relies

exclusively on classical tests and presents findings through descriptive data based on predetermined criteria, without establishing a hierarchy of the specific difficulties that students encounter.

Testing mechanisms that rely on the principle of equality in assessing student ability can produce measurement errors that negatively impact test validity and reliability (Langoban & Langoban, 2020; Santoso et al., 2017). Conversely, students' abilities should be grouped according to specific proficiency levels to accurately represent the hierarchy of their cognitive processes (Akhter & Akhter, 2018; Kleden et al., n.d.). These ability levels serve as essential references for developing appropriate and targeted learning programs (Harsela et al., 2021; Hasanah et al., 2023; Pramesti & Prasetya, 2021).

Students' mathematical ability levels directly influence their perceived difficulty in learning mathematics: students with higher mathematical ability experience lower levels of difficulty, while those with lower ability face greater challenges (Fuchs et al., 2019; Mutflu & Akgün, 2019b). Consequently, increased difficulty in learning mathematics creates a barrier to students' mastery of mathematical concepts.

Based on the description of the theoretical studies and research results previously described, there are two things that concern researchers. First, it is necessary to diagnose the level of students' mathematics learning difficulties because descriptive studies with partial explanations are not sufficient to describe the hierarchy of students' thinking processes. Second, a more adaptive test approach is needed in diagnosing the level of mathematics learning difficulties because in classical tests the level of difficulty and distinguishing power of each question is inconsistent if applied to different subjects. Therefore, this research specifically aims to utilize Google Forms as a testing platform while employing jMetric to calibrate test items, creating an adaptive diagnostic assessment capable of detecting students' mathematics learning difficulty levels.

In the test system, each testee only gets items that match their abilities so that measurement errors will be smaller (Cetin-Berber et al., 2019; Ebenbeck & Gebhardt, 2022; Hula et al., 2015; Istiyono et al., 2020; Kaplan et al., 2015). So far, several studies have concluded that the test system provides enough information to differentiate testee ability scales (Martin & Lazendic, 2018; Samsudin et al., 2019). Meanwhile, the RASCH model will work to select items according to their difficulty level based on previous responses (answers) (Azmi et al., 2019). Thus, the diagnostic assessment will be adaptive and have the ability to select student difficulties based on their level systemically.

Google Forms is an online service from Google that is useful for creating online forms and collecting data and comments, which are then compiled using spreadsheets (Rinaldi et al., 2022; Whittaker et al., 2012). This service is usually used to conduct surveys, manage registrations, or create tests or quizzes online. In the world of education, Google Forms have several functions, including creating online exams or assessments, collecting opinions, collecting teacher and student data, creating registration forms, and distributing questionnaires online (Sari et al., 2020). The advantages of Google Forms include ease of operation, economy, freedom from space and time constraints, responsiveness, and ease of sharing. These reasons motivate the selection of Google Forms as an instrument for adaptive assessment of number concepts.

Google Forms-assisted adaptive assessment design has many advantages over paper-based formative assessment testing. It accurately shows students' ability levels, is very effective for teachers in assessment (Hadianti et al., 2021), the calibrated question pool means that it can be used throughout the year as long as there are no curriculum changes, provides immediate feedback to students after taking the test, can be easily implemented for online assessment, and is suitable for use in offline and online learning.

Meanwhile, jMetric itself is easy-to-use software designed to facilitate working in a production environment and to enable any researcher to use advanced psychometric procedures (Aksu et al., 2019; Loh & Lee, 2008; Rajnish, 2014; Stroulia & Kapoor, 2001). Compared to similar software products, jMetric provides a more integrated system in terms of performing psychometric analyses for research and operational purposes at no cost, unlike some other psychometric software. jMetric provides comprehensive statistical and psychometric procedures such as descriptive statistics, IRT parameter estimation, scale

linking, and score equating (Gusev & Armenski, 2013; Özyurt et al., 2012). In addition, jMetrics helps to create various graphs and tables for data visualization. The structure of the software's graphical user interface is intuitive and easy to learn. In addition, the scale is customized to the user's experience. New users can run psychometric procedures through pop-up menus with signs, while experienced users can use jMetric commands to automate analyses.

The integration of Google Forms, jMetric, and the Rasch model creates a powerful constructive collaboration in digital educational measurement, enabling an efficient workflow from mass data collection to in-depth psychometric analysis. Google Forms facilitates the accessibility and efficiency of raw data collection, which is then systematically processed by jMetric using the Rasch model to produce valid and reliable measurements, detect item anomalies, and provide comprehensive insights into learner abilities and instrument quality. This framework is a highly effective and efficient model for large-scale assessment research in the digital era, significantly reducing technical and time barriers in the instrument validation process.

Thus, this research is considered important to do because there is a level of novelty in the development of the test adaptive assessment model by utilizing Google Forms and using jMetric software to calibrate questions, using the Rasch model. This model can be used independently (self-directed), as needed (self-contained), is user-friendly (usable), and can adapt to technological developments.

Method

The research method used in this study is a qualitative approach with a research design based on the Plomp model. The techniques for collecting and analyzing research data involve data triangulation during the validation test process of qualitative data, which includes conducting interviews, observations, and focus group discussions (FGD) (Belkhatir et al., 2013). The research stages include the preliminary stage, prototype stage, and assessment stage (Plomp, 2013). The preliminary stage is to develop a frame of reference for the level of mathematics learning difficulties and their attributes. The prototype stage is to design an adaptive diagnostic assessment of mathematics learning difficulties based on the Rasch model. The assessment stage in the form of accuracy analysis refers to the modified test development model and formative evaluation using self-evaluation (Plomp, 2013; Tessmer, 2013).

In the preliminary stage, researchers have compiled a rubric for students' mathematics learning difficulty patterns, referring to several studies conducted by the research team in the last five years (Anggara, 2020; Anggara & Solahudin, 2022; Anggara & Wandari, 2021; Wandari & Anggara, 2021). Then observations and testing of questions will be conducted on research subjects to obtain a frame of reference along with symptoms that can be used as attributes in the level of students' mathematics learning difficulties. At this stage, the subjects were 26 students of class X from one of the high schools in Majalengka Regency who were selected using the snowball sampling technique. The instruments used in this stage consist of several questions from the PISA 2018 assessment. Then the students' error patterns were mapped, and the learning difficulty value was calculated. The error values obtained from each student were analyzed to obtain error patterns that would be used as a benchmark reference frame.

The next stage involves creating a prototype for the diagnostic assessment design, which utilizes the Rasch model algorithm to identify the level of mathematics learning difficulties based on mathematical principles, specifically mathematical knowledge, strategic knowledge, and communication. Test items are compiled from junior high school-level mathematics material to see the extent of mastery of prerequisite material for grade X high school students. The test design is in the form of clustering so that the logic system built into this computer-based test is able to think, make the right decisions, and act like humans do (Yang et al., 2022). The Rasch model will make the level of difficulty of test items, the differentiation of test items, and the testee's answer response the basis for decision-making to determine the right test items given to the testee. The logic in describing the testee's ability uses monotonous reasoning so that a level of certainty will be obtained regarding the level of difficulty in learning student mathematics based

on the responses given during the testing process. Based on this reference, it can be assumed that the adaptive test can be used as a learning outcome assessment system, as shown in the following figure.

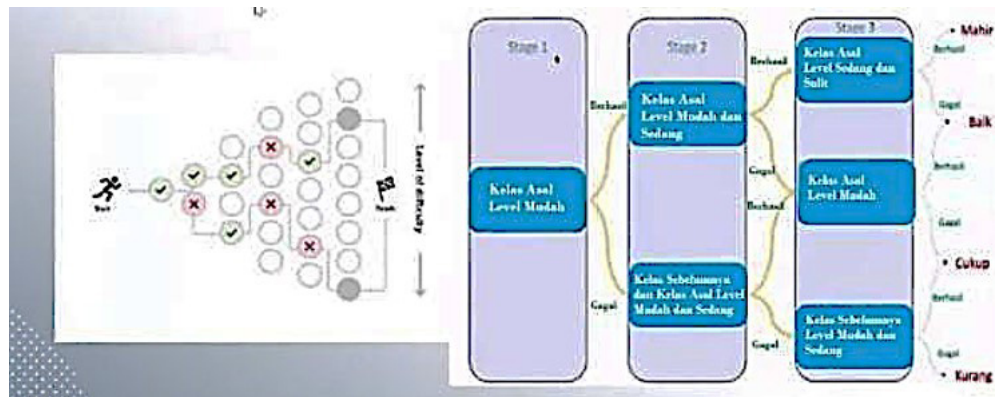


Figure 1 Adaptive model architecture

The classification of test difficulty in this study is divided into three groups: high, medium, and easy difficulty levels. Therefore, the number of test items that qualify to be used as a question bank must include these three groups. If the number of items to be tested is 10 items, then the item bank must have at least 30 test items, with details of 10 high-difficulty test items, 10 medium-difficulty test items, and 10 low-difficulty test items. Good test items should have difficulty and power parameters in the range of 0.3 to 0.8 (classically) and -3 to 3 for modern tests.

Next, the assessment stage includes test trials using a formative evaluation approach. First, an expert review of the diagnostic assessment design that has been developed is conducted with 10 mathematics education lecturers, 2 informatics engineering lecturers, and 10 mathematics teachers. Then, after making revisions from expert notes, a one-to-one evaluation will be conducted involving 10 grade X students from different schools in Majalengka district to conduct a review. This is important to do in order to obtain some information related to content suitability, assessment design, accuracy of use, and content quality. Then, a small group evaluation was conducted on 3 grade X students from different schools to evaluate the diagnostic assessment design. The information to be obtained from this step is related to effectiveness, efficiency, implementation, content, and test design. Finally, a field test was conducted with 200 grade X students in Majalengka district using snowball sampling to obtain an overview related to 'implementability', sustainability, effectiveness, suitability, and acceptance & attractiveness. At this stage, a screening test will be obtained that is able to measure students' level of difficulty in learning mathematics in detail.

Test measurements are conducted to obtain an overview of the effectiveness and efficiency of the diagnostic assessment design that has been designed. The implementation of this diagnostic assessment design will obtain qualitative data and quantitative data to be analyzed and grouped based on the level of mathematics learning difficulties of the testees. This is done to obtain a comprehensive picture of students' mathematics learning difficulties.

Results and Discussion

In the needs assessment stage, a literature study and field observations were conducted to identify potential problems. The literature includes theories, concepts, and studies that highlight effective development models. The field study is an initial research activity aimed at collecting basic data for further development. The data collected includes a description of the ongoing learning conditions, including administrative completeness, learning media, and infrastructure facilities.

Based on the results of the analysis conducted by the teacher and the researcher, class X students are selected, where class X students can represent the mathematical abilities of students at the X grade level, and based on the characteristics of students in class X who have easy, medium, and difficult abilities—in other words, heterogeneous. Assessments that are still widely used are non-adaptive and use paper and pencil (PGP test). Therefore, a new assessment model is needed, such as an adaptive assessment model with the use of Google Forms that can assess the ability of students at a certain level, allowing them to measure their achievement more accurately. Assessments that are structured according to learners' abilities have the advantage of measuring because they are able to adjust to their individual ability levels.

At the curriculum analysis stage, researchers analyzed various applicable curriculum tools. This analysis aims to formulate indicators and learning outcomes that apply at the grade X SMA level. The formulation of indicators based on learning outcomes is as follows.

Table I Learning Outcomes and Learning Indicators

Learning Outcomes	Learning Achievement Indicators
By the end of phase E, learners can generalize the properties of power numbers, root forms and logarithms (including fractional powers).	Writing down the power form.
	Convert negative to positive powers and determine the result
	Simplifying power numbers and solving them
	Simplifying the properties of power number
	Find the value of the root form
	Simplify the shape of a fraction with a power
	Transforming the root form of a word and solving it
	Converting power form to logarithm form
	Writing logarithmic numbers
	Determine the properties of logarithms

Table I shows some indicators of learning achievement on number materials in the independent curriculum. The indicators are designed to assess students' ability to think critically and logically when solving problems related to numbers. Researchers tailor a grid of test instruments to these indicators. Analyzing the characteristics of students is a stage used by researchers to find out the characteristics of students, which are the basis for researchers to develop adaptive assessment models. Based on this analysis, the adaptive assessment model can be applied to students and is expected to improve student learning outcomes.

Experts are now carefully correcting or validating the prepared questions. The expert validators consist of lecturers of mathematics education at Sindang Kasih University and mathematics subject teachers at the high school level. The instrument validation stage is conducted by providing a validation instrument consisting of 30 multiple-choice questions, question indicators, and answer keys. Additionally, the validators provide criticisms and suggestions for each item as well as general feedback. Validators are also expected to provide conclusions from the validated test instrument and state its feasibility before it is tested on students. If it is declared not feasible, then revise the questions according to the suggestions of each validator. The validation results can be seen in the following table.

Table II Expert Validation Results

Question Number	Question	Notes and Revisions
1	The simplest form of is ...	In question number one, the context of the question was improved and the indicators of the question were improved to match the learning outcomes of the number concept.
5	The simplest form of is ...	In question number five, the context of the question was improved and the indicators of the question were improved to match the learning outcomes of the number concept
29	The simplest form of is ...	In question number twenty nine, the context of the question was improved and the indicators of the question were improved to match the learning outcomes of the number concept.

Based on the results of validation by experts, it was found that the items required revision based on suggestions, such as improving the context of the questions and adjusting the indicators. The next step is validation and calibration. This calibration is a process to determine the characteristics of the items. The calibration process is conducted with the help of Jmetric software

As for the calibration results, good items can be determined and built into a question bank that will be adapted to Google Forms.

FINAL JMLE ITEM STATISTICS						
Item	Difficulty	Std. Error	WMS	Std. WMS	UMS	Std. UMS
in1	-2.43	0.64	0.98	0.10	0.86	-0.14
in2	0.13	0.50	1.08	0.48	1.08	0.43
in3	-1.76	0.53	0.83	-0.62	0.76	-0.79
in4	-2.07	0.57	0.95	-0.04	0.85	-0.28
in5	0.40	0.53	1.10	0.48	1.14	0.54
in6	-1.02	0.48	1.02	0.18	1.01	0.13
in7	-0.12	0.49	0.97	-0.15	0.96	-0.16
in8	2.30	1.03	1.03	0.33	1.03	0.37
in9	1.54	0.76	1.05	0.27	1.02	0.25
in10	-1.50	0.50	1.01	0.14	1.16	0.75
in11	1.06	0.64	1.11	0.40	1.27	0.66
in12	-0.57	0.47	0.96	-0.33	0.96	-0.34
in13	3.55	1.84	0.02	-0.64	0.02	-0.46
in14	1.06	0.64	0.90	-0.11	0.94	0.03
in15	-0.12	0.49	1.20	1.26	1.19	1.05
in16	3.55	1.84	0.02	-0.64	0.02	-0.46
in17	2.30	1.03	1.08	0.38	1.89	1.03
in18	-1.76	0.53	0.91	-0.30	0.85	-0.43
in19	0.70	0.57	0.92	-0.15	0.94	-0.03
in20	-0.35	0.48	0.97	-0.21	0.96	-0.25
in21	2.30	1.03	1.03	0.33	1.03	0.37
in22	0.13	0.50	1.14	0.73	1.10	0.51
in23	-0.57	0.47	0.92	-0.75	0.91	-0.76
in24	-1.50	0.50	0.99	0.02	0.94	-0.19
in25	-0.35	0.48	1.12	1.00	1.17	1.23
in26	0.40	0.53	1.12	0.54	1.20	0.74
in27	-0.57	0.47	0.79	-2.18	0.77	-2.11
in28	-0.35	0.48	0.90	-0.82	0.94	-0.40
in29	0.40	0.53	0.96	-0.06	1.12	0.48
in30	2.30	1.03	0.91	0.20	0.50	-0.26

Figure 2 Problem bank calibration results

Figure 1 presents the calibration test results for difficulty levels that will be implemented in Google Forms. The initial question bank development yielded three packages, with each package containing ten items. The calibration employed the Rasch model methodology.

The Rasch model calibration results demonstrate difficulty values within the normal range, as shown in the difficulty column, spanning from -3 to +3. In this scale, more negative values indicate easier questions, while more positive values represent more difficult questions. The difficulty level test results for this stage are presented below.

SCALE QUALITY STATISTICS		
Statistic	Items	Persons
Observed Variance	1.7905	0.2205
Observed Std. Dev.	1.3381	0.4696
Mean Square Error	0.4001	0.2066
Root MSE	0.6325	0.4546
Adjusted Variance	1.3904	0.0138
Adjusted Std. Dev.	1.1792	0.1177
Separation Index	1.8643	0.2588
Number of Strata	2.8190	0.6784
Reliability	0.7766	0.0628
Elapsed time: 1 secs, 470 msec		
Data	Variables	freq1
	descriptives2	item3
	rasch4	rasch5 x

Figure 3 Scale quality statistic of the tested-questions

In Figure 2, we can see the description of the output related to the question instrument below. The person reliability value is 0.06, and the item reliability value is 0.77. This shows that the consistency of answers from our subjects is still weak, but the quality of the items in the instrument in terms of reliability is quite good. The person strata value is 0.67, and the item strata value is 2.81, which shows the quality of the instrument as well as the quality of our subjects. The greater the strata value, the better because it can identify a wider group of subjects (able-unable) and groups of items (difficult-easy). The criteria in the rating scale instrument quality criteria column must be revised, especially the poor ones that explain the calibrated items. Fair items are valid, but there are some items that must be revised. Good, very good, excellent items are valid and suitable for testing.

Following the calibration, storing and securing the items is important. The results of the instrument content calibration indicate that the overall instrument falls into a good category, with a stratum score of 2.81. This means that, theoretically, the question bank instruments are calibrated and can be continued with testing in the next process.

The product developed is an adaptive assessment of the concept of numbers using Google Forms. Software design, or the process of creating software used for adaptive testing, is conducted in stages according to the stages of the Rasch model of software development. The first stage is the analysis of the needs in the development of the software to be made. The next stage is the design stage, which includes application design, database design, and required interface design. Then the third stage is the software coding stage, and the last stage is testing the software.

Then the instruments used in this research are questionnaires and tests. This questionnaire is used to assess the quality or attractiveness of this evaluation model through media expert validation, assessment, and user response. This questionnaire was developed from the evaluation criteria for the assessment model based on several experts. This questionnaire was given to the validators of the development model and material experts, namely lecturers and teachers, who were used to determine the feasibility of developing the assessment model and also given to class teachers to find out the response to the use of the assessment model.

Then, to find out the feasibility and results of the development, a test is given to students. All questionnaires in this study used a Likert scale questionnaire to measure the opinions, attitudes, and perceptions of a person or group of people toward this development (Sugiyono, 2016).

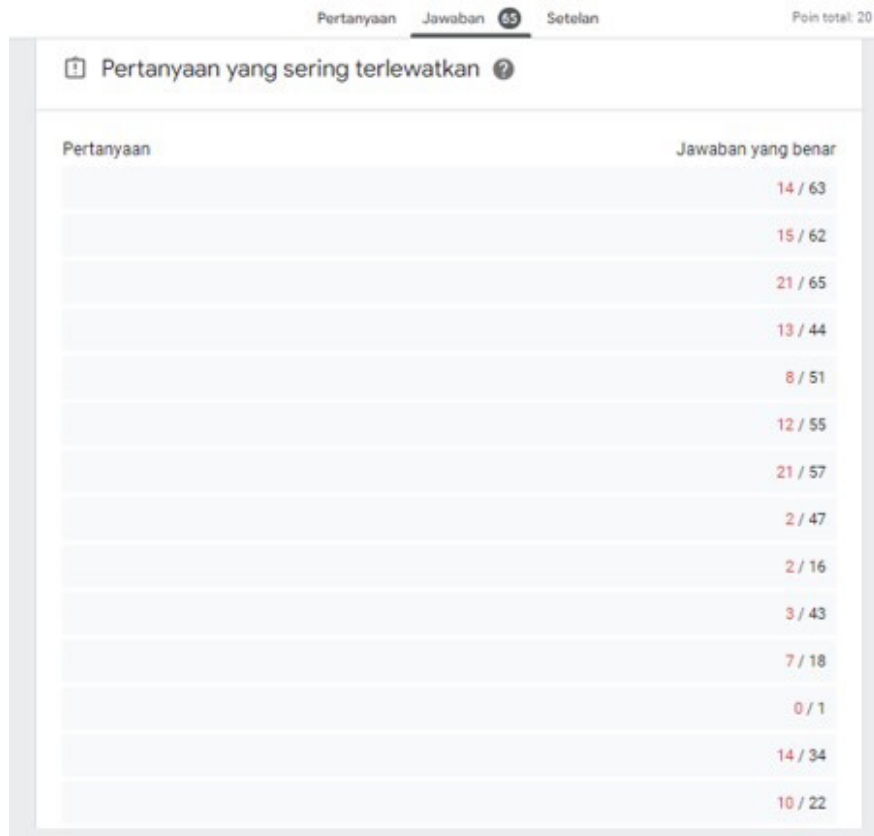


Figure 4 User response display of missed questions

Figure 3 indicates that the development of the Google Forms-based adaptive assessment model has been adjusted to the level of ability of each learner. The advantage of using adaptive tests is that the time used in the exam is shorter, and learners ask questions individually. This means that the questions asked by each learner are different, reducing opportunities for collaboration.

At this stage, the researcher conducted a trial directly in the field of test instruments that had gone through the expert validation stage and made revisions based on suggestions. The test trial was conducted on Class X students, consisting of 26 students. The trial was conducted according to the schedule given by the school in the implementation of face-to-face teaching and learning activities. The trial was conducted twice in a meeting for 90 minutes during math class time, precisely on Tuesday, June 4, 2024, and Tuesday, June 11, 2024. The trial implementation was conducted in 2 meetings.

- Meeting 1 on Tuesday, June 4, 2024, started at 08.00 a.m. Western Indonesia Time. The first trial was to see the level of ability of students using non-adaptive tests.
- Meeting 2 on Tuesday, June 11, 2024, starts at 08.00 a.m. Western Indonesia Time. The second trial was of the adaptive assessment model test in the form of a Google Forms link.

After working on the test instrument, students are given an adaptive test instrument questionnaire to see feedback from the perspective of students. Furthermore, the researcher analyzed the results of the implementation of the adaptive test instrument to Class X students. This stage aims to determine the quality or feasibility of the test instrument. Details of the test analysis are described as follows.

Table III Recap of Expert Validation Assessment Results

Validator	Number of Aspects	Yield (%)	Category
1	3	80%	Valid

Based on the results of the development of Google Forms-based adaptive assessments that have been conducted, it is known that the validator's results are 80%. Therefore, based on the validator's results and the conversion table, we can conclude that the developed assessment is suitable for use with students but requires revisions by the researchers.

Table IV User Response Validation Results

No	Aspects	Indicator	Yield (%)	Category
1	Website Interest	Convenience in using the website	61,8 %	Valid
		Level of trust in using the website	56,4 %	Fairly Valid
		Website appearance and performance	76,4 %	Valid
2	Ease of Website	Ease of the use of the website	67,3 %	Valid
		Seeking information on using the website	56,4 %	Fairly Valid
		Website Function and Capacity	69,1 %	Valid

Based on the data above, it can be seen that the overall average is 64.5% with valid criteria. Thus, the development of an adaptive assessment model on the concept of number by utilizing Google Forms is declared valid and does not need to be revised.

The research conducted is a type of adaptive assessment development research on the concept of number based on Google Forms class X SMK. The development of this assessment refers to the analyze, design, develop, implement, and evaluate (ADDIE) model development procedure developed by Haddad & Kalaani (2014) and Rinaldi et al. (2022). The ADDIE model serves as a strategic assessment ecosystem manager, ensuring that the selection, design, development, implementation, and evaluation of assessment instruments (both digital, such as Google Forms, and traditional, such as P&P) are coherently integrated across the learning lifecycle. With an emphasis on continuous and comprehensive evaluation, ADDIE guides the use of assessment tools and methods to systematically monitor progress, identify areas for improvement, and validate the effectiveness of educational interventions, making it key to the development of planned, high-quality assessments. Stage Two is the design of the initial product. This includes the selection of materials that match learner characteristics and competency demands, the learning strategies applied, and the forms and methods of evaluation used (Gusev & Armenski, 2013; Yang et al., 2022). In this context, you want to refer to the mathematics textbook for grade X, semester two of the independent curriculum, to collect references for number material. The preparation of the question grids must cover all the indicators and learning outcomes set.

The third step includes several activities, namely entering the questions that have been made into the Google Forms website, making instructions for working on the questions, setting points on each question, compiling an answer key for each question, and coding. The last step is to prepare the questions that have been created in Google Drive. The fourth stage involves copying the Google Forms link containing the adaptive number of material questions to be distributed to students. One of the obstacles in the third stage is the variation in learners' abilities within a single class, as they often possess different background knowledge. Therefore, it can be a challenge to choose materials that are appropriate for all learners and to design questions that are challenging but not too difficult.

The third stage is the development of question instruments that are expected to be used for evaluation, especially for class X students in the number material. In the validation process by media experts, there are several comments from each validator that need to be corrected so that the instrument is more suitable for students' use. The instrument has been improved in accordance with the comments from the validator. The results of the material validation process show that there are several comments that need to be corrected to make it better and suitable for use by students. The instrument that has been improved is in accordance with the comments of the validator. The material expert gave an average percentage value

of 80% in the "very good" category to the Google Forms-based question instrument, which indicates that the instrument is suitable for use and testing. This aligns with the perspective of Reiser & Dempsey (2012), Sari et al. (2020), and Stroulia & Kapoor (2001), which state that a development product is deemed effective if it meets the learning objectives established for learner outcomes. Barriers at this stage include managing and analyzing the assessment results from Google Forms, especially when the number of respondents is large. While Google Sheets can help, more in-depth analysis may require additional expertise in using spreadsheets or other data analysis tools. Stage four involves piloting the Google Forms-based adaptive question instrument with learners. After learners completed the instrument, the results were then validated and calibrated as follows.

Based on the results of the validity and calibration analysis using jMetric Software, information was obtained that the item validity test showed a variety of difficulty levels. Of the 30 items tested, there were 10 items with a "medium" level of difficulty, 10 items with an "easy" level of difficulty, and 10 items with a "difficult" level of difficulty. Thus, from these 30 items, we can represent the ability of students by looking at the assessment score of the adaptive assessment model used.

From the analysis results obtained from the table, it can be concluded that all 30 items are classified in the good category, which indicates that these questions have good differentiating power. Thus, based on the results of the reliability test, difficulty level, and question differentiation, the question instrument used for this test can be considered good. This is in accordance with the opinion (Belkhatir et al., 2013; Gusev & Armenski, 2013) that the validity of test development logically shows the test is very valid. In addition, the reliability, difficulty level, and differentiating power tests conducted have been assessed as good to use. Based on the results of data analysis, the effectiveness of the distractor or the power of the question instrument can be measured. It was found that there were five items that had distractors that functioned properly. These distractors are not just a complement to the answer choices but are designed to mislead students not to choose the answer key. To achieve this goal, distractors must be designed to resemble the answer key as accurately as possible (Aksu et al., 2019; Whittaker et al., 2012). The bottleneck in stage four is the question testing process, which requires sufficient time to ensure that the questions can accurately measure learners' abilities. Time constraints are often a major challenge in this regard.

In the evaluation stage, an assessment is conducted from the beginning of the process, namely needs analysis, curriculum analysis, and analysis of learner characteristics, as well as the design and development stages that have been passed. After passing the validation process by validators, consisting of expert lecturers and material lecturers, this evaluation stage can provide an overview of how feasible the assessment questions that have been developed are in terms of validity.

Conclusion

Adaptively prepared assessments can improve the ability of learners at a certain level with moderate, difficult, and easy (heterogeneous) categories. The assessment model shows that students' ability is reflected in the number of students who get the highest scores. The development of this adaptive assessment was responded to well by students. This is partly because the assessments used are still non-adaptive and use paper and pencil (P&P test). Based on the results of the development of Google Forms-based adaptive assessments that have been carried out, it is known that the results of the validator at the question trial stage obtained the readability of the assessment of 80%; some items were revised to suit the language development of students; and at the trial stage, the assessment model and user response were declared valid in the aspect of website attractiveness and website convenience on average 64.5%. Thus, the adaptive assessment developed has met the criteria for development products, namely, being valid, practical, effective, and showing added value.

In applying this adaptive assessment, teachers or researchers are advised to check students' concept knowledge. Checking students' concept mastery is done to find out the relationship between students'

concept mastery and the character being assessed. To study a subject's character, first observe and gather as much data as possible. All information will be especially useful as a consideration in the preparation of indicators and the development of a question grid that will be compiled as a character assessment tool. The development of an adaptive assessment model on the concept of number by utilizing Google Forms can be done for the development of further assessment models. Teachers or researchers can make assessments with other materials or lessons.

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