DEVELOPMENT OF A DYSCALCULIA IDENTIFICATION TEST INSTRUMENT

Budi Azhari[*], Rahmah Johar[**], Evi Ramadhani[***], Mailizar[****]
[*]*Graduate School of Mathematics and Applied Sciences, Universitas Syiah Kuala, Banda Aceh, Indonesia and Department of Mathematics Education, Universitas Islam Negeri Ar-Raniry Banda Aceh, Aceh, Indonesia, budiazhari@ar-raniry.ac.id*
[**]*Department of Mathematics Education, Universitas Syiah Kuala, Banda Aceh, Indonesia, rahmah.johar@usk.ac.id*
[***]*Department of Statistics, Syiah Kuala University, Aceh, Indonesia, evi.ramadhani@gmail.com*
[****]*Department of Mathematics Education, Universitas Syiah Kuala, Banda Aceh, Indonesia, mailizar@usk.ac.id*

Email Correspondence : rahmah.johar@usk.ac.id

Received : May 8, 2024 Accepted : June 25, 2024 Published : June 30, 2024

Abstract: This research aims to develop a dyscalculia test instrument for early identification of children with dyscalculia learning disorders through a series of validity and reliability tests involving various experts from various related fields. This research uses the Tessmer model in developing test instruments through several stages, including: preliminary, self evaluation, prototyping (expert reviews, one-to-one, and small group), and field tests. The research results show that each research variable, namely X1 (type A), X2 (type B), and X3 (Dyscalculia), has met high validity. All question items in these three variables have an r-value that exceeds the r-table, ensuring that the instrument measures what it is intended to measure and reflects the construct accurately. The reliability test results show that each variable has a raw_alpha above 0.80, which reflects very high reliability. This shows that the instrument has the ability to produce consistent and reliable results under repeated use and on different samples. So that the instrument developed can be used to identify and diagnose dyscalculic children in helping dyscalculic children overcome the difficulty of learning mathematics.
Keywords: dyscalculia; test instruments; question development

Abstrak: Penelitian ini bertujuan untuk mengembangkan instrumen tes diskalkulia untuk mengidentifikasi awal anak dengan gangguan belajar diskalkulia melalui serangkaian uji validitas dan reliabilitas yang melibatkan berbagai pihak ahli dari berbagai bidang terkait. Penelitian ini menggunakan model Tessmer dalam mengembangkan instrumen tes melalui beberapa tahapan, antara lain: preliminary, self evaluation, prototyping (expert reviews, one-to-one, dan small group), dan field test. Hasil penelitian menunjukkan bahwa setiap variabel penelitian, yakni X1 (tipe A), X2 (tipe B), dan X3 (Diskalkulia), telah memenuhi validitas yang tinggi. Semua item soal di ketiga variabel tersebut memiliki r-hitung yang melebihi r-tabel, memastikan bahwa instrumen mengukur apa yang dimaksudkan untuk diukur dan mencerminkan konstruk dengan akurat. Hasil uji reliabilitas menunjukkan bahwa setiap variabel memiliki raw_alpha di atas 0,80, yang mencerminkan reliabilitas yang sangat tinggi. Ini menunjukkan bahwa instrumen memiliki kemampuan untuk menghasilkan hasil yang konsisten dan dapat diandalkan dalam penggunaan berulang dan pada sampel yang

berbeda. Sehingga instrumen yang dikembangkan dapat digunakan keperluaan identifiksi dan mendiagnosa anak diskalkulia dalam membantu anak diskalkulia mengatasi masalah kesulitan belajar matematika.
Kata kunci: diskalkulia; instrumen tes; pengembangan soal

Recommended APA Citation :
Budi, A., Rahmah, J., Evi, R. & Mailizar. (2024). Development of A Dyscalculia Identification Test Instrument. *Elkawnie*, *10*(1), 184-204. https://doi.org/10.22373/ekw.v10i1.23347

Introduction

Dyscalculia is a specific learning disorder associated with difficulties in understanding concepts and carrying out mathematical tasks (Mahmud, Zainal, Rosli, & Maat, 2020; Munro, 2003; Sudha & Shalini, 2014). Dyscalculia is included in the category of Specific Learning Disorder which refers to difficulties with learning and use of academic skills. Dyscalculia not only impacts arithmetic abilities, but also extends to difficulties in organizing time, measuring, and processing spatial data (Ashkenazi, Rosenberg-Lee, Tenison, & Menon, 2012; De Castro, Bissaco, Panccioni, Rodrigues, & Domingues, 2014; McCaskey, von Aster, O'Gorman Tuura, & Kucian, 2017; Vigna et al., 2022). These difficulties are of course a barrier for individuals in achieving academic potential and future success (Clouder et al., 2020; Kunwar & Sharma, 2020; Wang'ang'a, 2023).

These disorders are not limited to aspects of arithmetic but also involve issues in organizing time, measuring, and processing spatial data, which can have a significant impact on academic achievement and future success (Butterworth, 2002; Wadlington & Wadlington, 2008). Therefore, early identification of dyscalculia using accurate and reliable measurement instruments is a core concern (Butterworth & Laurillard, 2010; Ann Dowker, 2005; Mazzocco & Myers, 2003; Patricia & Sara, 2019; Snowling, 2013).

The standard tests that currently exist have several limitations, such as a lack of sensitivity to certain areas of difficulty, especially the potential for socio-cultural bias. Some researchers argue that the exclusive use of standardized tests can result in missing important aspects of individual strategies and difficulties (Ann Dowker, 2005). Efforts to identify dyscalculia need to consider non-standard assessment approaches, such as dynamic assessments and cognitive profiles (Ann Dowker, 2005). So research related to the development of proven dyscalculia test instruments needs to be continuously developed by researchers.

The emergence of various test instruments to detect dyscalculia has become a debate regarding validity and reliability, especially within the framework of an educational context (Abdou, Hamouda, & Fawzy, 2020; Eteng-Uket, 2023; Purwaningrum, Muzid, Siswono, Masriyah, & Kurniadi, 2023; Soo May Yoong et al., 2022). The validity and reliability of the dyscalculia measurement instruments that have been developed are crucial matters to be emphasized, considering their

significant implications in the formulation of educational interventions (Ruth S. Shalev & Gross-Tsur, 2001). About learning in schools, the continued development of more contextual diagnostic instruments is essential to strengthen an integrated and meaningful intervention approach (Sari, et al., 2019). By adopting a development research methodology, this research aims to create a product in the form of dyscalculia test questions designed based on applicable scientific principles.

Early identification through accurate measurement instruments is a crucial aspect (Gersten, Jordan, & Flojo, 2005; R S Shalev & von Aster, 2008; Williams, 2013). The use of appropriate measurement instruments is the key to accurate diagnosis, which can then formulate appropriate interventions for individuals experiencing dyscalculia (Haberstroh & Schulte-Körne, 2019; Kin Eng et al., 2014; Nair, Joseph, & Andrews, 1759). Therefore, a valid and reliable dyscalculia measurement instrument is an urgent need (Ogbogo & Orluwene, 2021; S M Yoong, 2022). Thus, early identification of children with dyscalculia is very important to provide appropriate support and intervention (Kaufmann & Von Aster, 2012; Snowling, 2013). On the other hand, identifying dyscalculia can be challenging, as there is no single diagnostic test for the condition. Currently, various tools and assessment approaches have been introduced to identify dyscalculia, such as the computer screening test developed by Butterworth (2002), DysCalculiUM (Beacham & Trott, 2005), and the Screening Test from (Gliga & Gliga, 2012), and there is also identification and diagnose using paper (Chinn, 2012; Geary, Bailey, & Hoard, 2009; Jordan, Kaplan, Locuniak, & Ramineni, 2007). However, these standardized tests have limitations, such as a lack of sensitivity to specific areas of difficulty, especially the potential for socio-cultural bias. Therefore, it is necessary to conduct research into the development of instruments that suit students' problems and characteristics and encounter significant challenges in their problem-solving skills, comprehension of mathematical ideas, logical reasoning, and memory capacity. The study indicates that enhancing the cognitive components of learners during their arithmetic learning process can effectively address the challenges mentioned earlier (Jeya, 2021), especially in the context of education in Indonesia.

This research aims to develop a dyscalculia test instrument that can be used to detect children with dyscalculia learning disorders. Through the development of effective instruments, based on scientific evidence, and passed a series of tests, it is expected that this research can contribute significantly to supporting efforts to understand, identify, and then consider interventions to help children with dyscalculia.

In the development process, the prepared questions are aimed at measuring students' critical thinking abilities, in line with one of the objectives of the development of this research. This includes not only the measurement of basic math skills, but also specific identification of dyscalculia. The importance of developing instruments that integrate contextual nuances and local population characteristics cannot be ignored, as this contributes to the validity of dyscalculia diagnoses as

well as assisting in the formulation of more specific and effective intervention strategies (A Dowker, 2005).

The instrument being developed will go through a series of validity and reliability tests involving various experts from various fields. Through collaboration between fields such as mathematics and educational psychology, the resulting instrument is expected to present a more holistic and valid perspective in the identification of dyscalculia (Haynes, Richard, & Kubany, 1995).

Research methods

Instrument Design and Development Approach

This research is development research, using qualitative and quantitative approaches. In general, the definition of development research can be interpreted as a scientific way to obtain data so that it can be used to produce, develop, and validate products. With this development research, test questions will be produced to identify dyscalculia, which consists of test questions for students' basic mathematical abilities and dyscalculia test questions.

This test question development research uses the Tessmer model which consists of several stages, including: preliminary, self evaluation, prototyping (expert reviews, one-to-one, and small group), and field tests (Tessmer, 1998). The reason for using the Tessmer development model in this research is because, in the Tessmer development model, there are stages that help in perfecting the development of the questions. After all, the questions were tested on several groups of students.

Apart from that, the advantage of using the Tessmer development model lies in its ease and practicality for use by users in learning and educational environments. This model is also effective and able to meet various needs in developing tools related to learning.

The use of the Tessmer development model (Tessmer, 1998) in this research offers a series of organized stages, including self-evaluation, prototypes, and field tests, providing sufficient space for the development of mature and detailed questions. This model is known to be effective in accommodating the development of questions that require various forms of evaluation and testing, with the ultimate goal of pursuing the validity and practicality of the questions. The stages in Tessmer's model involve the involvement of experts, testing the readability of questions, and trials on student samples, making the resulting test instrument not only valid in terms of measuring ability, but also relevant and practical in its application (Tessmer, 1998).

The stages in the Tessmer development model are suitable for use in developing products in the form of questions. This is because when developing valid questions, assessment from experts is very necessary so that the developed questions can measure critical thinking skills in accordance with the objectives of developing this research. Apart from that, the questions that have been developed

also need to be field tested, such as readability tests to find out whether students understand well the questions that have been developed, and tests on several students to determine the level of validity and practicality of the questions that have been developed. Therefore, the Tessmer model is more suitable for developing questions because the stages in the Tessmer model have one-on-one testing stages and small group trials before being tested on one class of students so that the questions developed have many suggestions and input so that the questions are valid and practical for use by teachers.

Procedure Development

The development procedures in the Tessmer development model consist of several stages, including: preliminary, self evaluation, prototyping (expert reviews, one-to-one, and small group), and field tests. Tessmer's development design model can be described as follows in Figure 1.

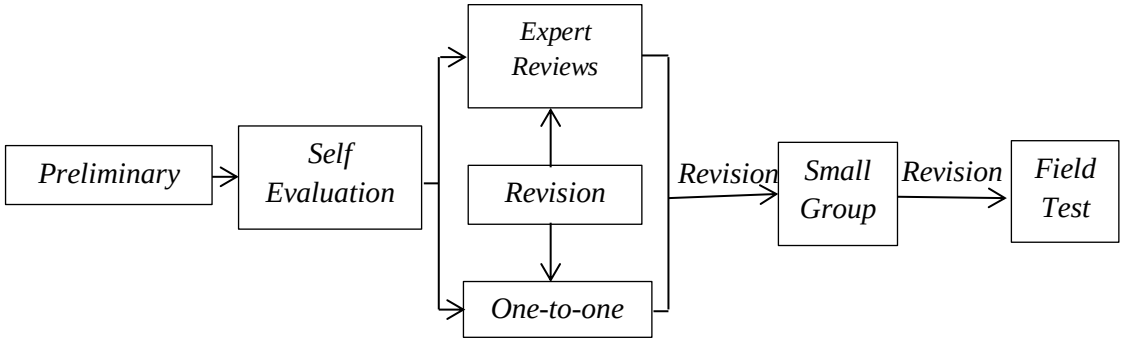

Figure 1. Tessmer Development Model (Dian Angriani, Nursalam, Fuadah, & Baharuddin, 2018)

a. Preliminary Stage

In this first stage, what must be done is to determine the school that will be used as a research location and research subject. The school where the research was conducted was elementary school (SDN 56 Banda Aceh) and the research subjects chosen were class II and class III students.

b. Self Evaluation Stage

At this stage, what is done is to carry out self-assessment, namely designing grids, and questions to measure students' basic mathematical abilities and drafting dyscalculia test questions by considering the basic theory of dyscalculia and paying attention to dyscalculia questions that have been developed by experts. To design basic math skills questions, the first step taken was to examine the elementary school curriculum and teaching materials to facilitate the initial steps of research. Next, create a grid of questions to measure basic abilities. The books used as a reference for this question were mathematics textbooks for Grade II and Grade III in accordance with the curriculum in force at the school where the research took

place. The questions developed must of course meet the characteristics of questions measuring basic abilities. The questions to be developed are then assessed based on the language object, content, and construct of the questions that have been designed into Draft I.

c. Prototyping Stage

The prototyping stage aims to produce a refined draft instrument. This refinement is about draft II of draft I which has been revised based on input from experts (expert reviews), and data obtained from one-to-one trials. Activities at this stage include instrument validation by validators followed by revisions and trials with students. The prototyping stage consists of three stages, namely as follows.

1) Expert Reviews

The draft questions at the self-evaluation stage, called Draft I, are then carried out by expert reviews. Expert trials are carried out to get input and suggestions for improvements and whether the product is suitable for testing on students. If Draft I is valid, then Draft I can be tested. However, if Draft I is not valid, it must be revised first before testing. The collection technique used at this stage is using a question validation sheet and a question grid sheet. The expert analysis in this research involved 2 expert lecturers in the field of mathematics and 2 elementary school teachers who had at least 5 years of teaching experience in elementary schools.

2) One-to-one

Draft questions that have been revised and said to be valid by the validator, are tested one-to-one or one-on-one on 4 students (2 students from class III and 2 students from class II) who are randomly selected to work on the ability questions on the basis that has been created. The results of this trial are then analyzed and evaluated. If there are revisions, the draft will be refined for further testing. In this trial, the readability of the questions was analyzed.

3) Small Groups

The draft questions that had been corrected at the one-to-one stage were tested again on 4 other students, who were not test subjects at the one-to-one stage. Next, the results of the trial were analyzed again for the readability of the questions according to students.

d. Field Test Stage

Draft questions that have been tested at the small group stage are then tested again on subjects from one class. Students who work on questions at this stage are students who have not yet worked on questions at the one-to-one and small group stages. Next, the results of the trial are evaluated by calculating the validity and reliability of the questions.

Data Collection

In this research, the data source used is primary data, namely in the form of basic ability test results and dyscalculia test results. The basis for preparing basic ability test indicators is (1) reviewing the elementary school mathematics curriculum and creating a grid of test questions, and (2) reviewing the basic theory of dyscalculia.

Data collection was carried out using the test method. The initial test was carried out at SDN 56 Banda Aceh. The test was carried out by giving basic mathematics ability questions to 2 classes (Grade II and III), students with low abilities or low test scores were then given dyscalculia test questions. The results of the data from the basic mathematics ability test and the initial dyscalculia test were the data analyzed.

Data Analysis

Data analysis techniques were carried out to produce ability test question sheets with basic mathematics skills and dyscalculia test questions. The qualitative data analysis used in this research is descriptive data analysis. In educational evaluation, tests and non-tests are both instruments or tools to help collect and process data about the variables studied. The characteristics of a good instrument as an evaluation tool are that it meets the requirements for validity and reliability (Mohajan, 2017; Newton, Soleimani, Kirkland, & Gokiert, 2017; Ramadhan, Sumiharsono, Mardapi, & Prasetyo, 2020). So data analysis was carried out to test the reliability and validity of the test questions using SPSS V.20.0 and AMOS V.21.0.

Research result

Test Instrument Development

In the results of this development research, what will be discussed is the question development process and the results of the development. The process of developing basic mathematics ability test questions and the dyscalculia test is a process carried out in stages according to the Tessmer development model.

This research is development research that produces products in the form of basic mathematics ability tests and dyscalculia tests. Details of the research results from each stage of development research carried out can be seen in the following chart in Figure 2.

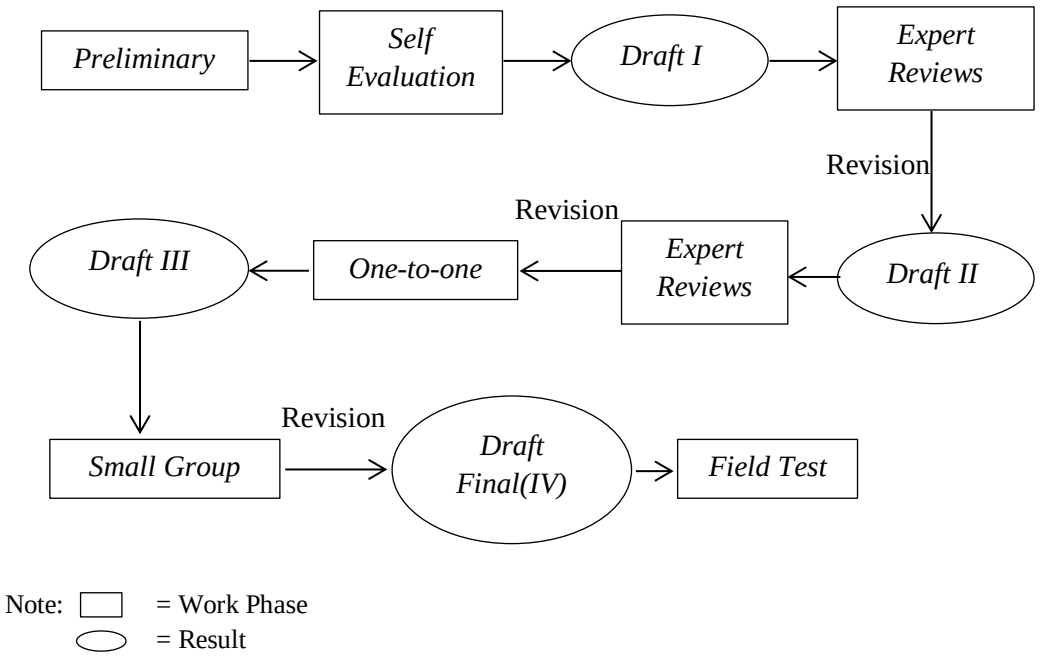

Figure 2. Work procedures

1. Preliminary Stage

In the preliminary stage, this was done by searching for information and analyzing the meaning of children experiencing dyscalculia. Before designing basic mathematics ability test questions and dyscalculia tests, the first thing to do was analyze the curriculum and student textbooks as a guide in designing and creating questions. Then look for several articles and journals that discuss dyscalculia questions which serve as a guide in designing and creating questions. The information obtained is also needed to design basic mathematics ability test questions and dyscalculia test questions.

The preliminary stage is also carried out by analyzing the condition of the school that will be used as a research location. The school that was the research site was SDN 56 Banda Aceh. The reason for choosing this school was because they wanted to see the mathematical abilities of elementary school students in answering math questions and then help students who experience dyscalculia. Analysis of school conditions was carried out by interviewing teachers by asking several questions related to students' abilities and questions given by teachers when evaluating students at the school.

2. Self Evaluation Stage

The self-evaluation stage is a stage carried out to assess oneself, namely by assessing the grid design, basic ability test questions and dyscalculia test questions, question validation sheets, dyscalculia confirmation lists for teachers and parents, as well as list validation sheets, confirmation of dyscalculia for teachers and parents. At this stage, the results of the initial design will be assessed based on their

own opinion. After this assessment is carried out, the design will be called draft I which will be validated and refined through the development stage.

At this stage, test grids will be produced, basic ability test questions and dyscalculia test questions, question validation sheets, dyscalculia confirmation lists for teachers and parents, as well as dyscalculia confirmation list validation sheets for teachers and parents which will be validated and refined through the development of the stages. The final results of this stage are Draft I questions in the form of basic mathematics ability test questions and dyscalculia test questions. The basic mathematics ability test questions designed consist of type A and B basic mathematics ability test questions for first and second grade elementary school material. Each type consists of 15 questions. Then the dyscalculia test questions were designed and developed by adopting the dyscalculia test questions developed by Weaver L. (2014), Emerson & Babtie (2014), and Butterworth (2003). Based on the existing dyscalculia screening test, the researcher adjusted it to the curriculum that applies in Indonesia, so that there were 17 questions which were then tested in this research and tested the validity and reliability of the questions created by the author.

3. Prototyping Stage

The Prototyping stage is the third stage in this development research. The Prototyping stage consists of expert review, one to one, and small groups.

a. Expert Review

At this stage, it is carried out by providing Draft I which has been designed for the validators (V) for assessment. This assessment was carried out to obtain input and suggestions from the validators regarding whether or not the basic mathematics ability test questions and dyscalculia test questions which had been designed for field trials were appropriate.

At this stage, the instrument used is a validation sheet filled in by an expert. The validation process was carried out by providing a draft I document in the form of a question grid, basic mathematics ability test questions (type A and type B), and dyscalculia test questions along with an expert validation sheet for review. The researcher also provided a list of confirmation of dyscalculia for teachers and parents, along with an expert validation sheet to evaluate the list of confirmation of dyscalculia for teachers and parents in the form of an initial draft or Draft I.

Next, the validators check the test grid, basic ability test questions, and dyscalculia test questions, and the teacher and parent dyscalculia confirmation lists provided. Validators provide input and suggestions to improve and perfect the basic ability test questions and dyscalculia test questions which are developed so that the questions are more effective and have good quality and can assess students' abilities so that dyscalculia students can be detected.

The following are the results of the validation of the draft I instrument which was validated by four experts as validators with codes V1, V2, V3, and V4 for each

validator. The validation results are displayed in table form according to the draft reviewed.

1) Draft I Validation Results

The validation results of draft I are presented including validation results on the basic ability test questions for type A, and type B students and dyscalculia test questions as follows:

a) Basic Ability Test Questions - Type A

Based on the results of the validator assessment in Draft I and the revision results from the validators, it is known that all Type A basic ability test questions can be used. Revisions to Draft I were carried out by slightly changing the language in the questions which then became Draft II. The resulting Draft II will be tested on students at the one-to-one stage.

Based on the validation results from the four validators, the total value obtained from the validators is as follows.

Table 1. Validation Value in Draft I

The $\sum$**xi**	**Maximum Score**	$\frac{\sum \text{xi}}{\text{Maximum Score}}$ **x 100%**	**Criteria**
16	16	100%	Very Valid
14	16	87,5%	Very Valid
12	16	75%	Valid
16	16	100%	Very Valid
12	16	87,5%	Very Valid
16	16	100%	Very Valid
16	16	100%	Very Valid
15	16	93,75%	Very Valid
15	16	93,75%	Very Valid
16	16	100%	Very Valid
16	16	100%	Very Valid
16	16	100%	Very Valid
15	16	93,75%	Very Valid
15	16	93,75%	Very Valid
15	16	93,75%	Very Valid

b) Basic Ability Test Questions – Type B

The type B basic ability test is for Grade III students. Based on the table of validator assessment results in Draft I and the revision results from the validators, it is known that all Type B basic ability test questions can be used. Revisions to Draft I were carried out by slightly changing the language in the questions which then became Draft II. The resulting Draft II was tested on students at the one-to-one stage.

c) Dyscalculia Test Questions

The results of the validator assessment on Draft I and the results of revisions from the validators show that several questions can be used. However, several questions were rejected, namely questions number 5, 8, 17, 20, 21, and 22, so these

questions will be deleted based on suggestions from the validator. Revisions to Draft I were carried out by changing several questions which then became Draft II. The resulting Draft II consisted of 17 dyscalculia questions.

Based on the assessments of all validators, the resulting type A and type B basic ability test questions can be tested directly on students at the one-to-one stage. Meanwhile, the dyscalculia test questions need improvement and suggestions from the validator again. Therefore, the dyscalculia test questions were given back to the validator to be re-validated.

Following are the results of validation by four validators with the total values as follows.

Table 2. Validation Value in Draft II

$The \sum$ xi	Maximum Score	$\frac{x_i}{Maximum\ Score}$ x 100%	Criteria
16	16	100%	Very Valid
16	16	100%	Very Valid
16	16	100%	Very Valid
16	16	100%	Very Valid
14	16	88%	Very Valid
16	16	100%	Very Valid
16	16	100%	Very Valid
16	16	100%	Very Valid
16	16	100%	Very Valid
16	16	100%	Very Valid
16	16	100%	Very Valid
15	16	94%	Very Valid
16	16	100%	Very Valid
16	16	100%	Very Valid
16	16	100%	Very Valid
14	16	88%	Very Valid
16	16	100%	Very Valid

Based on the validation assessment and suggestions from validators, Draft II was revised to Draft III. All validators said that the Dyscalculia test questions were valid. Next, the questions will be tested on students, namely in the one-to-one test stage. The question packages that have been developed can be seen in the attachment.

b. One-to-one

This stage was carried out to test draft II on 3 students in Grade 2 of elementary school and Grade 3 in elementary school who were chosen randomly. The trial time was during 70 minutes. This one-to-one trial was carried out at SDN 68 Banda Aceh City on Wednesday 25 July 2023. This stage was carried out to test the readability of the questions given. During the process of answering the basic ability test questions - Type A, basic ability test questions - Type B, and the Dyscalculia Test questions given, it was seen that students were able to understand

the meaning and language of the questions well and they were able to answer the questions given.

In this study, several initial terms are used to refer to respondents involved in the One-to-one trial, as presented in the following table.

Table 3. Respondents on One-to-one

Respondent	Note
SO1A	*One-to-one* Subject 1 who works on type A questions
SO2A	*One-to-one* Subject 2 who works on type A questions
SO3A	*One-to-one* Subject 3 who works on type A questions
SO1B	*One-to-one* Subject 1 who works on type B questions
SO2B	*One-to-one* Subject 2 who works on type B questions
SO3B	*One-to-one* Subject 3 who works on type B questions
SO1D	*One-to-one* Subject 1 who worked on Dyscalculia questions
SO2D	*One-to-one* Subject 2 who worked on Dyscalculia questions
SO3D	*One-to-one* Subject 3 who worked on Dyscalculia questions

c. Small Groups

Draft II of the basic ability test question package for type A, basic ability test question for type B, and Dyscalculia Test Questions were not revised because, at the one-to-one stage, it was found that students at SDN 68 Banda Aceh City were able to read and understand the questions well. Furthermore, Draft II of the type A basic ability test questions was tested on 25 students from Grade II of SDN 61 Banda Aceh City, Type B for basic ability test questions was tested on 15 students from Grade III of SDN 61 Banda Aceh City, and the Dyscalculia Test Questions were tried out in 23 students from Grade II and III at SDN 58 Banda Aceh. The small group trial at SDN 61 in Banda Aceh was carried out on June 26 2023 for 70 minutes and at SDN 58 Banda Aceh City it was carried out on August 24 2023 for 70 minutes.

In this study, several initial terms are used to refer to respondents involved in small-group trials, as presented in the following Table 4.

Table 4. Respondents in the Small Group at SDN 61

Respondent	Note
SD611A	*Small Group 1* subjects who worked on type A questions
SD612A	*Small Group 2* subjects who worked on type A questions
SD613A	*Small Group 3* subjects who worked on type A questions
	Etc...
SD611B	*Small Group 1* subjects who worked on type B questions
SD612B	*Small Group 2* subjects who worked on type B questions
SD613B	*Small Group 3* subjects who worked on type B questions
Etc...	

Table 5. Respondents in the Small Group at SDN 58

Respondent	Note
SD581D	*Small Group 1* subjects who worked on Dyscalculia questions
SD582D	*Small Group 2* subjects who worked on Dyscalculia questions
SD583D	*Small Group 3* subjects who worked on Dyscalculia questions
Etc...	

Validity and Reliability Test

Next, the scores obtained by each student are calculated and the validity and reliability of each question are analyzed. Below are presented the results of the level of validity and reliability of the questions.

Validity test

The validity test aims to check whether the instruments/question items in each question that will be used in this research are valid or not. This test is carried out on each instrument/question item. An instrument is said to be valid if $r_{count} > r_{table}$ where r_{count} can be seen through r-cor, while r_{table} can be seen through rtable.

a. Validity Test X1 = Type A Ability Questions

In this study, it is known that n = 25 and $\alpha = 0.05$, so $r_{table} = r(\alpha, n-2) = 0.3961$. So an instrument in this research is said to be valid if r-cor > 0.3961. The results of the validity test are as follows.

Tabel 6. Validity Test on Variable X1

Variable	Question Items	r_{hitung}	r_{tabel}	Note
TIPE A (X1)	1	0,82	0,3961	Valid
	2	0,79	0,3961	Valid
	3	0,45	0,3961	Valid
	4	0,85	0,3961	Valid
	5	0,87	0,3961	Valid
	6	0,79	0,3961	Valid
	7	0,8	0,3961	Valid
	8	0,41	0,3961	Valid
	9	0,46	0,3961	Valid
	10	0,61	0,3961	Valid
	11	0,43	0,3961	Valid
	12	0,46	0,3961	Valid
	13	0,44	0,3961	Valid
	14	0,85	0,3961	Valid
	15	0,51	0,3961	Valid

Based on the validity test results in the table above, it can be seen that all instruments in variable X1 (Type A) are declared valid because each instrument has a value of $r_{count} > r_{table}$. So that all instruments can be used (nothing is omitted).

b. Validity Test X2 = Type B for Ability Questions

In this study, it is known that n = 15 and α = 0.05, so $r_{table} = r(\alpha, n-2) = 0.5140$. So an instrument in this research is said to be valid if r-cor > 0.5140. The results of the validity test are as follows.

Table 7. Validity Test on Variable X2

Variable	Question Items	*r-count*	*r-table*	Note
TIPE B (X2)	1	0,73	0,5140	Valid
	2	0,73	0,5140	Valid
	3	0,77	0,5140	Valid
	4	0,81	0,5140	Valid
	5	0,8	0,5140	Valid
	6	0,91	0,5140	Valid
	7	0,75	0,5140	Valid
	8	0,54	0,5140	Valid
	9	0,66	0,5140	Valid
	10	0,56	0,5140	Valid
	11	0,64	0,5140	Valid
	12	0,64	0,5140	Valid
	13	0,52	0,5140	Valid
	14	0,81	0,5140	Valid
	15	0,58	0,5140	Valid

Based on the validity test results in the table above, it can be seen that all instruments in variable X2 (TYPE B) are declared valid because each instrument has a value of $r_{count} > r_{table}$. So that all instruments can be used (nothing is omitted).

c. Validity Test X3 = Dyscalculia Question

In this study, it is known that n = 23 and α = 0.05, so $r_{table} = r(\alpha, n-2) = 0.4132$. So an instrument in this research is said to be valid if r-cor > 0.4132. The results of the validity test are as follows.

Tabel 8. Uji Validitas pada Variabel X3

Variable	Question Items	*r-count*	*r-table*	Note
Dyscalculia (X3)	1	0,44	0,4132	Valid
	2	0,53	0,4132	Valid
	3	0,49	0,4132	Valid
	4	0,59	0,4132	Valid
	5	0,43	0,4132	Valid
	6	0,43	0,4132	Valid
	7	0,52	0,4132	Valid
	8	0,49	0,4132	Valid
	9	0,43	0,4132	Valid
	10	0,46	0,4132	Valid
	11	0,44	0,4132	Valid
	12	0,54	0,4132	Valid
	13	0,49	0,4132	Valid

Variable	Question Items	*r-count*	*r-table*	Note
	14	0,56	0,4132	Valid
	15	0,42	0,4132	Valid
	16	0,58	0,4132	Valid
	17	0,45	0,4132	Valid

Based on the validity test results in the table above, it can be seen that all instruments in variable X3 (Discalculia) are declared valid because each instrument has a value of $r_{count} > r_{table}$. So that all instruments can be used (nothing is omitted).

Reliability Test

The reliability test is used after all instruments on the variable are declared valid. The following are the conditions for the reliability of a questionnaire.

$0.80 <$ raw_alpha ≤ 1.00 very high reliability
$0.60 <$ raw_alpha ≤ 0.80 high reliability
$0.40 <$ raw_alpha ≤ 0.60 moderate reliability
$0.20 <$ raw_alpha ≤ 0.40 low reliability
$-1.00 <$ raw_alpha ≤ 0.20 very low reliability

The results of the reliability test are as follows in Table 9.

Table 9. Reliability Test

No	Variable	*Raw_alpha*	Note
1	Type A (X1)	0,88	Very High
2	Type B (X2)	0,91	Very High
3	Dyscalculia (X3)	0,81	Very High

Based on the table above, it can be concluded that variable X1 (TYPE A) has very high reliability because $0,80 <$ raw_alpha $X_1 \leq 1,00$ ($0,80 < 0,88 \leq 1,00$). Variable X2 (TYPE B) has very high reliability because $0,80 <$ raw_alpha $X_2 \leq 1,00$ ($0,80 < 0,91 \leq 1,00$).

Discussion

Based on the research data presented previously, the development of measurement instruments for variables X1 (TYPE A), X2 (TYPE B), and X3 (Dyscalculia) has gone through two important phases of testing, namely validity testing and reliability testing. Based on the validity tests carried out, the instrument developed must have valid and reliable criteria so that the measurement results obtained can accurately reflect the construct being measured. In the validity test phase, the instrument is declared valid if $r_{-count} > r_{-table}$. For variable High variability in the r_{-count}, which ranges from 0.41 to 0.87, may indicate that there is variety in the respondents' responses, but it is still within the limits of validity.

The validity test conducted for variable X2 (TYPE B), similar to variable X1, indicates good validity for all instruments in variable X2 as well, with an r-value higher than the $r_{\text{-table}}$ (0.5140). Significant inter-item variability is also evident, indicating good response diversity.

Meanwhile, the validity test for variable X3 (dyscalculia), and the validity test for the test items also show positive results with all items having an r-value greater than the $r_{\text{-table}}$ (0.4132), validating that these items are relevant to the measured construct.

Furthermore, the instrument must also demonstrate good reliability to be relied upon for measuring the construct across various conditions and different samples. Based on the research data findings, the reliability for these three variables (X1, X2, and X3) has a raw_alpha > 0.80, indicating that the instrument's reliability is very high. This indicates that the instrument has good internal consistency in measuring the intended construct.

Similarly, variables X2 (TYPE B) and X3 (Dyscalculia) also show similar results, with all items recording $r_{\text{-values}}$ exceeding their respective $r_{\text{-tables}}$, namely 0.5140 and 0.4132. This indicates that the instrument can be relied upon to measure the desired variables and obtain valid information from respondents, ensuring that the collected data aligns with the measurement objectives.

In this research outcome, both validity and reliability tests indicate good results. However, despite the instrument demonstrating good validity and reliability, its use in different contexts and samples may require adjustments. The high variability in $r_{\text{-values}}$ for some items indicates that there are items that elicit significantly different responses from some respondents, suggesting the need for adjustments.

The diversity of respondent demographics, contextual differences, and other factors influence the validity and reliability of the instrument when applied to different samples or contexts. In practical application, the use of this instrument needs to be accompanied by an in-depth understanding of the construct being measured and the characteristics of the respondent. In the future, modification or addition of items may need to be considered to adapt the instrument to different contexts and populations.

Overall, the good validity and reliability of the instrument in this study show that the instrument developed has solid credibility and can be an effective measuring tool for related variables, provided that its application needs to be done carefully and considering variability between contexts and samples.

With the instrument that has been developed, it is hoped that it can be used to identify and diagnose the learning difficulties of children with dyscalculia. With the right instrument, it will provide an overview of how interventions should be carried out by teachers in schools to help children with dyscalculia overcome the problem of mathematics learning difficulties they face.

Conclusion

In the context of developing and validating research instruments, validity, and reliability analysis play a crucial role in determining the effectiveness and reliability of the instrument in measuring the target variables. Each research variable, namely X1 (TYPE A), X2 (TYPE B), and X3 (Dyscalculia) has shown high validity. All question items in these three variables have an r_{count} that exceeds the r_{table}, ensuring that the instrument measures what it is intended to measure and reflects the construct accurately.

The reliability test results show that each variable has a raw_alpha above 0.80, which reflects very high reliability. This shows that the instrument has the ability to produce consistent and reliable results under repeated use and on different samples. The instruments that have been developed and validated in this study show good potential for use in similar research settings or can be adapted for slightly different contexts, providing a solid foundation for other researchers to build on or adapt these instruments for specific needs.

Overall, the developed instruments demonstrate a good ability to measure variables accurately and consistently, making a significant contribution to the literature and practice in the relevant domain. Future implementation and use should consider the specific context and target population to maximize the usefulness and relevance of the instrument.

Acknowledgement

Thank you to the advisors (from the Graduate School of Mathematics and Applied Sciences, Universitas Syiah Kuala, Banda Aceh, Indonesia) who have supported the writing of this research article. Furthermore, thanks to the survey team of UIN Ar-Raniry for collecting data in chosen schools.

References

Abdou, R. M., Hamouda, N. H., & Fawzy, A. M. (2020). Validity and reliability of the Arabic dyscalculia test in diagnosing Egyptian dyscalculic school-age children. *Egyptian Journal of Otolaryngology*, 36(1), 1–5. Retrieved 18 October 2023 from https://doi.org/10.1186/S43163-020-00020-6/FIGURES/3

Ashkenazi, S., Rosenberg-Lee, M., Tenison, C., & Menon, V. (2012). Weak task-related modulation and stimulus representations during arithmetic problem solving in children with developmental dyscalculia. *Developmental Cognitive Neuroscience*, 2(SUPPL. 1), S152–S166. Retrieved from https://doi.org/10.1016/J.DCN.2011.09.006

Beacham, N., & Trott, C. (2005). Screening for Dyscalculia within HE. *MSOR Connections*, 5(1). Retrieved from https://doi.org/10.11120/msor.2005.05010004

Butterworth, B. (2002). Mathematics and the Brain. *Mathematics and the Brain*, 1–

26. Retrieved from www.mathematicalbrain.com/pdf/

Butterworth, B., & Laurillard, D. (2010). Low numeracy and dyscalculia: Identification and intervention. *ZDM - International Journal on Mathematics Education*, 42(6), 527–539. Retrieved from https://doi.org/10.1007/s11858-010-0267-4

Chinn, S. J. (2012). *More trouble with mathematics: a complete guide to identifying and diagnosing mathematical difficulties*. London: Sage.

Clouder, L., Karakus, M., Cinotti, A., Ferreyra, M. V., Fierros, G. A., & Rojo, P. (2020). Neurodiversity in higher education: a narrative synthesis. *Higher Education*, 80(4), 757–778. Retrieved 18 October 2023 from https://doi.org/10.1007/S10734-020-00513-6/METRICS

De Castro, M. V., Bissaco, M. A. S., Panccioni, B. M., Rodrigues, S. C. M., & Domingues, A. M. (2014). Effect of a Virtual Environment on the Development of Mathematical Skills in Children with Dyscalculia. *PLOS ONE*, 9(7), e103354. Retrieved 18 October 2023 from https://doi.org/10.1371/journal.pone.0103354

Dian Angriani, A., Nursalam, Fuadah, N., & Baharuddin. (2018). Pengembangan Instrumen Tes Untuk Mengukur Kemampuan Pemecahan Masalah Matematika Siswa. *Auladuna: Jurnal Pendidikan Dasar Islam*, 5(2), 211–223. Retrieved 18 October 2023 from https://doi.org/10.24252/auladuna.v5i2a9.2018

Dowker, A. (2005). *Individual differences in arithmetic*. Hove [U.K.]: Hove [U.K.]: Psychology Press.

Dowker, Ann. (2005). Early Identification and Intervention for Students With Mathematics Difficulties. *Journal of Learning Disabilities*, 38(4), 293–304. Retrieved from https://doi.org/10.1177%2F00222194050380040801

Eteng-Uket, S. (2023). The Development, Validation, and Standardization of a New Tool: The Dyscalculia Test. *Numeracy*, 16(2), 1. Retrieved 18 October 2023 from https://doi.org/https://doi.org/10.5038/1936-4660.16.2.1417

Geary, D. C., Bailey, D. H., & Hoard, M. K. (2009). Achievement and Mathematical, 265–279.

Gersten, R., Jordan, N. C., & Flojo, J. R. (2005). Early identification and interventions for students with mathematics difficulties. *Journal of Learning Disabilities*, 38(4), 293–304. Retrieved from https://doi.org/10.1177/00222194050380040301

Gliga, F., & Gliga, T. (2012). Romanian screening instrument for dyscalculia. Retrieved from https://doi.org/10.1016/j.sbspro.2012.01.074

Haberstroh, S., & Schulte-Körne, G. (2019). The Diagnosis and Treatment of Dyscalculia. *Deutsches Ärzteblatt International*, 116(7), 107. Retrieved 19 March 2023 from https://doi.org/10.3238/ARZTEBL.2019.0107

Haynes, S. N., Richard, D. C. S., & Kubany, E. S. (1995). Content Validity in Psychological Assessment: A Functional Approach to Concepts and

Methods. *Psychological Assessment*, 7(3), 238–247. Retrieved from https://doi.org/10.1037/1040-3590.7.3.238

Jeya, A., & Pio Albina, A. (2021). Development and Standardization of Dyscalculia Screening Tool (DST). *Elementary Education Online*, *20*(5), 1982-1982.

Jordan, N. C., Kaplan, D., Locuniak, M. N., & Ramineni, C. (2007). Predicting First-Grade Math Achievement from Developmental Number Sense Trajectories. *Learning Disabilities Research & Practice*, 22(1), 36–46. Retrieved from https://doi.org/10.1111/j.1540-5826.2007.00229.x

Kaufmann, L., & Von Aster, M. (2012). The Diagnosis and Management of Dyscalculia. *Deutsches Arzteblatt International*, 109(45), 767–778. Retrieved from https://doi.org/10.3238/arztebl.2012.0767

Kin Eng, C., Pang, V., Ken Keong, W., Choon Keong, T., Kean Wah, L., & Yoon Fah, L. (2014). A Preliminary Study For Dyscalculia In Sabah, Malaysia. In *The Eurasia Proceedings of Educational & Social Sciences (EPESS) The Eurasia Proceedings of Educational* (Vol. 1). Retrieved 18 October 2023 from www.isres.org

Kunwar, R., & Sharma, L. (2020). Exploring Teachers' Knowledge and Students' Status about Dyscalculia at Basic Level Students in Nepal. *EURASIA Journal of Mathematics, Science and Technology Education*, 2020(12), 1906. Retrieved 4 October 2023 from https://doi.org/10.29333/ejmste/8940

Mahmud, M. S., Zainal, M. S., Rosli, R., & Maat, S. M. (2020). Dyscalculia: What We Must Know about Students' Learning Disability in Mathematics? *Universal Journal of Educational Research*, 8(12B), 8214–8222. Retrieved from https://doi.org/10.13189/ujer.2020.082625

Mazzocco, M. M. M., & Myers, G. F. (2003). Complexities in Identifying and Defining Mathematics Learning Disability in the Primary School-Age Years. *Annals of Dyslexia*, 53(Md), 218–253. Retrieved from https://doi.org/10.1007/s11881-003-0011-7

McCaskey, U., von Aster, M., O'Gorman Tuura, R., & Kucian, K. (2017). Adolescents with developmental dyscalculia do not have a generalized magnitude deficit – Processing of discrete and continuous magnitudes. *Frontiers in Human Neuroscience*, 11, 228568. Retrieved from https://doi.org/10.3389/FNHUM.2017.00102/BIBTEX

Mohajan, H. K. (2017). Two Criteria For Good Measurements In Research: Validity And Reliability. *Annals of Spiru Haret University. Economic Series*, 17(4), 59–82.

Munro, J. (2003). Dyscalculia: A unifying concept in understanding mathematics learning disabilities. *Australian Journal of Learning Difficulties*, 8(4), 25–32. Retrieved 18 October 2023 from https://doi.org/10.1080/19404150309546744

Nair, A. A., Joseph, J., & Andrews, T. (1759). Early Diagnosing and Identifying Tools For Specific Learning Disability. *Www.Irjmets.Com @International*

Research Journal of Modernization in Engineering. Retrieved 18 October 2023 from https://doi.org/10.56726/IRJMETS41883

Newton, A. S., Soleimani, A., Kirkland, S. W., & Gokiert, R. J. (2017). A Systematic Review of Instruments to Identify Mental Health and Substance Use Problems Among Children in the Emergency Department. *Academic Emergency Medicine*, 24(5), 552–568. Retrieved 18 October 2023 from https://doi.org/10.1111/ACEM.13162

Ogbogo, S., & Orluwene, G. W. (2021, September 17). Psychometric Analysis of Dyscalculia Test. Retrieved 18 October 2023 from https://papers.ssrn.com/abstract=3925658

Patricia, B.-L., & Sara, R.-C. (2019). Dyscalculia: Clinical Manifestations, Evaluation, and Diagnosis. Current Perspectives of Educational Intervention. *RELIEVE - Revista Electronica de Investigacion y Evaluacion Educativa*, 25(1), 1–11. Retrieved from https://doi.org/10.7203/relieve.25.1.10125

Purwaningrum, J. P., Muzid, S., Siswono, T. Y. E., Masriyah, & Kurniadi, G. (2023). Validity of mathematics module based on character education with Kudus local content 'gusjigang' for dyscalculia students. *AIP Conference Proceedings*, 2614(1). Retrieved 18 October 2023 from https://doi.org/10.1063/5.0126610/2897218

Ramadhan, S., Sumiharsono, R., Mardapi, D., & Prasetyo, Z. K. (2020). The Quality of Test Instruments Constructed by Teachers in Bima Regency, Indonesia: Document Analysis. *International Journal of Instruction*, 13(2), 507–518. Retrieved from https://doi.org/10.29333/iji.2020.13235a

Shalev, R S, & von Aster, M. (2008). Identification, classification, and prevalence of developmental dyscalculia. *Shalev, R S; von Aster, M (2008). Identification, Classification, and Prevalence of Developmental Dyscalculia. Encyclopedia of Language and Literacy Development: Published Online.*, published online. Retrieved 18 October 2023 from https://doi.org/10.5167/UZH-12874

Shalev, Ruth S., & Gross-Tsur, V. (2001). Developmental dyscalculia. *Pediatric Neurology*, 24(5), 337–342. Retrieved from https://doi.org/10.1016/S0887-8994(00)00258-7

Snowling, M. J. (2013). Early identification and interventions for dyslexia: A contemporary view. *Journal of Research in Special Educational Needs*, 13(1), 7–14. Retrieved from https://doi.org/10.1111/j.1471-3802.2012.01262.x

Sudha, P., & Shalini, A. (2014). Dyscalculia : A Specific Learning Disability Among Children. *International Journal of Advanced Scientific and Technical Research*, 2(4), 912–918.

Tessmer, M. (1998). *Planning and Conducting Formative Evaluations*. Philadelphia: Kogan Page.

Vigna, G., Ghidoni, E., Burgio, F., Danesin, L., Angelini, D., Benavides-varela, S.,

& Semenza, C. (2022). Dyscalculia in Early Adulthood: Implications for Numerical Activities of Daily Living. *Brain Sciences*, 12(3), 373. Retrieved 18 October 2023 from https://doi.org/10.3390/BRAINSCI12030373/S1

Wadlington, E., & Wadlington, P. L. (2008). Helping Students With Mathematical Disabilities to Succeed. *Preventing School Failure: Alternative Education for Children and Youth*, 53(1), 2–7. Retrieved from https://doi.org/10.3200/psfl.53.1.2-7

Wang'ang'a, A. W. (2023). Dyscalculia in Kenyan Schools: Implications for Transition to Higher Education and Employment: Literature Review. *East African Journal of Education Studies*, 6(2), 121–138. Retrieved 3 October 2023 from https://doi.org/10.37284/EAJES.6.2.1254

Williams, A. (2013). A teacher's perspective of dyscalculia: Who counts? An interdisciplinary overview. *Australian Journal of Learning Difficulties*, 18(1), 1–16. Retrieved 18 October 2023 from https://doi.org/10.1080/19404158.2012.727840

Yoong, S M. (2022). Applying the ADDIE Model to Design and Develop an Instrument for Dyscalculia. *SEAMEO Journal*, 1, 55.

Yoong, Soo May, Hosshan, H., Arumugam, S., Lee, A. Q. N. A., Lau, S. C., & Govindasamy, P. (2022). Validity and Reliability of Needs Analysis Questionnaire for Dyscalculia Instrument. *South Asian Journal of Social Sciences and Humanities*, 3(3), 111–124. Retrieved 18 October 2023 from https://doi.org/10.48165/SAJSSH.2022.3307