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Development of Digital Literacy Instruments in Junior High School Mathematics Learning

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Abstract

The study underscores the need for advanced IL instruction that moves beyond foundational skills to address critical evaluation and synthesis, preparing students for both academic and professional contexts. Recommendations for targeted interventions and curriculum enhancements are discussed, contributing to the discourse on effective IL education in higher education. This study aims to create a mathematics assessment tool in the form of valid and reliable digital literacy test questions, and characterise the quality of digital literacy test questions in junior high school mathematics learning. This research is a development research adapted from the Borg & Gall development model, which includes the following steps: research and information gathering, planning, initial product development, limited testing, initial product evaluation, field testing, and final product revision. The results showed that the digital literacy assessment tool in the form of digital knowledge multiple choice questions consisting of 20 complex multiple choice questions covering aspects of logic, construction, and language has been declared valid and feasible to use. This instrument is valid and has a reliability coefficient of 0.384. The multiple choice questions have an average difficulty of 0.438 (medium) and an average differentiating power of 0.938 (good).

Keywords: *Development; Digital Literacy; Instrument; Junior High School Mathematics*

Introduction

The success of education, whose main goal is to improve human resources, is influenced by various factors. One of the factors that influence this success is the teacher's ability to conduct and utilise assessment, evaluation, processes and learning outcomes (Budiman & Jailani, 2014). These skills are needed by teachers to improve learning outcomes. In addition, these skills can also be used to improve or enhance the learning process that teachers have carried out. According to Menristekdikti RI No 56 Year 2022 concerning the standards of teacher knowledge and skills, it is stated that one of the standards of teaching success is the development of assessment instruments. on the standards of teacher knowledge and skills states that one of the standards of successful teaching is the development of assessment instruments.

Education Assessment Menristekdikti RI No 56 Year 2022 teacher education and competency standards is the process of collecting and processing information to determine the achievement of student learning outcomes. Assessment is not only the collection of student data, but also processing to obtain a picture of the process and results of student learning. Assessment is not the only thing that students are asked to complete, but teachers must follow up to ensure that learning is understood.

Assessment is an important part of learning mathematics. Assessment can provide positive feedback to teachers and students (Wulandari et al., 2022). Assessment results can also motivate students to achieve success. In fact, assessment influences learning behaviour. This is because students align their learning with the assessment given by the teacher. The quality of learning outcome assessment tools relates to the accuracy of student achievement status (Faradillah & Adlina, 2021).

In the last five years, the utilisation of information and communication technology (ICT) in Indonesia has grown rapidly. The biggest development in ICT indicators is seen in the use of the Internet in households, which will reach 86.54% by 2022. With the increasing use of the Internet at home, the number of people who own mobile phones will reach 67.88% by 2022. per cent. In 2022, the home computer ownership rate will drop slightly to 18.04%. In addition to changing the way students learn, there are also many cases of misuse of online platforms.

Given the widespread use of digital technology in education and the rampant misuse of digital media. Therefore, everyone needs digital technology to enhance daily activities in personal and professional life. One of the strengths that can address inequality and overcome the impact of digital media is digital language skills. Digital language is the ability to understand and freely use any kind of information that comes from digital media. Common and free use is mentioned in terms, methods and methods (Silalahi et al., 2022). Rusydiyah et al., (2020) Digital literacy is important to implement in the world of education because it allows us to access resources contextually, visually and aurally, think and do.

Digital literacy has a relationship in terms of assessment that can improve student learning outcomes. Zulkarnain et (2020) said that mathematics digital literacy can help in improving student learning outcomes. According to Bai & Wang (2023) Although digital literacy is very important, there is still not much research specifically to develop digital literacy instruments in mathematics learning. So there is a need for a special digital literacy instrument in learning mathematics.

Method

This research is a developmental research. The result is a digital literacy assessment tool developed in the form of complex multiple choice test type questions. To obtain a developmental model, the Borg and Gall developmental model was used in this study. The ten stages of development of the Borg and Gall model were taken with seven stages of development: (1) research and information gathering, (2) planning, (3) initial product development, (4) limited trial, (5) initial product revision, (6) field trial, and (7) final product revision. Research was conducted and information was gathered to study the theory from relevant theoretical studies. Assessment tools were validated to assess the validity of the instrument in the form of test questions. Validation was conducted at the initial product development stage by two mathematics education experts. Empirical trials of digital literacy test items were conducted using limited trials and field trials. Limited trials were conducted on 28 participants from SMP Negeri 3 Ngaglik. The field trial was conducted on 58 students from SMP Negeri 3 Ngaglik and SMP Negeri 4 Gamping. Classical test theory parameters were used in the analysis of trial data to empirically determine the quality of mathematics digital literacy test questions as a basis for revision and assembly of questions.

This research combines two data, namely qualitative and quantitative. These data are expected to provide an overview of the nature of the items developed. Qualitative data was obtained from the results of expert validation of the initial product of the test questions, while quantitative data was obtained from the test product of the mathematics digital literacy test questions. The test instrument created in this review consists of two types, each of which is used to fulfil valid and reliable criteria.

The instrument to measure validity used a validation sheet (review of test questions) which was analysed qualitatively. Validation was reviewed from three aspects, namely material, construction, and language. The test questions are valid or feasible to use based on the assessment of the validator. Based on the validator's assessment, the test questions can be used or valid. For each item number, there are three choices of item validation criteria, namely feasible to use (score 3), needs to be corrected (score 2), and needs to be replaced (score 1). Two sets of complex multiple-choice questions were used in the instrument to measure reliability. Each of the digital literacy test questions was pilot tested, and the results were analysed quantitatively to estimate the reliability coefficient of the assessment instrument.

The following are the methods that researchers used to collect data: 1) make instruments that will be used in the research, such as digital literacy test questions, scoring rubrics, and assessments, 2) determine the content validity of the instrument by using expert judgement or asking several experts in the field of mathematics education to validate the instruments that have been made, (3) modify the instrument according to the suggestions of the validator, 4) conduct a trial of the research instrument, 5) determine the reliability of the items, the level of difficulty, and the differential power, 6) revise the instrument based on the results of the trial analysis.

Data analysis techniques qualitative analysis of digital literacy test questions was obtained from the results of the validation sheet (test questions) which was carried out in a qualitative descriptive manner. Data in the form of the value of each item of expert assessment results were analysed using Aiken's V formula to calculate the content validity coefficient. The range of V numbers that can be obtained is between 0 and 1.00.

Quantitative analysis the data obtained from the responses of students' answers were analysed using the help of SPSS Version 25 and Anbuso 8.0. SPSS Version 25 to measure the validity and reliability of the questions. Anbuso 8.0 is used to measure the level of difficulty, and distinguishing power.

Findings and Discussion

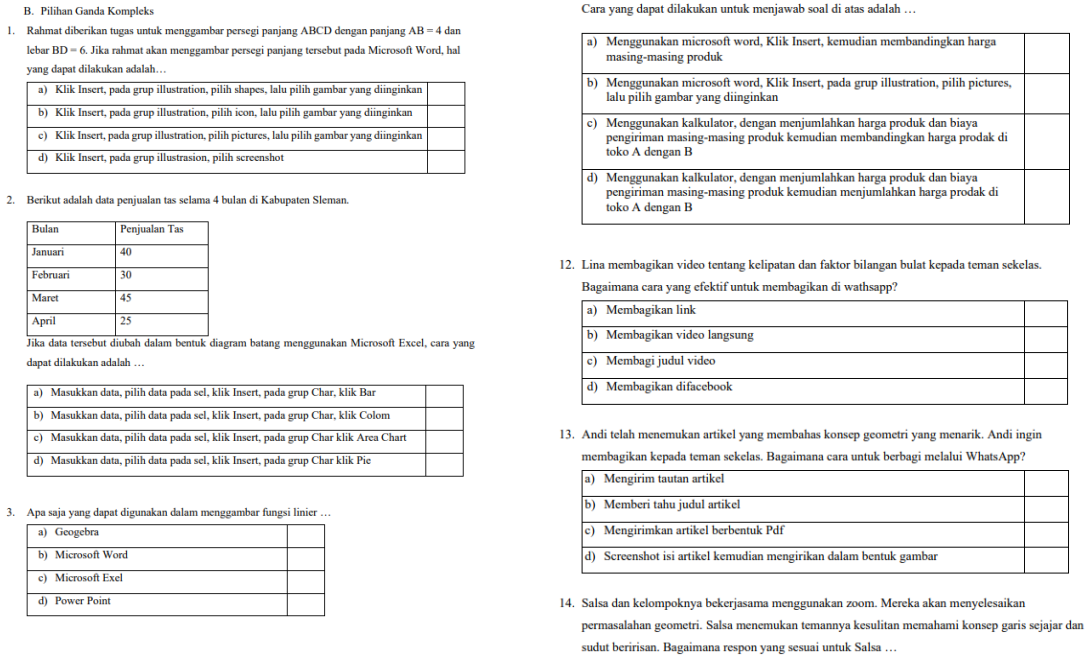
Developing the Instrument

A valid and reliable multiple-choice test of complex junior high school mathematics in grade VIII is the result of the development of this research as a digital literacy assessment tool for mathematics learning. The assessment instrument created has passed two stages of evaluation. The validity of the assessment instrument was evaluated by mathematics education experts in the first stage of assessment.

The preparation of digital literacy instruments based on qualitative analysis obtained Mathematics digital literacy test questions are arranged based on indicators (Mayuni et al., 2022). The indicators in question include: (1) digital media (2) content creation (3) critical thinking and evaluation (4) communication, (5) security, (6) searching for information. The preparation of the test then begins with making a question grid in Figure 1.

No	Indikator	Indikator Soal	Soal
1	Mampu megerjakan tugas matematika dalam media digital	Siswa diberikan permasalahan yaitu menggambarkan persegi panjang. Kemudian siswa diminta untuk menggambarkan persegi panjang didalam Microsoft Word.	Rahmat diberikan tugas untuk menggambar persegi panjang ABCD dengan panjang AB = 4 dan lebar BD = 6. Jika rahmat akan menggambar persegi panjang tersebut pada Microsoft Word, hal yang dapat dilakukan adalah… a) Klik Insert, pada grup illustration, pilih shapes, lalu pilih gambar yang diinginkan b) Klik Insert, pada grup illustration, pilih icon, lalu pilih gambar yang diinginkan c) Klik Insert, pada grup illustration, pilih pictures, lalu pilih gambar yang diinginkan d) Klik Insert, pada grup illustrasion, pilih screenshot

Figure 1. Digital Literacy Test Question Grid in Maths



B. Pilihan Ganda Kompleks

1. Rahmat diberikan tugas untuk menggambar persegi panjang ABCD dengan panjang AB = 4 dan lebar BD = 6. Jika rahmat akan menggambar persegi panjang tersebut pada Microsoft Word, hal yang dapat dilakukan adalah…

a) Klik Insert, pada grup illustration, pilih shapes, lalu pilih gambar yang diinginkan	
b) Klik Insert, pada grup illustration, pilih icon, lalu pilih gambar yang diinginkan	
c) Klik Insert, pada grup illustration, pilih pictures, lalu pilih gambar yang diinginkan	
d) Klik Insert, pada grup illustrasion, pilih screenshot	

2. Berikut adalah data penjualan tas selama 4 bulan di Kabupaten Sleman.

Bulan	Penjualan Tas
Januari	40
Februari	30
Maret	45
April	25

Jika data tersebut diubah dalam bentuk diagram batang menggunakan Microsoft Excel, cara yang dapat dilakukan adalah …

a) Masukkan data, pilih data pada sel, klik Insert, pada grup Char, klik Bar	
b) Masukkan data, pilih data pada sel, klik Insert, pada grup Char, klik Colom	
c) Masukkan data, pilih data pada sel, klik Insert, pada grup Char klik Area Chart	
d) Masukkan data, pilih data pada sel, klik Insert, pada grup Char klik Pie	

3. Apa saja yang dapat digunakan dalam menggambar fungsi linier …

a) Geogebra	
b) Microsoft Word	
c) Microsoft Exel	
d) Power Point	

Cara yang dapat dilakukan untuk menjawab soal di atas adalah …

a) Menggunakan microsoft word, Klik Insert, kemudian membandingkan harga masing-masing produk	
b) Menggunakan microsoft word, Klik Insert, pada grup illustration, pilih pictures, lalu pilih gambar yang diinginkan	
c) Menggunakan kalkulator, dengan menjumlahkan harga produk dan biaya pengiriman masing-masing produk kemudian membandingkan harga prodak di toko A dengan B	
d) Menggunakan kalkulator, dengan menjumlahkan harga produk dan biaya pengiriman masing-masing produk kemudian menjumlahkan harga prodak di toko A dengan B	

12. Lina membagikan video tentang kelipatan dan faktor bilangan bulat kepada teman sekelas. Bagaimana cara yang efektif untuk membagikan di wathsapp?

a) Membagikan link	
b) Membagikan video langsung	
c) Membagi judul video	
d) Membagikan difacebook	

13. Andi telah menemukan artikel yang membahas konsep geometri yang menarik. Andi ingin membagikan kepada teman sekelas. Bagaimana cara untuk berbagi melalui WhatsApp?

a) Mengirim tautan artikel	
b) Memberi tahu judul artikel	
c) Mengirimkan artikel berbentuk Pdf	
d) Screenshot isi artikel kemudian mengirikan dalam bentuk gambar	

14. Salsa dan kelompoknya bekerjasama menggunakan zoom. Mereka akan menyelesaikan permasalahan geometri. Salsa menemukan temannya kesulitan memahami konsep garis sejajar dan sudut beririsan. Bagaimana respon yang sesuai untuk Salsa …

Figure 2. Display of Test Questions

Initial Product Development

At this stage, the test questions in learning mathematics that are designed are evaluated by expert validators, revised and then obtained initial products of test questions in learning mathematics that are ready to be used as limited trial materials.

At this stage, the mathematics learning test questions that have been designed are evaluated by expert validators and revised before obtaining initial products that are ready to be used as limited trial materials. Expert validation was conducted to review the content of the initial product. This approval intends to get input, development ideas, and at the same time evaluate the question items concerned

before the limited trial is carried out. The approval was carried out by giving the grids of questions that underlie the network of questions and computerised proficiency test questions in mathematics learning and approval sheets to two expert validators. Aiken's V formula was used to calculate the content validity coefficient, and the assessment of digital literacy test items in mathematics learning was analysed according to the validator's assessment. Table 1 displays the results of the expert validation analysis.

Table 1. Results of Expert Validation Analysis of Digital Literacy Test Questions

Item No.	Aiken's V coefficient	Criteria
1-20	0.67-1.00	Worth using

Based on the results of the analysis using Aiken's V formula, the digital literacy test questions consisting of 20 complex multiple choice questions were all declared fit for use. However, there were some questions that were worked on according to the information and ideas of the two validators, more specifically in terms of improvements in digital literacy including sentence details, peaks from the initial data of the material on proficiency, and instructions that did not match the things being asked.

Limited Trial

After making revisions based on expert validation and conducting a limited trial, information was obtained regarding the amount of time needed to complete one package of complex multiple-choice questions from the digital literacy test in mathematics learning. Validity, reliability, difficulty level, and differentiating power can also be known by interpreting the item analysis.

Table 2. Validity of Digital Literacy Questions

Item No.	Pearson Correlation	Criteria
1-6,8-14, and 16-20	a > 0.38	Valid
7,15	a < 0.38	Invalid

Based on Table 2, it can be seen that the questions that have a valid category are 18 (90%) questions and 2 (10%) questions in the invalid category. The level of validity of the items is known by Pearson Correlation using SPSS version 25.

Table 3. Reliability of Digital Literacy Questions

Cronbach’s Alpha	N of Items
0.845	20

Table 3 obtained Cronbach's Alpha of 0.845, it can be seen that the estimated reliability of digital literacy questions for mathematics learning is high.

Table 4. Digital Literacy Test Level of Difficulty

Item No.	Quantity	Category	Percentage
19	1	Hard	5%
1,3,4,8,9,10,11,12,13,16,17, and 18	13	Medium	65%
2,5,6,7,15, and 20	6	easy	30%

The difficulty level of the questions can be seen in Table 4. There are 1 difficult question (5%), 13 medium questions (65%), and 6 easy questions (30%). The coefficient can be used in the Anbuso 8.0 application to determine the level of difficulty of the question.

Table 5. Digital Literacy Test Distinguishing Power

Item No.	Quantity	Category	Percentage
1,2,3,6,8,9,11,12,13,14, 16,17,18,19, and 20	15	good	75%
4	1	good enough	5%
5,7,10, and 15	4	Not good	20%

The differences between these questions can be seen in Table 5. There were 15 questions with good separation, 1 question with sufficient separation, and 4 questions with poor separation.

Table 6. Results of Analysis of Initial Characteristics of Digital Literacy Test Questions

Item No.	Quantity	Category	Percentage
1,2,3,4,6,8,9,11,12,13,14,16,17,18,19, and 20	16	accepted	80%
5,7,10, and 15	4	accepted with revision	20%
	0	rejected	0%

Based on Table 6, the items that fall into the good and acceptable category without modification are 16 items (80%). Without modification, items in the good and acceptable category were directly used in the main product. There were four (20%) items in the acceptable category that were revised before being used in the main product. The main product of the test questions was rearranged from the items in the good and acceptable categories that had not been revised or revised. complex multiple choice questions that will be tested in the field trial.

Statistics of Digital Literacy Test Items from Limited Trial Results. Statistics on the initial product of digital literacy test questions based on limited trials can be seen in Table 7 below.

Table 7. Statistics of digital literacy items in the limited trial

Statistical Scales	Average Score	Category
Average Level of Difficulty	0.653	Medium
Average Distinguishing Power	0.402	Medium

Based on table 7, the normalised coefficient of item difficulty is 0.653, implying that the items in the advanced proficiency test are medium. The normalised discriminating power of 0.402 implies that the questions in the advanced education test are very good (acceptable). The questions are generally acceptable, with further refinement.

Field Trial

Based on the item characteristics and main product statistics of the complex multiple-choice digital literacy test questions developed from the limited trial, a field trial was conducted to determine the quality of the mathematics digital literacy test questions.

Statistics of Digital Literacy Test Items from the Field Trial Results

Table 8. Main Product Digital Literacy Test Level of Difficulty

Item No.	Quantity	Category	Percentage
-	0	Hard	0%
1,3,4,8,9,10,11,12,14,16, and 19	11	Medium	55%
2,5,6,7,13,15,17,18, and 20	9	Easy	45%

The level of difficulty of these questions can be seen in Table 8. There are 11 questions with moderate difficulty (55%) and 9 questions with easy difficulty (45%). The coefficient can be used in the Anbuso 8.0 application to determine the level of difficulty of the questions.

Table 9. Digital Literacy Test Distinguishing Power

Item No.	Quantity	Category	Percentage
1,2,3,4,5,6,8,9,11,12,13 ,14,16,17,18,19, and 20	18	Good	90%
7	1	Good enough	5%
15	1	Not good	5%

By looking at table 9, the separating power of the questions can be clearly seen. There are 18 questions that have good separating power, 1 question that has sufficient separating power, and 1 question with poor separating power.

Table 10.Results of Analysis of Initial Characteristics of Digital Literacy Test Questions

Item No.	Quantity	Category	Percentage
1,2,3,4,5,6,7,8,9,10,11,12,13,14,16,17,18,19, and 20	19	Accepted	95%
-	0	Accepted with revision	20%
15	1	Rejected	0%

Based on Table 10, the items in the good category and accepted without revision were 19 items (95%). Items in the good and acceptable category without revision are directly used in the main product. Items in the accepted category with revisions were 1 item (5%), rejected before use.

Table 11.Statistics of digital literacy items in the field trial

Statistical Scales	Average Score	Category
Average Level of Difficulty	0.938	Easy
Average Distinguishing Power	0.438	Medium

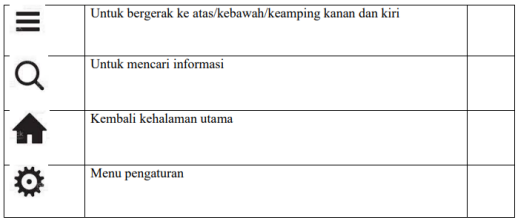
Based on table 11, the average coefficient of the difficulty level of the question 0.938 means that the digital literacy test questions are Easy. The average differentiating power of 0.438 means that the questions on the digital literacy test are good (accepted). There are 19 questions that are accepted and 1 question that is rejected.

Product Revision

Product revision is carried out to obtain a final product that meets valid and reliable criteria. Revisions were made based on the results of the assessment and analysis of the assessment instrument at each stage of the product trial. Product revisions in this study consisted of: product revision of validation results, product revision of limited trial results, and product revision of field trial results.

After the expert assessment, limited trial, and field trial, the assessment instrument developed underwent several revisions based on the evaluation results. Initially, the modifications made depended on the information from the validators. In general, the input and ideas were related to improvements in digital literacy, such as sentence details, exposure of initial data in questions, and markers that did not match the material. Secondly, item revisions based on the results of the limited trial of the initial digital literacy test questions. The items asked in the recognised classification with modifications were overhauled by considering the consequences of checking the quality of the items asked. changes to the way sentences are written. Thirdly, the items were changed in connection with the consequences of the restricted introduction of the fundamental results of the computerised education test questions. Items in the class that are recognised with modifications and replaced are not used (discarded). Items that were good and recognised without changes were confirmed again with the advanced proficiency markers to know that all clues had been addressed. A set of ready-to-use digital literacy test items was developed from the item validity results.

Table 12.Revised Maths Digital Literacy Instrument

Question No.	Before Revision	After Revision
1	Jika kamu diberikan soal latihan matematika melalui google classroom dan diminta untuk mengerjakan dan mengumpulkannnya melalui google classroom. apa yang anda lakukan?	Rahmat diberikan tugas untuk menggambar persegi panjang ABCD dengan panjang AB = 4 dan lebar BD = 6. Jika rahmat akan menggambar persegi panjang tersebut pada Microsoft Word, hal yang dapat dilakukan adalah…
4	a) Untuk menyimpan dokumen yang baru kamu buat, kamu bisa memilih "Save As" dan memberikan nama serta lokasi penyimpanan b) Jika kamu ingin mengubah format teks menjadi tebal (bold) di Microsoft Word, kamu bisa menggunakan tombol pintasan "Ctrl + B" atau menekan ikon tebal pad toolbar c) Saat ingin membuat daftar dengan nomor atau bullet point, kamu bisa menggunakan fitur "Numbered List" atau "Bulleted List" yang terdapat di menu "Insert" d) Pengaturan halaman seperti orientasi (potrait/landscape) dan ukuran kertas dapat diubah melalui menu "Page Layout"	
9	Anda ingin meningkatkan pemahaman Anda tentang materi matematika, terutama dala memecahkan masalah aljabar. Anda memiliki beberapa opsi aplikasi yang dapat membantu. Pilihlah pilihan yang paling tepat? a) Aplikasi untuk memasak dan resep masakan. b) Aplikasi untuk bermain game online c) Aplikasi pembelajaran matematika dengan latihan soal aljabar interaktif d) Aplikasi kamera untuk mengambil foto dan video	Guru memberikan tugas untuk menggambar grafik $f(x) = 2x + 1$. Untuk menggabarkan grafik sebaiknya menggunakan… a) Mathigon b) Mathway c) Geogebra d) Desmos

Final Product Review

This study developed a mathematics digital literacy test kit for secondary schools. This test device has gone through a process of expert validation, limited trials, field trials, and improvement. The results of data analysis showed that the test tool was valid, reliable, and had good item quality.

The validation criteria that have been determined for the development product become the basis for the assessment instrument, namely the digital literacy test questions. The instrument was validated by two Yogyakarta State University postgraduate lecturers who are experts in their fields. The experts' approval of the computerised proficiency test questions met reasonable legitimacy. The complex multiple-choice digital literacy test product developed was declared eligible for use by both validators.

Of the 20 questions piloted, 18 questions were categorised as valid and 2 questions were categorised as invalid. In general, the instrument is acceptable. The reliability of the Cronbach's Alpha digital literacy test instrument of 0.845 indicates that this instrument has high reliability.

The nature of the evaluation instrument as an advanced proficiency test item relies on the consequences of the items examined from the main results of the computerised educational test items, specifically outlining all items based on experimental information. The average difficulty level for the complex multiple-choice digital literacy test items was 0.434 (medium), and the average difficulty level for the complex multiple-choice digital literacy test items was 0.434 (medium). The average discriminating power was 0.938 (good).

Based on the literature search, there are several studies that developed instruments to measure digital literacy (Van der Vaart & Drossaert, 2017). However, these instruments have limitations, such as lack of broad coverage, accuracy and reliability. The digital literacy test instrument developed in this study has advantages over previous digital literacy test instruments, namely broad coverage, high accuracy and good reliability.

Conformity with the basic concepts of digital literacy: The results of this study show that the instrument developed can measure digital literacy in junior high school mathematics learning (Cholily et al., 2021). This is in line with the basic concept of digital literacy, which is the ability of individuals to access, understand, evaluate and use digital information effectively.

Conformity with the results of previous research: The results of this study show that the instrument developed has good validity and reliability (Silalahi et al., 2022). This is in line with the results of previous studies which show that a good instrument must have good validity and reliability.

Contrary to the results of previous research: The results of this study show that the instrument developed has a broad scope (van der Vaart & Drossaert, 2017). This is in contrast to the results of previous studies which showed that the instruments developed had limited coverage.

Overall, the results of this study make an important contribution to the development of digital literacy in junior high school mathematics learning. The instrument developed can be used to measure digital literacy widely and accurately. This instrument can be used for further research on digital literacy in junior secondary mathematics learning.

Conclusion

Based on the results of the research and discussion, the following conclusions were obtained: (1) A digital literacy assessment instrument was produced as a digital literacy instrument in junior high school mathematics learning. as many as 20 complex multiple choice questions. Seven development stages were used to create the assessment instrument, including: a) information gathering and research; b) planning; c) initial product development; d) limited trial; e) initial product revision; f) field trial; g) final product revision. The results of the expert assessment showing that the instrument can be used based on a review of the material, construction, and language aspects indicate the validity of the instrument. In addition, the instrument also met the reliability requirements. The multiple-choice questions have a medium level of difficulty, and have high differentiating power.

Based on the research findings and conclusions mentioned above, the final use of digital literacy assessment instruments can be guided by the following recommendations: 1) Students can use the final product of the digital literacy assessment instrument, and 2) mathematics teachers in junior high schools can use the final product of the digital literacy assessment instrument to measure students' digital literacy skills.

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