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Development of CBT Testlet Model for Minimum Competency Assessment of Numeracy Literacy at Elementary School Level

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ABSTRACT

The application and development of accurate and reliable technology-based test instruments to assess aspects of knowledge and attitudes is an innovation teachers need to meet the demands of the National Assessment Policy. This research aims to apply the Computer-Based Test (CBT) Testlet Model with Local Wisdom Context as a New Form of Innovation in Supporting the Implementation of Minimum Competency Assessment and Integrated Character Survey. In addition, this research is a new solution for teachers in learning assessment. This research is development research. This research involved 11 experts, each from media and computer experts, material experts from mathematics education study programs, and measurement experts. The test instrument that has been developed has been proven to be valid using content validity and analyzed using the Aiken formula. In contrast, validity has been proven for the character survey using confirmatory factor analysis and reliability estimation using Cronbach alpha. This research produced a testlet model of CBT and test instruments in the form of a minimum competency assessment and an integrated character survey, which have proven valid and reliable.

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INTRODUCTION

Teaching is one aspect of education that must be optimized comprehensively. Optimizing teaching can be implemented through the use of information technology to increase the accuracy of response analysis and create innovations. The use of technology in teaching can be implemented by developing assessment models. The validity of the assessment results greatly influences the information that will be used as a guide in determining follow-up actions for students. Therefore, a flexible assessment tool with a good level of accuracy is needed. One type of assessment tool that is suitable and has a good level of accuracy is a computer-based assessment tool known as a computer-based test (CBT).

Computer-based testing (CBT) is part of computer-based assessment (CBA). According to Van der Kleij (2013), CBT is a form of assessment where students are given tests using a computer. CBT is generally used to conduct formative assessments. Furthermore, Van der Kleij also explains that CBA is very useful for knowing and identifying differences in student output and in knowing the characteristics of each student regarding the type of answer, level, and time used. Everything can be calculated in a relatively short time. This means that developing tests using the testlet model helps teachers in analyzing the responses given by students with a fairly efficient duration of time and energy.

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The difference between the developed CBT and the previous CBT can specifically be seen from the types of test items or questions contained in it. The type of test used is a testlet model with questions or items adapted to local wisdom. The use of CBT is in line with current developments, namely the Industrial Revolution 4.0 era. In particular, Popkova et al. (2018) explain that the Republic of Indonesia Era 4.0 is an era related to the "digitalization" of the economy and society, including the development of smart services, smart data, cloud technology, digital networks, digital science, digital education, and digital environments for life. Meanwhile, the World Economic Forum/WEF (2018) explains "The top ten skills that will be needed in order of priority by employers by 2020 are: complex problem solving, critical thinking, creativity, people management, coordinating with others, emotional intelligence, judgment and decision making, service orientation, negotiation, and cognitive flexibility".

Ghorbani et al. (2018) explain that the findings obtained from two qualitative and quantitative sections of the present study show that the teachers of the 21st century should educate students in a way that they can learn how to be in today's. The same thing is also conveyed by Van Hong et al. (2018) who reveals that 21st-century teachers are required to have the ability to teach students in such a way that they can learn how to face the world today. Teachers are required to have at least three competencies, namely the ability to apply technology in learning, the ability to build effective relationships with students and the school community, and the ability to use technology to support improving the quality of teaching and reflect and improve their teaching practices continuously through quality assessment.

CBT was chosen as an alternative because through computer features students can see directly the value, validity, and transparency of the assessment process (Dammas, 2016). Several problems related to assessment, namely: (1) the question models used are generally the same from year to year even though the material has changed; (2) the question model is not fully based on local wisdom; (3) the question model cannot be used to see students' knowledge specifications in detail, and (4) it cannot be used to determine students' character in answering. Therefore, we need a test model that can be used to accurately predict the level of knowledge and character of students who have indications of dishonesty. So, the test model that can be used as a solution is the testlet model.

Based on theoretical and empirical studies, the reliability of test scores consisting of testlets gave higher results than conventional reliability estimates (Wainer, 1995). In addition, according to Wainer et al. (2007), a testlet is a type of test that can be used to determine various stimuli that can reveal the same information that will be integrated with a student character survey. The results of research conducted by Hamdi et al. (2018) showed that the teacher's response to the testlet model mathematics test instrument for class assessment in elementary schools was very good because it was able to provide a good understanding of student character.

Sireci et al. (1991) state that research on testlets using computers serves to increase accuracy and time efficiency compared to using pencils or full paper. Specifically, Sideridis et al. (2016) explain that testlet is an approach used to combine dichotomous items that have one polytomous item with correct and partial correct responses. Additionally, Paap et al. (2015) state that a testlet is a high-level test that is equipped with stimulus groups such as item groupings. Furthermore, Wainer et al. (2007) define a testlet as a type of test that can be used to solve problems, especially to carying out tasks efficiently and to determine the effectiveness of the various stimuli used. Thus, teslet model test instruments in the form of multiple-choice, complex multiple-choice, or short entries are very suitable as a solution to making AKM numeracy and character surveys successful, especially teleslets developed on a computer basis and oriented to local culture.

Minimum Competency Assessment (AKM) is a minimum ability assessment carried out on students. The minimum abilities in question are the most basic abilities that students at a

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certain level must have, which include reading literacy and numeracy (source: AKM Framework). Numeracy is not just the ability to count, but the ability to apply counting concepts in a context, both abstract and real. The assessment is carried out not based on the ability to master material according to the curriculum as in the national exam but is designed to map and improve the overall quality of education (Rohim, 2021).

Publications of study results related to AKM include Cahyanovianty and Wahidin (2021), who conclude that students' numeracy abilities are predominantly medium level with a percentage result of 75%. Teachers already know about AKM, but 62.5 percent of them do not know the competencies tested in more detail. Apart from that, the research results of Rokhim et al. (2021) show that 46.6% of students understand the national assessment and 53.2% of students do not understand the national assessment well. Furthermore, the results of Handayu's (2020) show that the proportion of AKM questions based on the domain and level of PISA mathematical literacy ability is not evenly distributed and the majority of students still do not demonstrate the mathematical literacy process well.

The research results that have been described show that AKM is important to research, especially in developing applications that support the implementation of AKM which involve teachers directly. This is confirmed by research by Resti et al. (2018) who concluded that training activities in the form of AKM tests were successful in improving the numeracy skills of SD IT teachers. This is important to support government programs related to the Minimum Competency Assessment for numerical abilities for elementary school students based on CBT which is integrated directly with character surveys.

Kamarudin (2019) states that a person's character cannot be formed in just one or two ways. Therefore, in the world of education, character education must be prepared through the development of a program that is appropriate to student characteristics and can be integrated into learning or assessment. Research conducted by Sabani and Mihardi (2015) explains that one form of character education is the integration of character values into the subject matter given to students. This integration can be done by implementing an appropriate learning model or in accordance with the character being developed. For this reason, developing testlets using CBT based on local wisdom is a form of implementing character education because students will be moved and understand and love regional culture as one of Indonesia's riches that must be protected and preserved.

There are three principles for implementing strengthening character education, namely: (1) it is oriented towards developing students' potential in a comprehensive and integrated manner, (2) exemplary implementation of character education is given in each educational environment, and (3) it takes place through habituation and over time in daily life. The implementation of strengthening character education optimizes the function of the tri-center educational partnership (school, family, and community) with a class-based approach, school culture, and community (Van der Kleij et al., 2013).

The results will be more optimal if they are adapted to local wisdom and to make the latest government program a success, namely the national assessment which consists of a minimum competency assessment (AKM), character survey, and learning environment survey at each level of education. This research began at the first formal education level, namely elementary school. This is important because it can help students see and solve problems logically and empirically without forgetting the cultural values that exist in their area. The CBT testlet model is important to develop regarding AKM numeracy at the elementary level considering: (1) at the elementary level an application is needed, which can be easily used by children, especially technology-based ones, namely the CBT testlet model; (2) a test instrument has not been developed with a testlet model at the basic level for AKM numeracy which is integrated with a character survey; and (3) more complete information can be obtained in one

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test. Thus, based on the background above, the research entitled "Development of CBT Testlet Model for Minimum Competency Assessment of Numeracy Literacy at Elementary School Level" needs to be implemented and developed optimally.

RESEARCH METHOD

Research Design

This research is development research. The development model uses the Plomp model combined with the instrument development model from Oriondo and Antonio. The focus of this research is the CBT testlet model for AKM numeracy integrated with character surveys. So the results presented are in the form of a flow chart and instrument grid model that is different from other instruments.

Sample and Data Collection

The test sample in this research is grade 5 students of elementary schools in four city districts in the Special Region of Yogyakarta, namely Bantul District, Sleman District, Kulonprogo District, and Yogyakarta City. Apart from involving students, this research also involved elementary school teachers from four districts/cities to review questions and initial trials of the system that would be used. Apart from that, this research also involved 11 experts from mathematics education, computer experts, and measurement experts. The data collection techniques used are tests, questionnaires, expert assessment sheets, and documentation. The test used is the AKM Numeracy test instrument, testlet model, and questionnaire, namely a student character survey questionnaire, as well as an expert assessment sheet to assess the quality of the CBT being developed.

Data analysis

Data on instrument validation results were obtained by using assessment sheets and analyzed in qualitative and quantitative descriptive format. The data were also analyzed using the Aiken formula and reliability estimates using Cronbach's alpha. The character survey instrument was analyzed using confirmatory factor analysis (CFA).

FINDINGS AND DISCUSSION

Findings

Results from the development of a CBT-based minimum competency assessment instrument for numeracy literacy use testlets at the elementary school education level. The development of this instrument was carried out in several stages and a series of processes to develop the media used to carry out CBT-based assessments on numeracy literacy. The stages in this development are presented in several stages which are described in the reviewer flowchart, teacher flowchart, student flowchart, testlet flowchart and administrator flowchart. The flowchart description for each stage is as follows.

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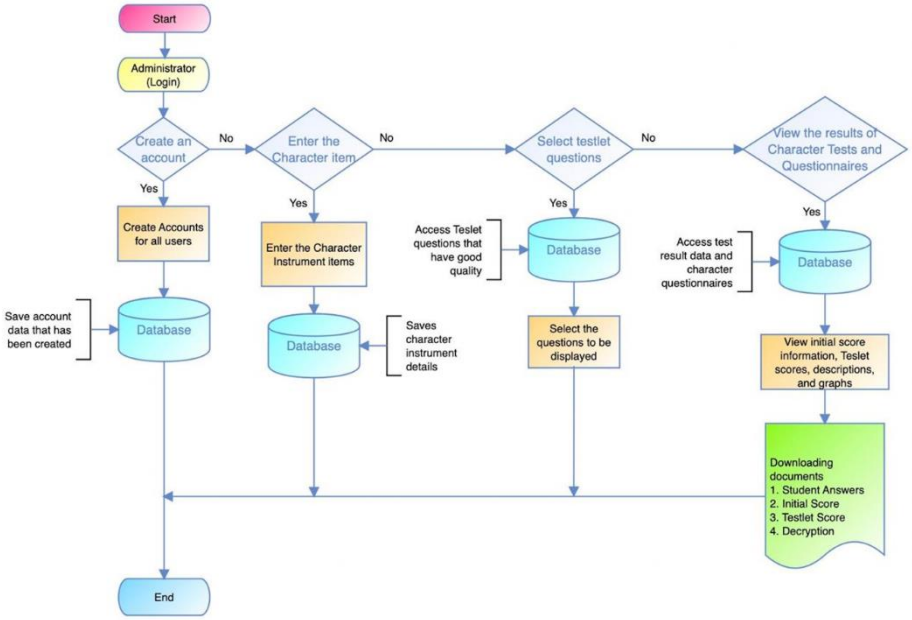

Figure 1. Flowchart Administrator

This administrator flow diagram Figure 1 illustrates how an administrator begins to develop a CBT-based assessment application with a testlet on the numeracy literacy skills of elementary school students, including the process of creating an assessment account, the assessment process, and analyzing the data submitted. This assessment data was then stored in a database to be described to find out how the data obtained were distributed.

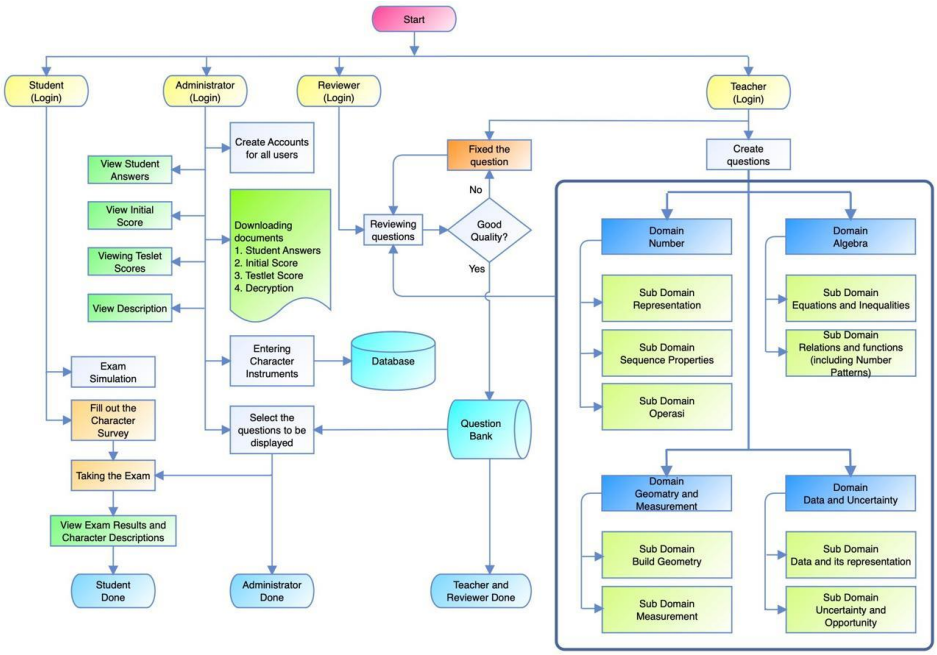

Figure 2. *Flowchart Testlet*

The Figure 2 is a teslet flowchart shows the results of the CBT-based application development process. This diagram explains how each subject in this research works in a

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literacy-based assessment application system. The subjects working on this assessment consist of teachers, students, administrators, and reviewers. The assessment activity starts with the teacher compiling the questions, then they are validated by the reviewer, then the administrator manages the questions which are validated by the reviewer and then the questions are given to students to work on as a form of the assessment process.

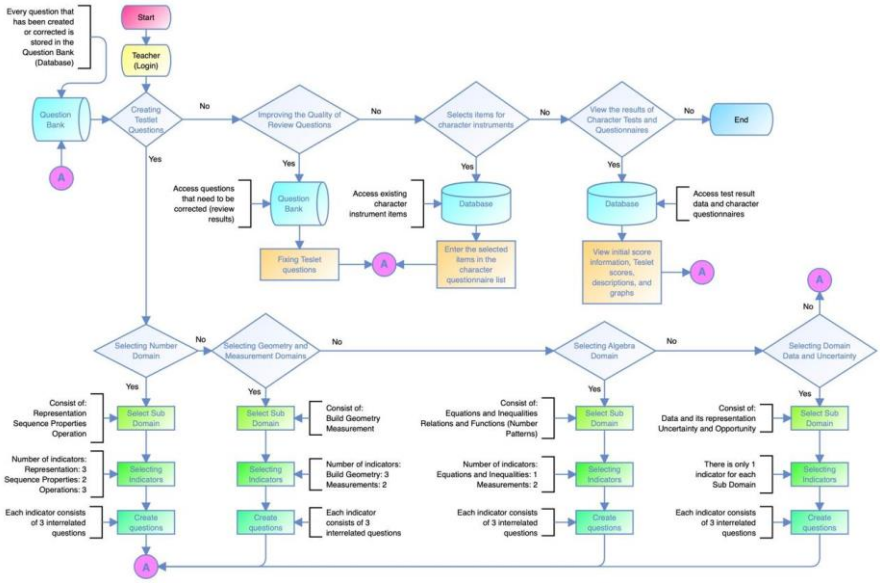

Figure 3. Teacher Flowchart

The Figure 3 is a teacher's flowchart illustrates how to develop a CBT-based assessment instrument with a testlet model to measure AKM on elementary school students' numeracy literacy. The flowchart above shows how the teacher prepares the questions and revises them using the CBT-based testlet model for elementary school students.

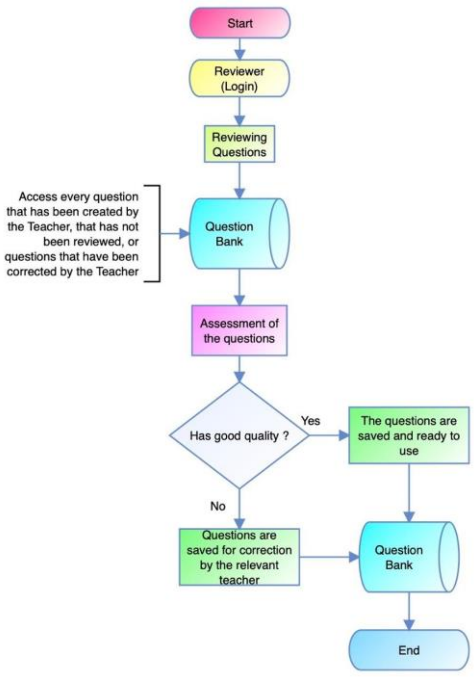

Figure 4. *Flowchart Reviewer*

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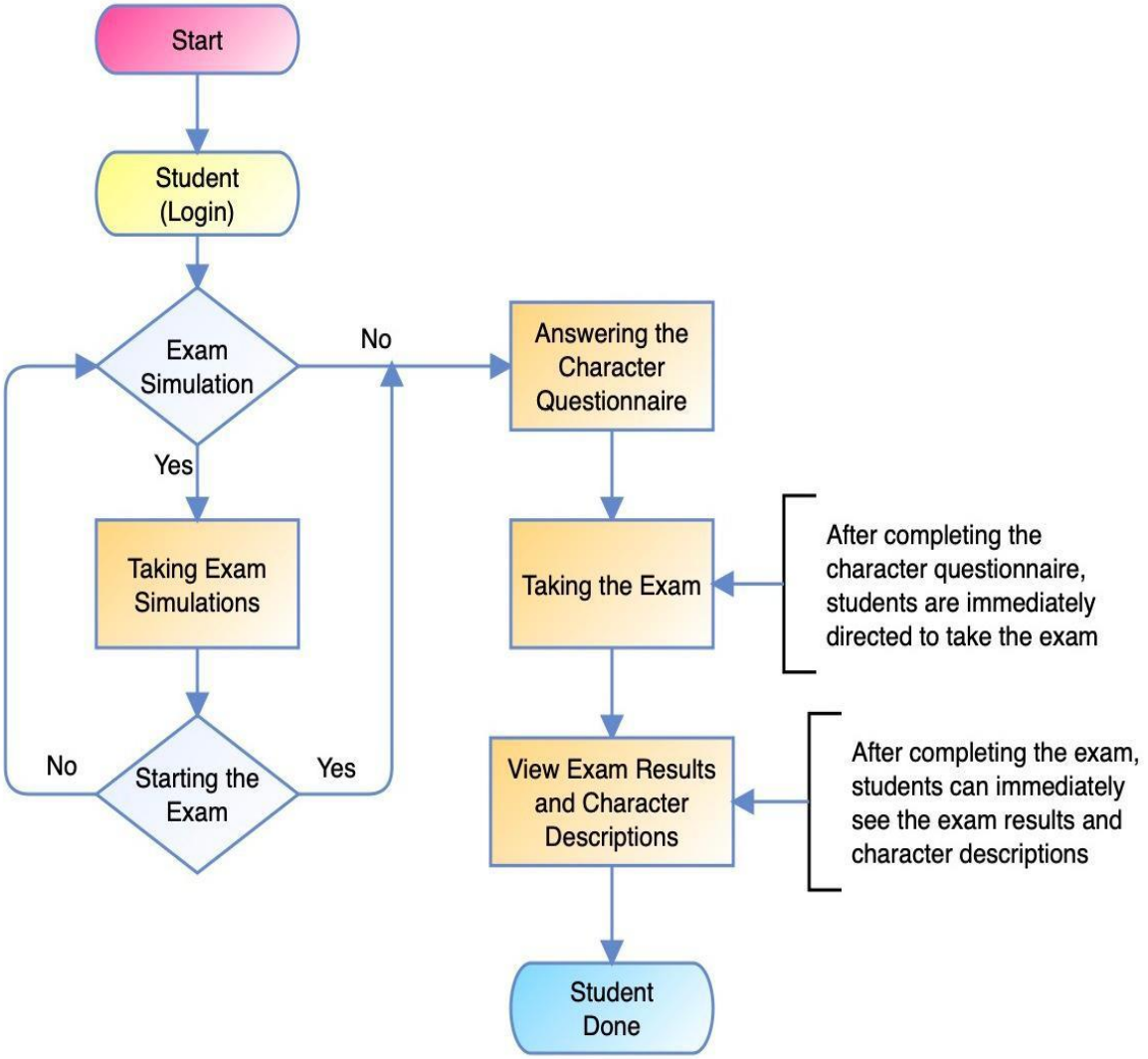

Figure 5. Student Flowchart

The Figure 5 student flowchart describes the student process in taking the AKM assessment exam using a CBT-based application with a testlet model on numeracy literacy. The test used is the AKM numeration test instrument of the testlet model, with the grid listed in Table 1.

Apart from the AKM Numeracy Model Testlet test instrument, this research also used a questionnaire, namely a student character survey questionnaire, as well as expert assessment sheets to assess the quality of the CBT being developed. The student character survey questionnaire grid is presented in Table 2.

Discussion

Testlet is a CBT assessment model developed by researchers in carrying out research related to AKM on numeracy competencies. The testlet flowchart explains the steps and roles carried out by each subject to play their role in the process of developing AKM for numeracy literacy. According to Nurhikmah. et al. (2021) and Aprilia et al. (2022) the use of computer based tests is suitable for use as a learning evaluation medium in mathematics subjects, one of which is AKM. Additionally, Tomasik et al. (2018) also explain that a computer-based formative assessment system for the educational context will provide teachers and students with valuable

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information regarding the evaluation and interpretation of assessments carried out without taking up a lot of time.

Table 1. Matrix of Numeracy AKM Test Instrument of Testlet Model

Domain	Sub Domain	Indicator	Item No	Context	Item Type
Number	Representation	Understanding whole numbers (maximum six digits)	1, 2, 3	Personal	PG, Short Answer, Matching
		2. Understanding fractions and fragments positive mixture with the denominator one or two digit numbers (e.g. 5/1, 2⅗)	4, 5, 6	Social Cultural	PG, Short Answer, Matching
		Recognizing the number line and know the position of whole numbers and fractions on the number line	7, 8, 9	Scientific	PG, Short Answer, Matching
	Sifat Urutan	Comparing two whole numbers (max. three numbers)	10, 11, 12	Personal	PG, Short Answer, Matching
		Comparing two fractions, including comparing fractions and whole numbers	13, 14, 15	Social Cultural	PG, Short Answer, Matching
	Operation	Calculating the result of subtraction/multiplication/division of two whole numbers (max. six digits), including the square of whole numbers (maximum three digits)	16, 17, 18	Scientific	PG, Short Answer, Matching
		Determining several (max. 5) multiples of a whole number n with $n \leq 10$. (Equivalent to skip counting.)	19, 20, 21	Personal	PG, Short Answer, Matching
		Determining the LCM, factors of a whole number, and FPB.	22, 23, 24	Social Cultural	PG, Short Answer, Matching
Geometry and Measurement	Shape Geometry	Recognizing quadrilaterals, triangles, polygons, and circles	25, 26, 27	Scientific	PG, Short Answer, Matching
		Calculating the area of a rectangle if the length and width are known, and calculate the length or width if the area and one of the sides are known.	28, 29, 30	Personal	PG, Short Answer, Matching
		Recognizing several geometric shapes, such as blocks, cubes, prisms and tubes	31, 32, 33	Social Cultural	PG, Short Answer, Matching
	Measurement	Knowing and using standard units for length (cm, m), weight (gr, kg), volume (liter, ml), time (seconds, minutes, hours)	34, 35, 36	Scientific	PG, Short Answer, Matching
		Knowing and using units of area (cm2, m2) and volume (cm3, m3)	37, 38, 39	Personal	PG, Short Answer, Matching
Aljabar	Similarities and Differences	Solving simple equations using addition, subtraction, multiplication and/or division operations (in a form adapted to the level of development of thinking processes in that class)	40, 41, 42	Social Cultural	PG, Short Answer, Matching
	Relation and Function (incl. Type of Number)	Recognizing image or object patterns	43, 44, 45	Scientific	PG, Short Answer, Matching
		Recognizing simple number patterns and continue the pattern	45, 47, 48	Personal	PG, Short Answer, Matching
Data and Uncertainty	Data and Representation	Understanding how to present simple data (using graph charts and graphs)	49, 50, 51	Social Cultural	PG, Short Answer, Matching
	Uncertainty and Opportunity	Determining which event is more likely among several events	52, 53, 54	Scientific	PG, Short Answer, Matching

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Table 2. Survey matrix of student character

Dimension	Aspect Indicators	Item Indicators
Have faith, fear God Almighty, and have good noble characters	Religious Morals (Knowing and loving God Almighty, understanding religion/beliefs, carrying out worship)	Performing prayers on time
	Personal Morals (Integrity, taking care of yourself physically, mentally, and spiritually)	Wearing school uniforms neatly
	Morals towards humans (Prioritizing equality with others and respecting differences, empathizing with others)	Respecting differences in ethnicity, race, and religion
	Morals towards nature (Understanding the interconnectedness of the earth's ecosystem, and protecting the natural environment)	Using enough water
	State Morals (Exercising rights and obligations as an Indonesian)	Ability to lead yourself to manage emotions well
Mutual Cooperation	Cooperativeness	Creating study groups and managing collaboration in achieving learning goals
	Willingness	Providing an important and valuable contribution to the study group
	Mutual Help	Concern: An active attitude in understanding the delivery of other people and groups and using communication strategies in learning
	Appreciating	An active attitude in understanding other people's submissions
	Solidarity	and groups and use strategies
Creativity	Smoothness Producing original work or acts	Providing many ways or suggestions for doing various things
	Flexibility	Looking for many alternatives or different directions
	Originality	Raising issues and developing ideas or things that other people have not thought of
	Elaboration	Developing or enriching other people's ideas
	Producing original ideas	Thinking of different ways to solve problems
	Producing original works or acts	Producing work that is driven by his interest and liking for something, the emotions he feels, and taking into account the impact on the surrounding environment
Critical Thinking	Understanding given problems	Ability to find the relationship between the problem and the material taught previously
	Analyzing	Gathering information and find solutions
	Evaluating	solution to the given problem
	Concluding	Evaluating and developing settlement strategies
Global Diversity	Conserving culture	Drawing conclusions
	Interacting interculturally	Exploring culture and cultural identity
	Appreciating	Intercultural communication skills in interacting between cultures
	Reflective and responsible	Fostering a sense of respect for cultural diversity
Independence	Inisiative	Reflections on the experience of diversity
	Responsible	Having the initiative in learning mathematics
	Not depending on others	Having a sense of responsibility for the tasks given
	Self-controlling	Not depending on other people

Maximizing the use of computer-based tests developed using the testlet model will provide teachers with a lot of information. Teachers will not only get information related to student competencies, but teachers will also get information related to the characteristics of each student. Not only that, the use of the testlet model will also make it easier for the government and teachers to map the quality of education (Wirasasmita et al., 2020). One of the studies conducted by Dwijayanti & Savitri (2022) regarding the CBT testlet model showed that

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the instrument developed was valid and reliable and could be used to measure the five skills in HOTS.

In line with this, in this research, the instrument developed by the researcher is valid and reliable. Instrument validation carried out by five experts explained that from the four numeracy domains (numbers, geometry, algebra, and data and uncertainty) it shows that: 1) all of the 27 questions in the number domain are valid (V Aiken> 0.63), 2) 13 questions in the geometry domain are valid (V Aiken> 0.63), 3) nine questions in the algebra domain are valid (V Aiken> 0.63), and 4) nine questions in the data domain and uncertainty are valid (V Aiken> 0.63).

This research involves several interrelated subjects and each has a role in each stage of the research. These subjects include administrators, reviewers, teachers, and students. The administrator in this development research plays a controlling role in distributing questions to students related to literacy and numeracy that have been validated by reviewers, where the validated questions are stored in the database system. According to Efendi et al. (2021), the use of a database system in computer-based tests can make tests easier to display questions and assess student answer results. This also makes it easier for testers to take tests and for administratoristrators to manage tests. Administratoristrators also have a role in collecting and describing students' AKM results on literacy and numeracy skills.

Teachers in this development research play a role in creating questions that will be tested on students, namely questions related to literacy and numeracy skills which are connected to local wisdom. According to Nazhifah et al. (2022), questions in CBT that are linked to local wisdom can measure students' science literacy abilities. Apart from that, by including the context of local wisdom in the assessment, it can also train students' science literacy abilities. Regarding the questions created by the teacher, before being tested, they will be validated first by a reviewer. If the questions created by the teacher are appropriate and follow the abilities to be measured, then these questions will be stored in the database system. However, if the questions created by the teacher are inappropriate and do not measure what is intended to be measured, then the teacher needs to revise the questions. This is in line with Dyrvold & Bergvall (2023) and Hani et al. (2021) who explain that validity in computer-based assessments is a crucial and important thing to pay attention to because validity in computer-based assessments can provide better test results.

Reviewers in this development research play a role in assessing questions made by teachers regarding literacy and numeracy skills which are connected to local wisdom which is developed using the testlet model. The reviewer assesses questions created by teachers online through a CBT-based application. If the questions that have been reviewed by the reviewer follow the abilities to be measured, then these questions will be included in the database system. However, on the other hand, if the questions that have been reviewed by the reviewer do not measure what is intended to be measured, then the reviewer will provide notes regarding the questions that have been made by the teacher to be corrected.

Students in this development research play a role as testees or users of product development results related to computer-based assessments developed using the testlet model in AKM numeracy. Students will work on questions on the website that have been validated by reviewers and compiled in a database system by the administrator. Students need to log in first to be able to take the test. After logging in, students will be asked questions related to the character. Then, when they have finished working on the character questionnaire, students can continue to the next session regarding AKM numerac.

CONCLUSION

This research produces a CBT testlet model which consists of a system for administrators, a system for students, a system for teachers, and a system for reviewers which

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is presented in flowchart form. Teachers play a role in creating questions that will be tested on students, students play a role as testees or users of product development results related to computer-based assessments developed using the testlet model in AKM numeracy. Reviewers play a role in assessing questions created by teachers, and administrators play a role as control in distributing questions to students related to literacy and numeracy that have been validated by reviewers, where the validated questions will be stored in the database system. This system is contained in one application that is integrated with the character survey. This research produced a testlet model of CBT and test instruments in the form of a minimum competency assessment and an integrated character survey, which have been proven valid and reliable.

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