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Developing an assessment instrument to measure the minimum competency of high school physics using item response theory

Resti Novika[1*]; Edi Istiyono[2]; Andriandrainiarimanana Anjamampionona Notiavina[3]
[1]Universitas Islam An-Nur Lampung, Indonesia
[2]Universitas Negeri Yogyakarta, Indonesia
[3]University of Antananarivo, Madagascar
[*]Corresponding Author. E-mail: restinovika123@gmail.com

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ABSTRACT

Minimum competence of reading literacy and numeracy is a basic competency that must be possessed by students to participate in society. The government stipulates a minimum competency assessment as a basic assessment to develop students' self-quality. This research aims to produce a minimum competency assessment instrument (MCA) for high school physics. This research is research and development research. Selection of test subjects using purposive sampling with 321 samples. This research and development resulted in the quality of the MCAPhys instrument in terms of content validity, the Aiken's V score was in the valid category. The empirical validity based on item compatibility with the IRT Rasch model and PCM approach proved that 80 items fit the model. Reliability estimation based on Cronbach's Alpha reliability is obtained in very reliable criteria. The item difficulty level is in the range of -3.5 to 2.9. The quality of the developed MCAPhys test instrument meets the eligibility of the test instrument, so that it can be used as a reference for making minimum competency assessment instruments by teachers and can be used as practice questions by students. This finding is a significant contribution to the development of education, especially related to the provision of an instrument model based on empirical evidence. This test development framework can be adapted to other subjects and add to the study of the validity and reliability of minimum competency assessments.

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INTRODUCTION

In 2021 the Ministry of Education and Culture formed an evaluation program, namely by removing the National Examination which was replaced with a national assessment. The main components of the national assessment include minimum competency assessment, character surveys, and learning environment surveys (Anas et al., 2021; Nurjanah, 2021; Widarti et al., 2022). Minimum competency assessment aims to develop students self-quality, so that students can participate in society (Ayuningtyas & Sukriyah, 2020; Fauziah et al., 2021). MCA aims to prepare students to face 21st century, namely having the ability to think critically, creatively, communicate and collaborate (Andiani et al., 2020). The two competencies are the minimum competency assessment that is measured by reading literacy and numeracy (Pusmenjar, 2020). Reading literacy and numeracy skills have an influence on the future of students and for making decisions in everyday life.

The importance of ability reading literacy and numeracy that must be possessed to train students' reasoning when faced with problems. Numeracy measures students' ability to use and

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apply mathematical concepts and facts (Winata et al., 2021). The importance of numeracy skills that students must have to face the world of work and everyday life (Jain & Rogers, 2019). Numerical understanding and thinking skills are important for students of all academic fields (Gazit, 2012). While reading literacy emphasizes students in understanding and analyzing reading (Yuliandari & Hadi, 2020). Mastering reading and writing literacy skills, a person will live his life with a better quality (Sunbanu et al., 2023). Reading literacy and numeracy aim to solve problems in various contexts to measure competency in depth (Astuti et al., 2023; Widarti et al., 2022). Numerical reading literacy competence is an early human ability that is useful in everyday life.

The school needs to carry out several MCA test exercises in the form of questions and guidelines on MCA questions according to those given by the ministry of education and culture (Andikayana et al., 2021). Before carrying out the minimum competency assessment, it is necessary to provide questions based on your minimum competency assessment and training modules based on minimum competency assessment (Handayani et al., 2021; Yamtinah et al., 2022). The minimum competency assessment aims to improve innovative learning which includes students' reading literacy, numeracy, and reasoning (Fauziah et al., 2021), so that the appropriate MCA questions must include reading literacy and numeracy (Hasanah et al., 2021). The basis for developing the instrument's minimum competency assessment refers to PISA, so that the minimum competency assessment questions will be different from the national exam questions.The form of MCA questions is different from the National Examination which has five forms of questions, including multiple choice, reasoned plural choices, short entries, matchmaking, and descriptions (Pusmenjar, 2021). The form of MCA questions is adjusted to the reading, data, or infographics in the questions (Meriana & Murniarti, 2021). The MCA questions presented are very different from the National Examination, from the competencies measured, the problems presented, the level of competence, and the different forms of questions. So, skills to understand and analyze questions need to be trained and honed.

The development of minimum competency assessment instruments has been carried out by several researchers, for example by Aprilia et al (2023) this research developed an AKM numeracy test instrument that integrates local cultural values. While research by Wardhani and Oktiningrum (2022) developed ethnomathematics-based AKM questions using the Canva platform to improve numeracy literacy of elementary school students. Elina et al (2024) in her research developed AKM questions based on the Malay Riau cultural context to measure the numeracy literacy skills of Phase D students. Tessmer's formative research model was used in the development of this instrument. The novelty in this research lies in the development of assessment instruments that integrate the two domains of basic competencies of literacy and numeracy into one assessment tool that is contextualized in Physics learning, an approach that has not been widely discussed in previous studies. Previous studies generally only focus on one domain, either numeracy or literacy, and rarely link them directly in the context of a particular subject such as Physics. In addition, this study also carries a comprehensive psychometric evaluation using the Item Response Theory (IRT) approach with the help of Quest software, resulting in strong empirical validity for various forms of questions.

A needs analysis involving 50 teachers in Lampung revealed the following: 94% support the national assessment policy replacing national exams, 68% attended its socialization, and 74% of schools are prepared. However, only 8% of teachers understand AN components, 76% face challenges in creating MCA questions, and 50% have introduced MCA examples to students. Despite 94% agreeing on the importance of MCA development, limited teacher knowledge and difficulties in question-making hinder its implementation. Thus, developing cross-subject MCA tests as a reference is essential. Related research conducted by Khairi and Desnita (2023) shows that the level of suitability of AKM literacy questions is very low and teacher-made numeracy. Research conducted by Noviantini et al. (2023) produce a minimum competency assessment instrument product to measure numeracy skills with one form of question, namely multiple

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choice only. Research conducted by Wardani et al. (2022) developed an MCA test instrument for reading literacy and numeracy in fifth grade elementary school thematic learning using expert assessment analysis. However, there is no specific research and development instrument with minimum competencies to measure numeracy and literacy in one field of study with varying question forms. In contrast to previous research efforts that aimed to explore more targeted and in-depth assessment approaches.

The research was carried out to develop minimum competency assessment instruments for reading literacy and numeracy competencies in the application of material physics subjects for class IX in the form of multiple choice questions, complex multiple choice, descriptions, matchmaking and short entries. The resulting product is an instrument that meets the feasibility of the test instrument from expert validity, empirical validity, reliability, and level of difficulty based on item response theory analysis. The scientific contribution of this research is the development of a Physics-based minimum competency assessment instrument (MCAPhys) that not only meets content and empirical validity, but also introduces a diversity of question forms at various cognitive levels. This instrument is a practical solution for educators in implementing relevant AKM in Physics subjects, while encouraging the development of literacy, numeracy, and reasoning skills of students in an integrated and contextual manner.

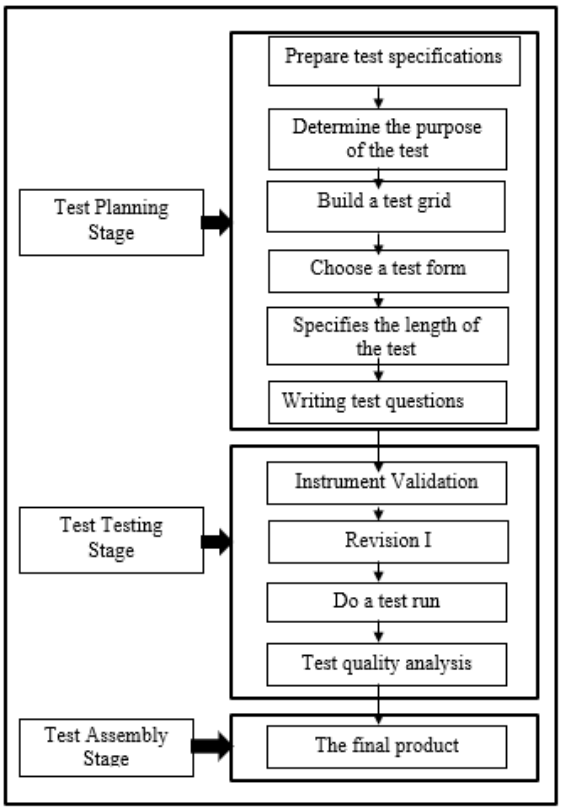

Figure 1. Test instrument development procedure

RESEARCH METHOD

This research is research and development. In this research, a minimum physics competency assessment test instrument (MCAPhys) was developed for class XI senior high school odd semester. The MCAPhys instrument developed consists of reading literacy and numeracy in the form of multiple-choice tests, complex multiple-choice tests, matching, short entries, and descriptions. The development model used was adapted from the Oriondo and

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Antonio development model Oriondo and Antonio (1998) to develop the MCAPhys test instrument. AKMPhys instrument development procedures include test design, test testing, and test assembly. The stages in this study are more fully described through the chart in Figure 1.

The test subjects in this study were public high schools in Lampung. When the research is conducted in the odd semester of 2022-2023. Selection of test subjects using purposive sampling. The population in this study were class XII students of public high schools in Lampung Province. Based on this population, it was determined that the limited trial sample was in senior high schools, there are SMA YP Unila class XII science and SMA AL-Kautsar class XII science. The trial sample is limited to 321 students. Data collection techniques are used in the form of tests and non-tests.

$$V = \frac{\sum s}{[n(c-1)]} \quad (1)$$

$$\alpha = \left(\frac{k}{k-1}\right)\left(1 - \frac{\sum {\sigma_i}^2}{{\sigma_t}^2}\right) \quad (2)$$

The quality of the developed MCAPhys instrument is based on content validity, empirical validity, reliability, and item difficulty level (1PL). The expert judgment consisted of two material physics expert, two measurement expert, two physics education expert, three and physics practitioner or teacher. The results of the expert judgment review were analyzed quantitatively using Aiken's V formula (See Formula 1). Aiken's V formula with the following formula Azwar (2012). In the calculation of validity scores, the formula s = r - lo is used, where s represents the adjusted score, r is the number given by the appraiser, and lo is the lowest validity rating within the assessment range. Meanwhile, c indicates the highest validity value, which serves as the upper limit of the range.

Empirical validity was analyzed based on the suitability of the items with the IRT approach (item response theory). Empirical validity analysis was carried out with the help of the Quest program. The quest program can help analyze dichotomous data, polytomous data, and combined dichotomous polytomous data. Analysis of dichotomous data items was based on item compatibility with the Rasch model, while polytomous data item analysis was analyzed using partial credit models. The suitability of the items is based on the trial results. According to Adams and Kho (1996), an item is said to be fit if the INFIT MNSQ value is between 0.77 and 1.33. The goodness of fit for each item can be seen in the INFIT t value, which meets the criteria if the INFIT t value is between -2 to 2.

Table 1. Criteria for reliability

Cronbach's Alpha value	Level
>0.80-1.00	Very Reliable
>0.60-0.80	Reliable
>0.40-0.60	Reliable enough
>0.20-0.40	Less reliable
0.0-0.20	Unreliable

The reliability estimation of the MCAPhys instrument is based on Cronbach's Alpha calculations with the help of SPSS. The reliability calculation uses Cronbach Alpha (See Formula

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2). Where α is reliability coefficient of the instrument, k is the number of question items in the instrument, $\sum \sigma i^2 =$ total variance of the instrument items, and σi^2 is total score variance. Cronbach's Alpha reliability criteria according to Hair et al. (2009) can be seen in Table 1. The difficulty level of the items was analyzed based on item response theory (IRT) using the Quest program. The greater the value of the parameter bi, the greater the ability of the test takers required to answer the items correctly.

FINDINGS AND DISCUSSION

Findings

The product developed in this study is a computerized adaptive test that is used to The product developed in this research is a minimum competency assessment instrument for high school physics with materials on equilibrium and rotational dynamics, elasticity and Hooke's law, fluid statics, fluid dynamics, and heat transfer. Products are in the form of multiple-choice test instruments, complex multiple-choice, descriptions, short entries, and matchmaking. The test was developed based on the Oriondo and Antonio model (Oriondo & Antonio, 1998). The development procedure consists of designing tests, testing tests, and assembling tests.

Designing Tests

The test design stage consists of a literature study, decision analysis, and test development. Based on a literature study, a minimum competency assessment is used to assess students' cognitive learning outcomes which include reading literacy and numeracy. The minimum competency assessment measures the basic competencies of students without differentiating their specialization. So, students will get questions that can measure the same competency (Winata et al., 2021). The minimum competency assessment will present a variety of problems that are expected to be solved with students' reading literacy and numeracy skills. MCA is used to measure in-depth competence so that it is not just content mastery. Reading literacy is the ability to understand, use, evaluate, and reflect on various types of written texts to develop the capacity of students to be able to participate productively in society (Pusmenjar, 2020).

Based on a needs analysis by distributing questionnaires to 50 teachers in several schools in Lampung, it was stated that (1) 94% of teachers agreed with the national assessment policy as a substitute for the national exam, (2) 68% of teachers had attended the socialization of the national assessment held by the government, (3)) 74% of schools have prepared all aspects in facing the national assessment, (4) 8% of teachers who can answer the AN component correctly, (6) 76% of teachers experience problems in compiling MCA questions, (7) 50% of teachers in schools have given examples -An example of MCA questions for students, (8) And there are 94% of teachers who agree with the development of MCA questions. In this case, it can be stated that the teacher's lack of understanding and knowledge regarding the components of the national assessment which consists of MCA, character surveys, and learning environment surveys, and teachers experience problems in making AKM questions. It is necessary to develop the MCA test to assist teachers in making MCA questions.

Test development includes preparing test specifications, determining test objectives, compiling test grids, selecting test forms, determining test length, and writing test questions. The questions generated are based on core competencies, basic competencies, and K-13 curriculum indicators in the Physics subject for the odd semester of grade XI high school. The test covers high school physics material consisting of equilibrium and rotational dynamics, elasticity and Hooke's law, fluid statistics, fluid dynamics, as well as temperature, heat, and heat transfer. The test developed is a minimum competency assessment that includes reading literacy and numeracy.

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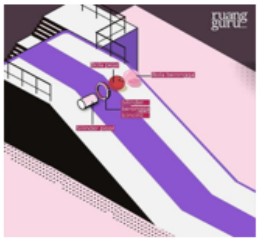
Text for questions 1-3



Newton once explained in Newton's Law I. He said that objects that were initially stationary will remain still and those that were initially moving will continue to move at a constant (fixed) speed. The tendency of objects to "preserve themselves" is called inertia. One thing you need to remember about inertia is: objects that have great inertia tend to be difficult to slow down or speed up. Take a look at the image above. There are objects that have different shapes that will be launched on the same trajectory. Starting from the box, solid ball (solid), hollow ball, solid cylinder, or hollow cylinder (ring). In physics, such objects are thought to be made up of super-small particles that compose them. Each particle in this object has its own moment of inertia.

Then, what is the relation between inertia and moment of inertia? Inertia is the inertia for translational motion (movement that is straight/linear), while the moment of inertia is the inertia for rotational motion (movement that is turning around the axis). When all objects are above (have not been released), objects have a height that has potential energy. When the object is released it will roll down, which means that some of its kinetic energy will be used for rotational motion. As a result, objects will convert potential energy into translational kinetic energy (energy to make objects slide down) and rotational kinetic energy (energy to make objects rotate. So that the object that will fall first is the smallest object converting potential energy into rotational kinetic energy. Because every objects have a moment of inertia, so the object that falls first has the smallest form constant.

Source: *https://www.ruangguru.com/blog/momen-inersia*

Question number 1 (Short answer)
If we assume that all the objects in the Figure have the same mass and radius, and all are released simultaneously from above, which object will reach the bottom first and put those objects in order!

Question number 2 (Matching)
Based on the text above, determine the magnitude of the moment of inertia for each of the following objects.

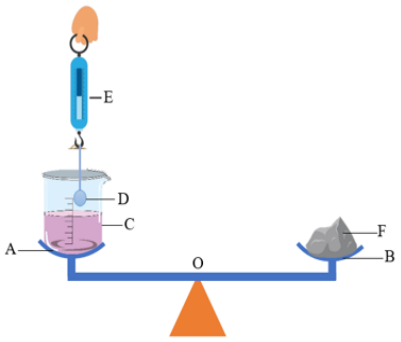
Solid Ball	$I = \frac{2}{5} mR^2$
Solid Cylinder	$I = 1\ mR^2$
Hollow Ball	$I = \frac{2}{3} mR^2$
Hollow Cylinder	$I = \frac{1}{2} mR^2$

Question number 3 (multiple choice)
The text object above, which causes the first object to go down after being launched simultaneously is....

A. The object that reaches the bottom first has the smallest shape constant, so the velocity (v) is the greatest
B. The object that reaches the bottom first has the largest shape constant, so the velocity (v) is the greatest
C. The object that reaches the bottom first has the shortest distance, the greater the moment of inertia
D. The object that reaches the bottom first has the farthest distance, the smaller the moment of inertia
E. The object that reaches the bottom first has a large rotational kinetic energy, so the translational kinetic energy becomes small

Figure 2. Display of reading literacy questions

Text for question numbers 4-6
The figure below shows a simple seesaw supported on O. A measuring cup C is in balance when a load F is placed on B. A metal ball D with a mass of 1000 g and a volume of 100 cc is suspended from a spring balance E. ($\rho_{air} = 1\ g/cc$).



Question number 4 (Complex Multiple Choice)
Metal ball D is slowly lowered into the measuring cup until the metal ball is completely submerged in water ($\rho_{air} = 1\ g/cc$). The following are statements of movement from seesaws A and B. Put a tick (✓) in the box in front of the statements for the correct answers.

- ☐ Just before the metal ball is immersed in the water, the force exerted by the measuring cup on the seesaw is equal to the weight of the water
- ☐ Just before the metal ball is immersed in the water, the compressive force exerted by the measuring cup on the seesaw is equal to the weight of the load F
- ☐ After the metal ball is slowly put into the water, there is an action force from the ball to the water
- ☐ The force from the measuring cup to the seesaw comes from the weight of the water, the force of action from the ball to the water
- ☐ The seesaw slowly tilts to the right, point A will move downwards and load F will slowly drop

Question number 5 (Description)
Determine the change in the mass of the load required for the load F to bring the seesaw back into balance! Is the change in the mass of the load on the load F in the form of a reduction or

Question number 6 (Multiple Choice)
The metal ball D is lowered until it touches the bottom of the measuring cup and is released from the spring balance E. Determine the additional mass of the load that must be given to the load F so that the seesaw returns to balance!

A. 100 g
B. 1000 g
C. 900 g
D. 9000 g
E. 800 g

Figure 3. Stimulus for numeracy questions

The preparation of the MCAPhys test is based on the center for assessment and learning of the ministry of education and culture. Based on this, the MCAPhys questions were generated, namely reading literacy and numeracy including text content, text context, and cognitive level. An important aspect of reading literacy is providing the availability of text and reading to be used as a stimulus for writing questions. The content of reading literacy texts is grouped into

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two, namely literary texts and informational texts. Literary texts and informational texts contain stimulus readings covering three contexts, namely the personal context, the sociocultural context, and the scientific context. Writing questions from a context or stimulus in literary and informational texts measures three different cognitive levels including finding information, understanding, and evaluating.

The development of numeracy MCAPhys questions in the content domain is categorized into four, namely numbers, geometry and measurement, algebra, and data and uncertainty. The context of numeration text includes personal, socio-cultural, and scientific. Writing MCAPhys numeracy questions for each stimulus has three different cognitive levels, namely understanding, application, and reasoning. The form of the test developed consists of multiple choice, complex multiple choice, short essay, description, and matchmaking. The number of items on reading literacy is 50 and numeracy is 30. Overall the minimum competency assessment item is 80 items. There are 20 multiple-choice questions in the form, 38 complex multiple-choice questions, 5 matching questions, 4 short answers, and 13 description questions. The following is a display of reading literacy and numeracy questions that are applied in physics learning.

Based on Figure 2, the text on reading literacy is an information text related to the moment of inertia with a scientific context. The questions are written with one stimulus which consists of three questions with different cognitive levels, namely understanding, interpreting, and reflecting. In one reading literacy text, there are three questions with different question formats. In question number 1 is a question with the form of a short answer question, the question demanding students to find explicit information related to the problem of the moment of inertia of the facts presented. In question number 2 is a question in the form of matching questions, this question requires students to understand what is implied related to the problem of the moment of inertia of the facts presented. In question number 3, it is a question in the form of multiple choice questions, based on this question students are asked to evaluate what is explicit about the moment of inertia problem against the facts presented.

Figure 3 shows a numeracy question. The stimulus in the question is a simple seesaw scientific context. Writing numeracy questions has one stimulus with 3 different questions with different cognitive levels, namely the cognitive levels of understanding, application, and reasoning, as well as in the form of complex multiple choice questions, summaries, multiple choice.

Based on the minimum physics competency assessment that was developed, students will apply mathematics to solve the problems presented. This is also explained by Bennison (2015) the problem-solving activity will involve students doing math, because a critical orientation is needed to evaluate the results and information presented to them. According to Zamnah et al. (2021) students will learn to improve their understanding of mathematics through carefully selected situations and apply mathematics to solve problems in this world. In this case according to Kurniasih et al. (2019) the teacher needs to provide stimulation to students so that they are accustomed to observing, asking questions, reasoning so that their abilities develop.

Testing Tests

MCAPhys Instrument Content Validity

Expert reviews on the minimum competency assessment test instrument were carried out to obtain content validity by material physics experts, measurement experts, physics education experts, and physics practitioners or teachers. The use of expert judgment through Aiken's V method was chosen because it is a widely accepted and reliable approach for evaluating the relevance and clarity of items in educational assessment instruments, particularly when quantitative validation from a panel of experts is required. Based on the assessment by experts on the MCAPhys test instrument, an average value of 0.95 was obtained which was in the high

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category and met the valid criteria. The expert judgment analysis is based on V Aiken's calculations. This finding is in line with previous research conducted by Kania et al. (2024) in their study developing an instrument to measure mathematical problem-solving ability. Validity has been tested by five experts using Aiken's V, with values between 0.817 and 0.884, indicating that the instrument is valid for use. Thus instruments that meet valid criteria can be used for trials.

MCAPhys Intrument Empirical Validity

The empirical validity of the instrument is known based on the suitability of the items with the IRT approach. Item analysis was carried out with the help of the Quest program. The Quest program can analyze dichotomous, polytomous, and combined dichotomous data polytomous. Dichotomous data were analyzed using the Rasch model IRT approach, and polytomous data were analyzed using the Rasch approach PCM, after being estimated by Quest obtained Infit MNSQ and Infit t as in Table 2**.**

Table 2. Empirical Validity Results

Parameters	Estimation Item	Estimation Testee
Infit's mean and standard deviation MNSQ	1.01±0.19	1.05±0.38
Mean and standard deviation of Infit t	-0.25±2.00	0.13±1.17
Infit MNSQ for each item	0.72 sd 1.31	
Infit t for each item	-2 sd 1.9	

Based on the results of the empirical validity analysis based on item compatibility with the Rasch and PCM models which can be seen in Table 2 the INFIT MNSQ average value on item estimation is 1.01 and the standard deviation is 0.19, while the INFIT t average value on item estimation - 0.25 with a standard deviation of 2.00. The average value of the INFIT MNSQ on the test estimate is 1.05 with a standard deviation of 0.38. The average value of INFIT t on testee estimates is 0.13 with a standard deviation of 1.17. According to Adams and Kho (1996), an item is said to fit with the model if the average value of INFIT MNSQ with INFIT t in both item estimates and testee estimates has an average value of around 1 and a standard deviation of 0.0. The results obtained as a whole are said to fit with the model.

Based on Table 2, the INFIT MNSQ value is obtained for items that are from 0.72 to 1.31. The INFIT t value is at -2 to 1.9. According to Adams and Kho (1996), an item is said to be fit if the INFIT MNSQ value is between 0.77 and 1.33. The goodness of fit for each item can be seen in the INFIT t value, which meets the criteria if the INFIT t value is between -2 to 2. The values obtained from the INFIT MNSQ with INFIT t fit with the model, as a whole can be seen in the Appendix. So that the items can be said to be valid for measuring. The results of this study are in accordance with the results of research conducted by Widyaningsih et al. (2021) that the analysis carried out using the Quest program shows that the items have an average MNSQ infit value and a standard deviation of 1.0 and 0.0, so that all items are declared valid.

MCAPhys Instrument Reliability

The reliability used in the analysis is based on the Cronbach Alpha reliability using the SPSS program. The results of obtaining reliability with Cronbach Alpha are known for the value of the reliability coefficient as shown in Table 3.

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Table 3. Reliability results with Cronbach Alpha

Cronbach's Alpha	N of Items
.935	80

Based on Table 3, the Cronbach alpha value is 0.935, which means that it is very reliable according to the Cronbach's Alpha reliability criteria according to Hair et al. (2009). The minimum competency assessment instrument for high school physics is a reliable instrument as a measuring tool.

Item Difficulty Level (1PL) MCAPhys

Item analysis was carried out with the help of the Quest program. The Quest program can analyze dichotomous, polytomous, and combined dichotomous polytomous data. Dichotomous data were analyzed using the IRT Rasch model approach and polytomous data were analyzed using the PCM approach. The results of the analysis can be seen in Table 4.

Table 4. Results of Item Difficulty Level (1PL)

No	The Easiest Question Items		The Most Difficult Item	
	Item to	b	Item to	b
1	Item 72	-3.5	Item 45	2.9
2	Item 47	-3.5	Item 34	2.6
3	Item 55	-3.3	Item 40	2.4
4	Item 79	-3.1	Item 23	2.2
5	Item 49	-3.0	Item 31	1.9
6	Item 75	-3.0	Item 41	1.9
7	Item 61	-2.7	Item 21	1.8
8	Item 64	-2.7	Item 38	1.8
9	Item 32	-2.4	Item 63	1.8
10	Item 62	-2.3	Item 10	1.7

Based on table 3, it is obtained that the item difficulty level is obtained from analysis with the Quest application, namely the item difficulty level values are in the range of -3.5 to 2.9. Item difficulty index close to -3 is an easy item, while item difficulty index close to 3 means it is more difficult.The degree of difficulty of the item is close to -3 and close to 3 are not discarded, because the items are said to be fit in the model fit test with the Rasch Model and PCM. This is also intended to provide opportunities for test takers who have higher abilities to work on more difficult items. The results of the research are also in accordance with those carried out by Khotimah and Mindyarto (2021), where the results obtained from the analysis of IRT items, has a difficulty level value of -3 to 3. Research conducted by Abidin et al. (2019) showed the results of the item difficulty index that had been developed from 136 items were at range -0.76 to 0.83 so it was concluded that the item difficulty index for all items was in the good category.

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DISCUSSION

The MCAPhys instrument that has been developed is based on the development design of the MCA Assessment Center questions and the Ministry of Education and Culture Learning (2020). MCAPhys that have been developed consisting of reading literacy and numeracy. MCA developed not only measures the topic or content but a variety of content, context, and level of cognitive processes. Content in reading literacy presents the type of text used in the questions which are divided into information text and text fiction. Numerical content includes numbers, measurement and geometry, data and uncertainty, and algebra. The context in question MCA reading and numeracy literacy shows the situation for the content used which consists of personal, social-cultural, and scientific. The cognitive level shows the way of thinking needed to solve the problem. The cognitive level of reading literacy consists of finding information, interpreting, and evaluating. The numerical cognitive level is divided into understanding, application, and reasoning.

The MCAPhys instrument developed has five forms of questions, namely multiple choice, complex multiple choice, matchmaking, brief entries, and descriptions. The number of reading literacy MCAPhys questions consists of 50 questions, meanwhile numeration totaling 30 questions. The physics material being tested is physics material for class XI in the odd semester, namely equilibrium and rotational dynamics, elasticity and Hooke's law, fluid statistics, fluid dynamics, as well as temperature, heat, and heat transfer. The quality of the instruments developed needs to be known. The quality of the instrument is a characteristic of the instrument which includes content validity, empirical validity, reliability, and item difficulty. According to Azwar (2012) the main characteristic of a good instrument must have a valid and reliable instrument. Based on the expert's assessment of the instrument MCAPhys SMA that has been developed is valid with an Aiken's V index value of 0.95 which is in the high criteria. Similar research was conducted by An Nabil et al. (2022) used the same approach in making a minimum competency assessment instrument based on the context of chemical science which measured Aiken's V in the range of 0.75 to 0.88. While in Hayati and Nindiasari (2024) research on the development of numeracy minimum competency assessment instruments for data and uncertainty domains in junior high school students, this analysis received high content validity. The Aiken's V value of this study was 0.95 which indicates a higher level of validity compared to the previous studies reviewed. This means that the MCAPhys instrument has high measurement quality for the minimum competencies of physics at the senior secondary school level. In addition, the novelty of this study lies in the integration of the two basic competency domains of the minimum competency assessment of literacy and numeracy in one instrument based on high school physics subjects, as well as the presentation of five variations of question forms, which have not been found in previous studies. For instruments that are declared valid based on expert judgment, trials can be carried out to determine the characteristics of the instrument. Test try is done to determine the empirical validity, reliability, and difficulty of the items.

The trial was carried out in two private schools in Lampung province, namely Al-Kautsar High School and YP-Unila High School. Amount Overall test-takers in the limited trial were 300 students. Next, the trial results were analyzed using the program Quest, to determine the empirical validity, reliability, and difficulty level of the items. Item analysis is done by Quest program assistance. The Quest program can analyze dichotomous, polytomous, and combined dichotomous polytomous data. Data dichotomous for the form of multiple choice questions were analyzed using the IRT Rasch model approach and polytomous data for the form of questions short entries, descriptions, matchmaking, and complex multiple choice were analyzed using the PCM approach. Based on the Quest analysis, empirical validity was obtained based on the suitability of the items with the IRT model approach Rasch and PCM, namely the INFIT MNSQ value on items that range from 0.72 to 1.31. INFIT value t is at value -2 up to 1.9.

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According to Adams and Kho (1996), items are said to be fit when the INFIT MNSQ value is at 0.77 up to 1.33. The goodness of fit of each item can be seen on the INFIT t value, which meets the criteria if the value INFIT t is in the value -2 to 2. The values obtained from the INFIT MNSQ with INFIT t fit with the model. The items can be said to be valid for measuring. Similar research was conducted by Supahar and Praasetyo (2015) in developing a performance assessment instrument for students' inquiry skills in high school physics subjects. The instrument was tested using the Rasch model which was analyzed with the help of the Quest program. The analysis results show that all items developed are in accordance with the IRT model used, with MNSQ infit values in the range of 0.77 to 1.30. This shows that the instrument has good empirical validity and can be used to measure students' inquiry skills. Another study was conducted by Heru and Suparno (2019) in the Development of Reasoned Multiple Choice Test Instruments on Physics Mobile Learning Media (PMLM) Interactive Effort and Energy Materials to Measure HOTS of High School Students. The results of his research show that the results of empirical tests using the QUEST program show that 20 question items fit the threshold limit (INFIT MNSQ) in the range of values 0.77 to 1.33. This shows that the instrument has good empirical validity and can be used to measure students' HOTS. The empirical validity of the developed MCAPhys instrument shows a very good empirical validity value, with all items in accordance with the IRT model. This shows that the MCAPhys instrument has excellent quality in measuring the minimum competence of high school physics.

A proper measuring tool for measuring is a valid and reliable test. Analysis in this study using reliability based on Cronbach Alpha with the SPSS program. Based on the results of the analysis with SPSS. The Cronbach Alpha reliability coefficient is 0.935, which means that it is very reliable according to the reliability criteria Cronbach's Alpha according to Hair et al. (2009). Thus, the minimum competency assessment instrument is an instrument reliable and usable for measurement. A similar approach was used by Wahyudi et al. (2023) in the development of AKM-based test instruments on trigonometry material for grade X high school students. The study used the ADDIE model and produced an instrument with a reliability coefficient obtained of 0.764, which is included in the high category. Another study by Sito et al. (2024) developed a competency assessment instrument on simple aircraft material for grade VIII junior high school students. This instrument was tested using the analysis of the level of difficulty, differentiating power, and the functioning of item checkers. The results of the analysis show that the instrument has good validity and reliability, with a reliability value of 0.85. In contrast to these studies, the MCAPhys instrument shows novelty not only in the form and structure of the questions, but also in a broader scope of competence, which includes literacy and numeracy in the context of high school physics material.

Acquisition of test instrument trials on students is known to be valid and reliable test instruments. Next characteristics of the test instrument on item difficulty were analyzed with the Quest program. Analysis for dichotomous data in the form of questions multiple choice was analyzed using the Rasch model, while the polytomous data was in the form of short answer questions, descriptions, matching, and choice Complex doubles were analyzed using the partial credit model. This is because the items developed have five forms of questions with different scoring. PCM analysis is an extension of the Rasch Model, resulting in results analysis that will obtain one parameter, namely the level of difficulty of the items. The results of the analysis were obtained from the items that meet the fit criteria with the model, which has a level of difficulty between -3.5 to 2.9. If the index item difficulty is close to -3 is an easy item, while the item difficulty index close to 3 means harder. The difficulty level of items that are close to -3 and close to 3 are not discarded, because the items are said to fit on the test model fit with the Rasch Model and PCM. It is also intended to provide an opportunity for test takers who have a higher ability to work on more difficult items. The results of the research are also by those conducted by Khotimah and Mindyarto (2021), where the results obtained from the analysis of IRT items, have a difficulty level value of -3 up to 3. This finding is in line with Hadianto (2024) which

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developed an AKM instrument for Islamic Religious Education subjects. In his study, the range of item difficulty levels was between -1.5 and +1.5 covering a wide range of participants' abilities. Meanwhile, Setiawati et al. (2022) in their analysis of the end-of-semester assessment items for physics class X, found that the level of difficulty of the items was in the range of -2 to +2. From the above analysis, it can be concluded that the level of difficulty of the items on MCAPhys is almost evenly distributed and thus becomes an important factor to emphasize the novelty in this study. In addition, the MCAPhys instrument demonstrates its effectiveness in not only bridging diverse content and item formats, but also achieving uniformity in item difficulty which allows teachers to utilize the instrument not only for assessment purposes, but also on learning outcomes.

The update on the results of research development conducted by researchers, namely the minimum competency assessment instrument measures two basic competencies, namely reading literacy and numeracy which are applied in physics subjects. The minimum physics competency assessment questions (MCAPhy) that were developed do not only measure topics or content but various content, contexts, and levels of cognitive processes. Content in reading literacy presents the types of text used in the questions and is divided into informational texts and fictional texts. Numerical content includes numbers, measurement and geometry, data and uncertainty, and algebra. The context in the MCA literacy and numeracy questions shows the situation for the content used which consists of personal, socio-cultural, and scientific. The cognitive level shows the way of thinking needed to solve the problem. The cognitive level of reading literacy consists of finding information, interpretation, and evaluation. Numerical cognitive levels are divided into understanding, application and reasoning.

The questions developed are different from the questions developed in previous studies. The questions are written with one stimulus which contains three questions with different cognitive levels. In writing reading literacy questions, one stimulus item consists of three questions with cognitive levels of understanding, interprete, and reflect. In writing numeracy questions, one stimulus item consists of three questions with cognitive levels of understanding, application and reasoning. The questions developed are interesting and measure reading literacy and numeracy applied in physics subjects. Thus, the product being developed can make it easier for teachers to create MCA-based questions with the two fundamental competencies being measured. The MCAPhys instrument developed has five forms of questions, namely multiple choice, complex multiple choice, matchmaking, short essay, and description. The number of MCAPhys reading literacy questions consists of 50 items, while numeration consists of 30 items. The questions developed contain physics material for class XI odd semester, namely rotational equilibrium and dynamics, elasticity and Hooke's law, fluid statistics, fluid dynamics, as well as temperature, heat and heat transfer. The developed MCAPhys instrument has fulfilled the eligibility of the test instrument, which has met the content validity, empirical validity, reliability, and good level of item difficulty.

CONCLUSION

The conclusions from the results of the research, discussion, and development of a minimum high school physics competency assessment instrument, namely the test instrument produced in the form of the SMA MCAPhys instrument include numeracy and reading literacy. The form questions consist of multiple choice, complex multiple choice, matching, short answer, and an essay with a total of 80 items. The quality of the minimum high school physics competency assessment instrument (MCAPhys) has fulfilled the eligibility of the test to be used for measurement, including: (a) content validation through expert assessment obtained Aiken's score V is in the high category and meets valid criteria. (b) Empirical validity based on item fit with the Rasch model for dichotomous data and PCM model for polytomous data obtained

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INFIT MNSQ values and INFIT values, then the items are stated fit the model. (c) Estimated reliability based on Cronbach's Alpha reliability in the very reliable criteria. (d) Level The difficulty of the item is in the difficulty range of -3.5 to 2.9.

As for suggestions for further research on the development of minimum competency assessment instruments, they include: (1) test items need to be developed more and create a question bank so that they can be used for teacher guidance and student training. (2) Development of a minimum competency assessment test instrument needs to be developed on application in other fields of study by assessing reading and numeracy literacy competence. (3) The test instrument developed is necessary a measurement test to be carried out, so that it can be seen that the test instrument that has been developed is capable of measuring minimum competency assessment of students.

Conflict of interests

There are no known conflicts of interest associated with this publication.

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