REID (Research and Evaluation in Education), 11(1), 2025, 29-44
Available online at: http://journal.uny.ac.id/index.php/reid

Rasch model analysis of essay questions to measure literacy and numeracy skills in plant and animal bioprocess topics based on AKM

Rianti Tri Wardani; Erni Nuraeni*; Sariwulan Diana
Universitas Pendidikan Indonesia, Indonesia
*Corresponding Author. E-mail: eninuraeni@upi.edu

ARTICLE INFO

Article History
Submitted:
May 23, 2025
Revised:
June 19, 2025
Accepted:
July 7, 2025

Keywords
test instruments; literacy; numeracy; plant and animal bioprocesses; Rasch model

Scan Me:

ABSTRACT

Literacy skills in reading and numeracy in Indonesia are classified as low, so the government has made new policies, one of which is the application of questions based on the Minimum Competency Assessment (AKM) in the National Assessment. Observation results from several high schools in Pekanbaru, Riau, have not shown the application of AKM questions to biology learning. This research aimed to produce AKM-based reading and numeracy literacy instruments on high school plant and animal bioprocess materials used in Research and Development (R&D) design, where the subjects were grade XII students at three high schools in Pekanbaru city. Data collection instruments were the test instruments that had been developed. Data were analyzed using Rasch modelling assisted by Winstep software, including Wright map analysis, person capability analysis, item capability analysis, scalogram analysis, and question item analysis. The results show that most students have a logic score below 0.0, meaning that reading and numeracy literacy skills and understanding concepts are still low. Four out of 63 students have inappropriate answer patterns, indicating that students did not work on the questions seriously. Then, the analysis results show 14 fit questions; having a Cronbach alpha value of 0.84 with a very high interpretation, a person reability value of 0.77 with sufficient interpretation, and an item reability value of 0.92 in the very high category; the difficulty level of the question items is in line with the rules of the test instrument development, since there is a spread of difficulty of the question items starting from very difficult, hard, medium, easy, and very easy. Thus, it is concluded that the instrument test can be used to measure reading literacy and numeracy skills based on AKM on plant and animal bioprocess materials.

To cite this article (in APA style):
Wardani, R. T., Nuraeni, E., & Diana, S. (2025). Rasch model analysis of essay questions to measure literacy and numeracy skills in plant and animal bioprocess topics based on AKM. *REID (Research and Evaluation in Education)*, *11*(1), 29-44. https://doi.org/10.21831/reid.v11i1.85614

INTRODUCTION

The Program for International Student Assessment (PISA) is an international standard educational research study. The three areas of learning topics that were evaluated included reading literacy skills, mathematical literacy (numeracy), and science literacy. The PISA survey in 2018 showed that the literacy competence of Indonesian students is classified as low, with a score of around 70% (OECD, 2019). The percentage of math and science skill levels is around 71% and 60% respectively, in the low category (OECD, 2019). The same results released in the Indonesian Student Competency Assessment (*Asesmen Kompetensi Siswa Indonesia* or AKSI) program showed that the reading and numeracy literacy skills of 600 schools in Indonesia resulted in 150 'good' criteria, 300 'medium' criteria, and 150 'less' criteria (Rigianti & Utomo, 2022). The results of the PISA survey have not increased in the last 10-15 years, so relevant and dynamic learning system regulations are needed to improve the quality of education in Indonesia.

ISSN: 2460-6995 (Online)

The Minister of Education and Culture, Nadiem Makarim, has taken a new policy to overcome these problems to improve the quality of education in Indonesia called the Freedom of Learning policy. One of the Freedom of Learning policies that the Minister of Education has initiated is the replacement of the National Exam (*Ujian Nasional* or UN) with the National Assessment (*Asesmen Nasional* or AN), which has been echoed since the 2019/2020 school year (Novita et al., 2021; Aisah et al., 2021). The National Assessment consists of three parts: the character survey, environmental survey, and minimum competency assessment (AKM) (Ministry of Education and Culture, 2020). This policy is sought as a reform of the UN into an assessment that contains a minimum competency assessment (*Asesmen Kompetensi Minimum* or AKM), which aims to improve the quality of learning in Indonesia and is designed to prepare students to face 21st-century skills (Cahyana, 2020; Ministry of Education and Culture, 2020; Meriana et al., 2021).

One of the demands for educators is to practice questions that lead to reading and numeracy literacy, as well as the implementation of classroom AKM; however, this is common among teachers, students, and other stakeholders (Fiskha & Heswari, 2022; Sartika & Mukhlis, 2023). The results of Rokhim et al.'s (2021) research show that as many as 25% of teachers do not understand AKM due to the lack of training activities for the development of AKM questions, so educators have never conducted an evaluation or learning process that refers to reading and numeracy literacy.

Several methods have been implemented in schools in order to support AKM as a government program in improving students' reading literacy and numeracy. Research by Rifqiawati et al. (2020) applies biomagazine as a biology teaching material so that it can improve reading literacy because the information presented is useful, the language is easy to understand, the appearance is attractive, and it is included with examples related to the material. Research by Fazilah et al. (2023) implements Wattpad as a learning tool to improve reading literacy, with research results increasing because there is contextual information and an attractive display, so that students are motivated to read. Research by Mardiani and Wahyuni (2022) and also Rijal and Imron (2020) implemented the school literacy movement (GLS) as an effort to improve students' reading and writing literacy. The literacy movement carried out includes reading mornings, diary books, local parenting, literacy corners, *mading (majalah dinding)* or wall magazine, book reviews, and writing essay compilations. These programs encourage an increase in students' reading motivation at school.

Efforts to improve numeracy literacy assisted by 3D V2 Cabri software technology allow students to see images and geometric shapes to build spaces from various directions, so that this learning method can attract students' interest in practising numeracy skills (Rintarti & Dwi, 2021). Based on this explanation, the implications for learning to support the AKM program, including developing learning strategies, learning resources, and learning media, have been developed by many other researchers. Teachers need to make various additional efforts to train students' reading literacy and numeracy in the learning process. Another implication that teachers can do to support the AKM program is to practice daily test questions, assignments, quizzes, pretests and posttests, end-of-semester assessments (*Penilaian Akhir Semester* or PAS), and mid-semester assessments (*Penilaian Tengah Semester* or PTS) that focus on reading literacy and numeracy.

One of the subjects that has minimal competence is biology. The concept of learning biology in harmony can be used in solving problems related to problems in daily life through the application of biological concepts (Millah et al., 2012). Plant and animal bioprocess materials are materials that are widely encountered in daily life, including in the fields of sports, health, and even in household life (Mawaddah, 2020). Plant and animal bioprocess material has a correlation with the nature of AKM questions that are applicable and related to daily life, so that plant and animal bioprocess material is chosen as material in the development of AKM questions in a scientific context. In addition, based on the results of the teacher's interviews, biology materials that are often developed in the context of reading literacy and numeracy are environmental changes, inheritance of traits, and the development and growth of living things. Qisthi et al.

(2023) developed literacy and numeracy questions in human respiratory system materials. Research by Rosidah and Sabtiawan (2024) and Sensus et al. (2022) developed reading literacy questions on ecosystem materials, showing that students' ability to analyse information is in the low category. The research by Rizki et al. (2022) developed numeracy literacy problems in the biology learning of grade XII evolution material, which shows that students' numeracy skills are in the low category. Thus, this research focuses on the development of reading literacy and numeracy problems based on AKM bioprocess material on plants and animals, which is often considered a topic that is underrepresented in existing research and practice in the development of reading literacy and numeracy questions based on AKM. By overcoming this, this research makes a new contribution to science education by enriching reading literacy-based questions and numeracy in a contextual and factual manner, as well as a guideline for educators and other researchers in developing reading literacy and numeracy-based questions based on AKM.

Rasch modelling will be used in the test instruments to be developed. The benefits of Rasch modelling include its ability to detect guesses, forecast scores from missing data, identify response errors, and not rely on the correct quantity of responses (Andrich & Marais, 2019; Jacob et al., 2019; Pereira et al., 2022; Sari & Mahmudi, 2024). The assessment instrument must meet a number of requirements before it can be said to be good; therefore, to fulfill these cues, it is necessary to (1) analyze the Wright map analysis (person-item map), (2) analyze the level of individual suitability (person fit), (3) analyze the scalogram, and (4) analyze the instrument.

Based on the aforementioned explanation of the importance of reading and numeracy literacy to be mastered by students as 21st-century skills and the limited number of questions that practice these skills, it is necessary to develop AKM-based questions in biology learning. Therefore, this study aims to produce a test instrument that can measure basic literacy and numeracy skills in high school plant and animal bioprocess materials reviewed from the Rasch model.

METHOD

Method and Respondent

The type of research used is Research and Development (R&D) using the Rasch model, which aims to examine the level of ability of question items that have been developed in measuring students' abilities based on the level of difficulty of question items as a test instrument. This research was carried out in three State High Schools in Pekanbaru City, Riau Province, which have the grade 'A' school accreditation and used the Merdeka curriculum on cell membrane transport materials, regulatory processes in plants, as well as substance transport and exchange. The population used in this study was all class XII groups having equal abilities; then, a sample was determined in this study where one class was a representative of each school in class XII, totalling 63 students, with cluster random sampling techniques. Class groups from each of the three high schools were randomly selected to be used as samples in this study.

Instrument

The test instrument that has been developed was subjected to a content validity test first to test the suitability between the text and the question item, and the suitability between the indicator item and the question item based on expert opinion. There were three experts involved, namely an expert in plant and animal bioprocess materials and an assessment expert who is a lecturer in Biology Education FPMIPA at Universitas Pendidikan Indonesia and Universitas Tanjungpura, as well as a biology teacher. The results of the validation test by experts were analyzed using Aiken's formula, where the 14 questions obtained a score with a range of 0.99 to 1. Based on Aiken's provisions, if the value obtained >0.8 is in the high category, it is declared that the items are in accordance with the purpose of content validity, and they are accepted and applied at the next stage.

The research instruments developed were test questions that refer to the AKM indicators, including content, cognitive processes, and context. The content of reading literacy is an informational text that contains factual data, events, and other things that really exist and happen in life. The content of numeracy literacy is numbers, geometry and measurement, algebra, and data and uncertainty. Cognitive processes in reading literacy include: (1) accessing and finding information, (2) interpreting and integrating information, and (3) evaluating and reflecting on information. In numeracy, the cognitive process is knowing, applying, and reasoning. Literacy questions of reading and numeracy developed in a scientific context. The question grids have been developed as follows, presented in Table 1 and Table 2.

Table 1. AKM-Based Reading Literacy Matrix

Sub-Material	Competence	Sub Competencies	Question Indicator	Question Number
Osmosis	Access and retrieve information	Access and discover in-text information	Finding explicit information about osmosis observations in carrots	1
Water diffusion and absorption	Interpret and integrate	Compile inferences, make connections and predictions of both single and plural texts	Compile generalizations (general conclusions) from the results of inference to the results of observations of soaking soybeans	4
Body fluids	Evaluate and reflect	Assess the format of the in-text presentation	Assess the accuracy of information sources (people/ institutions/institutions) on the impact of body fluid deprivation/ dehydration	7

Table 2. AKM-Based Numeracy Literacy Matrix

Sub-Material	Competence	Domain	Sub Domains	Question Indicator	Question Number
Body fluids	Knowing	Numbers	Counting operations	Define mathematical operations to solve problems in informational text	12
Osmosis and water absorption	Applying	Geometry and Measurement	Measurement	Predict the effect of temperature on soybean/jicama/kidney bean soaking on the speed of the water absorption process	6
Substance transport and exchange (abnormalities in the respiratory system and circulatory system)	Reasoning	Data and uncertainty	Data and its representation	Evaluate a given statement using number operations (integers, decimals, and percents)	11

The question items that have been developed are in the form of description questions, consisting of 14 questions. The data processing technique is carried out through a score test on the student's answer sheet based on the answer key of each question item, with a score of 2 if all the answers are correct, a score of 1 is given if some of the answers are correct, and 0 if the answers are wrong. An example of the developed instrument is shown in Figure 1.

Text 1- Cell Transport on Carrot Observation

High school students in grade XI observed cell membrane transport in carrots soaked using aquades as well as sugar solutions with different concentrations. The carrots are washed, peeled and cut into squares measuring 2 x 2 x 1 cm, observe the initial texture, then weigh the initial weight with a balance and measure the initial length. Each sample of carrot pieces gets a different treatment by immersion in aquades and a sugar solution with four concentration differences. The weight of sugar used consists of 0 gr, 5 gr, 10 gr and 30 gr. The soaking time of carrot pieces in some treatments based on the concentration of sugar solution is 1.5 hours. After 1.5 hours, the carrot pieces are drained using a petri dish that has been lined with a paper towel, then observe the final texture of the carrot and weigh and measure the final length. Next, observations were made on the weight, size and texture of the carrot pieces after soaking in Table 1.

Table 1. Results of Observation of Carrots Before and After Soaking in Different Concentrations

Sugar solution (gr)	Measured indicators					
	Starting weight (gr)	Final weight (gr)	Initial size (cm)	End size (cm)	Initial texture	Finishing texture
30	8,70	8,06	2×2×1	1.9×1.9×0.8	Hard	Soft
10	11,15	10,37	2×2×1	2×1.9×0.8	Hard	Soft
5	11,33	10,62	2×2×1	1.9×1.9×1	Hard	A bit mushy
0	10,18	10,59	2×2×1	2×2×1.1	Hard	Louder

In carrots soaked in a solution without sugar, the weight of 10.18 grams initially increased to 10.59 grams with a difference of 0.41 grams or 4% of the initial weight, and in size increased to 2x2x1.1 cm. This weight gain occurs because the plasma concentration of carrots is higher than the concentration of water outside the carrot. As a result, water outside the carrot cell goes into the carrot cell through a selective membrane.

1. Answer the questions below!
   a. Observation of cell membrane transport in carrots using sugar solutions of different concentrations. Which of the four sugar solutions is more concentrated?
   b. Explain why!

Figure 1. Reading Literacy and Numeracy Question Instruments Developed

Statistical Analysis

The data obtained was processed with the Rasch Model using Winstep Rasch. This analysis is used to determine the logit value, which is then interpreted to determine whether the instrument that has been developed is a fit or a misfit. The data from the research is processed and tabulated through data input in Microsoft Excel with file outputs in the form of *prn type files that can be opened in the Notepad application. After the file is saved in *prn format, the next step is to input data into the ministep application to further get the output tables (Widhiarso, 2013). The data analyzed included: (1) Wright map (person-item map), (2) individual fit level (person fit), (3) scalogram, and (4) instrument. The determination of fit items is based on the following criteria specified in Table 3.

Table 3. Interpretation of Validity

Statistics	Fit Indices
Outfit mean square values (MNSQ)	0.5 – 1.5
Outfit Z-Standarized values (ZSTD)	-0.2 + 2.0
Point measure correlation (PTMEA-CORR)	0.4 – 0.85

Two of them that meet the model criteria can be said to be fit items (Sari & Mahmudi, 2024). Then, a reliability analysis is carried out to see to what extent repeated measurements will produce consistent data or results. The interpretation of reliability is presented in Table 4.

Table 4. Interpretation of the Reliability Correlation Coefficient

Statistics	Conformity Index	Interpretation
Cronbach's alpha (KR-20)	< 0.5	Low
	0.5 – 0.6	Keep
	0.6 – 0.7	Good
	0.7 – 0.8	Tall
	> 0.8	Very high
Item and Pearson's Reliability	< 0.67	Low
	0.67 – 0.80	Enough
	0.81 – 0.90	Good
	0.91 – 0.94	Excellent
	> 0.94	Extraordinary

The data processing for this level of difficulty test uses the Racsh model assisted by Winstep software. The range of values for the difficulty level of the question item can be seen in Table 5.

Table 5. Difficulty Level Criteria

Value Range b (Logit)	Category Difficulty Questions
b < -2.00	It's easy
-2.00 ≤ b < -1.00	Easy
-1.00 ≤ b < 1.00	Keep
1.00 < b ≤ 2.00	Difficult
b > 2.00	Very difficult

(Sari & Mahmudi, 2024)

The value of the separation of items and persons shows the quality of the instrument and the quality of students into several groupings. Strata separation is a formula used to examine the grouping in more detail, as presented in Formula (1).

$$H = \frac{[(4 \times Separation) + 1]}{3} \quad \text{..... (1)}$$

The difference in the question can be analyzed through the SE model value; less than 0.5 indicates that the difference power of the item is good, while if the value is between 0.5 – 1, the difference power is categorized as capable enough to distinguish and if the value of the Standard Model Error is greater than 1, then the difference is bad or unable to distinguish (Purniasari et al., 2021).

FINDINGS AND DISCUSSION

Wright Map Analysis (*Person-Item Map*)

The analysis of literacy problems of reading and numeracy based on the AKM in plant and animal bioprocess materials can be comprehensively described in Rasch modelling through Wright's map, as shown in Figure 2. The distribution of students' ability level in answering questions on the left and the distribution of difficulties in reading literacy and numeracy based on AKM is on the right side (Boone, 2016; Hikmah et al., 2021; Rusiyah et al., 2020).

The distance between M-S-T (mean, ISD and 2SD) in Figure 2 shows the difficulty levels of the various questions, from the most difficult questions to the easiest questions to do (Hasanah & Aini, 2025; Sumintono & Widhiarso, 2015). This is in line with the opinion of Jimam et al. (2021) that the item located at the top is the category of questions with the highest level of difficulty, as well as the subject with the highest order, which is considered the best ability among

the others. This indicates that test instruments can provide useful information about the level of reading literacy and numeracy skills that students have. The M-S-T distance on the Wright map also states that the distribution of students' abilities is wider than the distribution of the difficulty level of the questions (Sumintono & Widhiarso, 2015; Uba & Khairani, 2024). This shows that the literacy skills of 63 students are very different. The spread is shown in Figure 2.

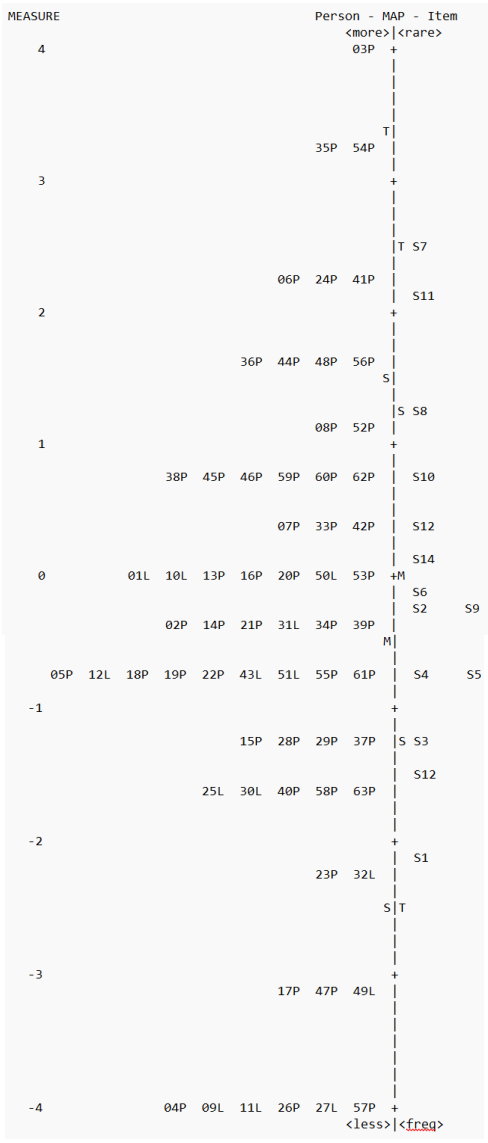

Figure 2. Wright Map

The distribution of students' abilities is analyzed by logit measurements, as we know the value of 0.0 is the average value of logit as a standard of student ability and the difficulty level of the item. Based on the map, it can be seen that the most difficult item is number 7, which is at the top of the map. 03P students have the highest logit score, which is +4.00, where students can answer the most difficult questions, namely S7. Item S7 is a question of reading literacy at the cognitive level, evaluating and reflecting with indicators of assessing the accuracy of information sources. Then, the other item with a high difficulty level is item 11. Item 11 is a numeracy problem on reasoning competence with indicators assessing the statements given using number operations (integers, decimals, and percents). Thus, it is diagnosed that the student has a high ability. This was followed by two respondents whose ability level was below 4, who were able to answer almost all difficult questions.

The logit value of almost all students is still below 0.0, showing that students' reading and numeracy literacy skills towards plant and animal bioprocess materials are still low, as shown by their inability to answer the S7 and S11 items. Four students 04P, 09L, 11L, 17P, 23P, 26P, 27L, 32L, 47P, 49L and 57P with the lowest or lower ability than the -2SD deviation were categorized as outliers. The eleven students were unable to do questions in the low category, namely S1, so they needed extra attention in understanding the text, literacy, reading and numeracy information, as well as understanding the concept of plant and animal bioprocesses. In fact, item S1 is classified as low competence (finding information) with indicators of finding explicit information about osmosis observations in potatoes. It can be described that the probability of 03P students agreeing to all questions on the question item is greater than 50%, while the student with the lowest ability shows the probability of agreeing to all questions below 50%. Based on the data, there is a spread of items and subjects with a logit value ranging from +4 to -4.

Many students continue to face difficulties with basic literacy skills, as reflected in their generally low performance levels. Sartika and Mukhlis (2023) found that 68% of high school and vocational students in Pekanbaru are still operating at a basic cognitive level in both literacy and numeracy. This suggests that a large number of students struggle to comprehend informational texts and perform fundamental mathematical tasks.

Student Ability Analysis: *Person Measure* and *Person Fit*

ENTRY NUMBER	TOTAL SCORE	TOTAL COUNT	JMLE MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD	PTMEASUR-AL CORR.	PTMEASUR-AL EXP.	EXACT MATCH OBS%	EXACT MATCH EXP%	Person
3	14	14	4.58	1.88	MAXIMUM MEASURE				.00	.00	100.0	100.0	03P
35	13	14	3.22	1.10	1.31	.63	1.28	.66	.09	.31	92.9	92.8	35P
54	13	14	3.22	1.10	1.35	.66	1.71	.89	.02	.31	92.9	92.8	54P
6	12	14	2.30	.85	.76	-.33	.40	-.36	.60	.41	92.9	86.2	06P
24	12	14	2.30	.85	1.01	.20	.59	-.07	.46	.41	78.6	86.2	24P
41	12	14	2.30	.85	.48	-1.09	.24	-.67	.74	.41	92.9	86.2	41P
36	11	14	1.67	.74	.48	-1.39	.31	-.98	.80	.46	92.9	82.6	36P
44	11	14	1.67	.74	.82	-.32	1.08	.36	.52	.46	92.9	82.6	44P
48	11	14	1.67	.74	1.00	.14	.67	-.22	.51	.46	78.6	82.6	48P
56	11	14	1.67	.74	.82	-.32	1.08	.36	.52	.46	92.9	82.6	56P
8	10	14	1.17	.68	1.28	.83	1.07	.31	.34	.49	64.3	78.6	08P
52	10	14	1.17	.68	1.56	1.45	1.79	1.30	.09	.49	64.3	78.6	52P
38	9	14	.73	.65	1.06	.28	1.02	.19	.46	.50	71.4	75.1	38P
45	9	14	.73	.65	1.24	.82	1.26	.68	.34	.50	71.4	75.1	45P
46	9	14	.73	.65	.93	-.13	1.00	.15	.53	.50	85.7	75.1	46P
59	9	14	.73	.65	1.24	.82	1.26	.68	.34	.50	71.4	75.1	59P
60	9	14	.73	.65	.79	-.63	.74	-.47	.64	.50	85.7	75.1	60P
62	9	14	.73	.65	.64	-1.25	.53	-1.09	.75	.50	85.7	75.1	62P
7	8	14	.33	.62	.96	-.07	1.13	.45	.50	.49	78.6	72.3	07P
33	8	14	.33	.62	.70	-1.14	.63	-.95	.70	.49	92.9	72.3	33P
42	8	14	.33	.62	1.40	1.41	1.31	.85	.24	.49	50.0	72.3	42P
30	3	14	-1.68	.71	.99	.10	.72	-.08	.41	.37	71.4	79.9	30L
40	3	14	-1.68	.71	1.29	.84	2.33	1.42	.02	.37	85.7	79.9	40P
58	3	14	-1.68	.71	.83	-.37	.62	-.22	.50	.37	85.7	79.9	58P
63	3	14	-1.68	.71	1.07	.32	.96	.24	.32	.37	85.7	79.9	63P
23	2	14	-2.25	.81	1.06	.28	.66	.07	.33	.32	85.7	85.7	23P
32	2	14	-2.25	.81	1.06	.28	.66	.07	.33	.32	85.7	85.7	32L
17	1	14	-3.10	1.08	1.20	.50	1.38	.71	.05	.23	92.9	92.8	17P
47	1	14	-3.10	1.08	.71	-.13	.26	-.30	.46	.23	92.9	92.8	47P
49	1	14	-3.10	1.08	.71	-.13	.26	-.30	.46	.23	92.9	92.8	49L
4	0	14	-4.42	1.86	MINIMUM MEASURE				.00	.00	100.0	100.0	04P
9	0	14	-4.42	1.86	MINIMUM MEASURE				.00	.00	100.0	100.0	09L
11	0	14	-4.42	1.86	MINIMUM MEASURE				.00	.00	100.0	100.0	11L
26	0	14	-4.42	1.86	MINIMUM MEASURE				.00	.00	100.0	100.0	26P
27	0	14	-4.42	1.86	MINIMUM MEASURE				.00	.00	100.0	100.0	27L
57	0	14	-4.42	1.86	MINIMUM MEASURE				.00	.00	100.0	100.0	57P
MEAN	6.1	14.0	-.50	.83	.99	.00	.98	.09			77.8	77.0	
P.SD	3.7	.0	1.96	.39	.30	1.02	.57	.90			13.1	7.0	

Figure 3. The Result of the Person Measure Table

The result of the Person Measure table in Figure 3 shows students' logit value, where there is a standard deviation (SD) value of 1.96 with a logit average of -0.50. Kurli et al. (2021), Sumintono and Widhiarso (2015), and Tyas et al. (2020) agree that standard deviation values can be used as a reference for grouping students' abilities. From the logical value of 63 students, only six people exceeded the SD value, so it can be interpreted that there are students who have a high level of reading and numeracy literacy skills in plant and animal bioprocess materials. Students with the highest ability are 3P, who get a logical value of 4.58 by doing all the correct questions, while students with a logical value in the range of 0-1.96 are included in the category of medium ability, such as students 36P, 44P, 48P, 56P, 08P, 52P, and 42P. Students who get a log score below 0.0 are categorized as having low abilities, such as 30L, 40P, 58P to 57P.

Figure 3 shows the analysis of Person Fit Order data to identify individuals who have inappropriate response patterns, meaning that some answers do not match when compared to their abilities and ideal models. Besides, Figure 3 is useful for evaluating the consistency of students' thinking and detecting if there is cheating committed by students (Nurjanah et al., 2024; Sumintono & Widhiarso, 2015). Based on the results of Rasch's modeling, 87.5% of students had a response pattern that matched the model, but 12.5% of students had a pattern that did not match the model because they did not meet the criteria for the person fit indicator, namely the MNSQ value received: 0.5 < MNSQ < 1.5, the ZSTD value received: -2.0 < ZSTD < +2.0, and the Pt Mean Corr received: 0.4 < Pt Measure Corr < 0.85. Two of them that meet the model criteria can be said to be person fit (Sari & Mahmudi, 2024). The value of the three outfit criteria that exceeded the criteria showed a discrepancy between the response patterns of students and the ideal model, and this was beyond the accepted limits (Dwinata, 2019). It can be seen that subjects 3P, 08P, 35P, and 24P have a good match with the infit and oufit values of MNSQ that are close to one and are considered to be in accordance with the Rasch model. Likewise, subjects 47P and 49L are said to have undesirable behavior in the RA model (Chan et al., 2014). The information about unusual response patterns can be seen more clearly in Figure 4.

Scalogram Analysis

The scalogram table in Figure 4 provides information on the consistency of the answers given by students (Sumintono, 2018). The result of the analysis is as follows.

```
GUTTMAN SCALOGRAM OF RESPONS
Person |Item
       | 1      111 1
       |12345296430817
       |--------------
     3 +11111111111111  03P
    35 +11111111101111  35P
    54 +11111111011111  54P
     6 +11111111111010  06P
    24 +11111111110101  24P
    41 +11111111111100  41P
    36 +11111111111000  36P
    44 +11110111111100  44P
    48 +11111111101001  48P
    56 +11110111111100  56P
     8 +11111101010101  08P
    52 +11011001111110  52P
    38 +11111101010001  38P
    45 +11011001111100  45P
    46 +11011110111000  46P
    59 +11011001111100  59P
    60 +11110111101000  60P
    62 +11111101110000  62P
     7 +11111101000001  07P
    33 +11110111100000  33P
    42 +11001010111100  42P
     1 +11111110000000  01L
    10 +11111110000000  10L
    13 +11000011110010  13P
```

Figure 4. Scalogram

The students who have the highest ability are 3P by answering questions with a maximum score, which means that the students have reading and numeracy literacy skills, as well as a good understanding of plant and animal bioprocess concepts. Students 46P and 59P are considered inattentive because they cannot solve easy problems, but are able to solve some problems with a higher level of difficulty, so it is concluded that they do not work seriously. 1L and 10L students have the same response pattern, thus there are indications of mutual cheating in filling out reading literacy and numeracy test instruments based on AKM on plant and animal bioprocess materials (Ngadi, 2023; Yulianto & Widodo, 2020). Rationally, if students are able to answer difficult questions, they should be able to answer easy to difficult questions, and conversely, if students are not able to answer easy questions, they should not be able to answer questions with a high level of difficulty (Lestari & Samsudin, 2020; Rosiqoh & Suhendi, 2021).

Analysis of the Suitability Level of Question Items (*Item Fit*)

Item fit provides information to evaluate the extent to which the item fits the measurement objective on the test. The results of the fit items in the Rasch modelling can be seen in Figure 5.

ENTRY NUMBER	TOTAL SCORE	TOTAL COUNT	JMLE MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD	PTMEASUR-AL CORR.	PTMEASUR-AL EXP.	EXACT MATCH OBS%	EXACT MATCH EXP%	Item
11	10	63	2.07	.42	1.22	.90	1.62	1.03	A .37	.48	85.7	86.3	S11
3	39	63	-1.22	.33	1.40	2.43	1.42	1.15	B .45	.60	67.9	75.5	S3
9	29	63	-.20	.31	1.17	1.27	1.25	1.01	C .51	.57	62.5	72.3	S9
5	35	63	-.80	.32	1.11	.85	1.24	.84	D .53	.59	66.1	72.5	S5
1	46	63	-2.08	.38	1.17	.80	.94	.08	E .57	.61	82.1	83.2	S1
2	30	63	-.30	.31	1.10	.76	.99	.06	F .55	.58	71.4	72.2	S2
14	26	63	.09	.32	.89	-.81	1.10	.45	G .60	.57	76.8	73.3	S14
8	16	63	1.19	.36	1.00	.08	1.09	.36	g .51	.52	78.6	80.3	S8
13	23	63	.40	.32	.92	-.49	.99	.05	f .58	.56	80.4	74.9	S12
10	20	63	.72	.33	.90	-.60	.90	-.24	e .58	.54	82.1	76.6	S10
7	8	63	2.46	.46	.86	-.42	.50	-.55	d .52	.45	91.1	88.7	S7
6	28	63	-.11	.31	.76	-1.89	.62	-1.66	c .67	.57	78.6	72.4	S6
4	35	63	-.80	.32	.75	-2.03	.60	-1.49	b .69	.59	80.4	72.5	S4
12	41	63	-1.44	.34	.71	-1.91	.52	-1.31	a .71	.60	85.7	77.5	S12
MEAN	27.6	63.0	.00	.35	1.00	-.07	.98	-.01			77.8	77.0	
P.SD	10.9	.0	1.25	.04	.20	1.28	.33	.91			7.9	5.3	

Figure 5. Item Fit Order

The fit order item indicator shows that S20 is in the misfit category (0.5 < MNSQ < 1.5), but the ZSTD and Pt Measure Corr models are in the fit category, so the S11 question is still maintained as an instrument to measure reading literacy and numeracy skills based on AKM in high school plant and animal bioprocessing materials. The outfit value of ZSTD items S7 and S10 is in the misfit category, namely -0.24 and -0.55, which are not included in the range of 2.0 < ZSTD < +2.0, but the MNSQ and Pt Mean Corr outfits meet the criteria so that the item can be said to be fit. Based on these results, all items analyzed using Rasch were in the *fit* category. In Rasch's modelling, if an item or question item is considered invalid because it does not meet all three criteria, then the question item needs to be changed, replaced or eliminated (Susilowati et al., 2023; Ridzuan et al., 2020). Referring to Sudihartinih and Wahyudin (2019), the value of Pt. Mean Corr also has a symbol +/-, which means that if it is positive, then the item really measures its construction, and if it has a negative value, the item must be discarded or perfected, which is indicated because it is too easy or difficult. If you look at the results of the data above, all the Pt. Mean Corr question items are positive, so nothing must be deleted or revised.

The difficulty index analysis can also be seen in Figure 5, which is in the JMLE Measure column, showing the logit value of the difficulty level from very easy to very difficult (Sumintono & Widhiarso, 2015). The analysis results show that the question items having a logic value of > 2.00 are included in the very difficult category, namely S7 and S11. Question items with difficult

categories are found in item S8, and the medium difficulty category is in items S2, S4, S5, S6, S9, S10, S12, and S14. Items S3 and S12 are included in the easy category since they are in the range of -2.00 ≤ b < -1.00. The question that has a very low category is S1 with a logic value of < -2.00.

The differentiation of the question, or in Rasch's modelling, is called the discriminating power of question items, which explains how good the level of the question is to be able to compare individuals who have high and low abilities (Bagiyono, 2017; Sumintono & Widhiarso, 2015). The difference in the question can be seen in the column of the S.E. model in Figure 5, which shows all values < 0.5, indicating that all questions have good item differences.

Instrument Analysis

The overall analysis of the instruments on Rasch modelling provides information about the quality of students' response patterns, the quality of instruments, and the interactions between responses and items. The person measure value of -0.50 logit shows the average score of 63 students who answered the question items.

SUMMARY OF 63 MEASURED (EXTREME AND NON-EXTREME) Person

	TOTAL SCORE	COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
MEAN	6.1	14.0	-.50	.83				
SEM	.5	.0	.25	.05				
P.SD	3.7	.0	1.96	.39				
S.SD	3.7	.0	1.98	.39				
MAX.	14.0	14.0	4.58	1.88				
MIN.	.0	14.0	-4.42	.61				
REAL RMSE	.95	TRUE SD	1.72	SEPARATION	1.81	Person RELIABILITY	.77	
MODEL RMSE	.92	TRUE SD	1.73	SEPARATION	1.89	Person RELIABILITY	.78	
S.E. OF Person MEAN = .25								

Person RAW SCORE-TO-MEASURE CORRELATION = .98
CRONBACH ALPHA (KR-20) Person RAW SCORE "TEST" RELIABILITY = .84 SEM = 1.48
STANDARDIZED (50 ITEM) RELIABILITY = .93

SUMMARY OF 14 MEASURED (NON-EXTREME) Item

	TOTAL SCORE	COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
MEAN	27.6	63.0	.00	.35	1.00	-.07	.98	-.01
SEM	3.0	.0	.35	.01	.05	.36	.09	.25
P.SD	10.9	.0	1.25	.04	.20	1.28	.33	.91
S.SD	11.4	.0	1.29	.04	.20	1.33	.34	.94
MAX.	46.0	63.0	2.46	.46	1.40	2.43	1.62	1.15
MIN.	8.0	63.0	-2.08	.31	.71	-2.03	.50	-1.66
REAL RMSE	.36	TRUE SD	1.19	SEPARATION	3.29	Item RELIABILITY	.92	
MODEL RMSE	.35	TRUE SD	1.20	SEPARATION	3.44	Item RELIABILITY	.92	
S.E. OF Item MEAN = .35								

Figure 6. Summary of Measured Person and Item

The average value of students' ability that is less than the item measure 0.00 logit indicates that the students' literacy ability is less than the difficulty level of the question item. In general, reliability analysis is seen from the SPSS application in the form of Cronbach's alpha output, which only provides an overview of the state of the test without assessing the constraints that occur either on the item or the subject; it can be interpreted by Rasch modelling, showing the reliability of the item and the subject (Tesio et al., 2024). The person reability value of 0.77 and the item reability of 0.92 (Figure 6) depict that the consistency of students' answers in solving

reading literacy and numeracy questions according to the level of difficulty is sufficient, and the question items quality used as an instrument to collect data on reading literacy and numeracy skills based on AKM on high school plant and animal bioprocessing materials is very good. The alpha Cronbach value of 0.84 indicates that the interaction between students' reading literacy and numeracy skills and the overall question items is very high. For this reason, it is interpreted that the question items developed at the number of items that are in accordance with different levels of cognitive levels and the range of students' abilities are diverse (high-low) (Chan et al., 2014).

The separation value indicates the quality of the instrument and the quality of the students (Finbråten et al., 2018). The higher the separation value, the better, as it can identify groups of students (those who are capable and those who are not) and groups of questions (difficult and easy) (Dwinata, 2019; Syadiah & Hamdu, 2020). Leeming and Wong (2016) believe that the separation value has a varying range from zero to unlimited, where a higher separation value indicates that the items are well distributed across all levels of difficulty and are acceptable. Based on Figure 6, the person separation value is 1.81, resulting in a stratum value of 3. This indicates that there are three levels of reading and numeracy literacy among students in the subject matter of plant and animal bioprocesses: high, moderate, and low. The item separation value is 3.92, resulting in a stratum value of 5, meaning that five item groups were detected. Based on the aforementioned statements, it can be evaluated that the developed test items are acceptable and implementable.

CONCLUSION

The test instruments that have been developed have a fit grain quality because they meet the criteria in Rasch modeling with the help of Winstep software that has been determined. The results of the Wright Map show that only one student is above the 0.0 logit scale, which is 3P, by answering all 14 questions. Based on the data, there is a spread of items and subjects with a logit value ranging from +4 to -4. Based on the person measure table, the 3P students with the highest logit value are categorized as having high ability in reading and numeracy literacy, as well as understanding the concept of plant and animal bioprocesses, as indicated by the logit value > a standard deviation value of 1.96. In addition, the results of the analysis on the scalogram image showed that students 1L, 10L, 46P, and 59P did not work on the problem seriously because they were not able to do easy problems, but were able to do problems with a higher level of difficulty.

Based on the results of the validity, the 14 questions developed are in the fit (valid) category because they meet two or all of the MNSQ, ZSTD, and Pt Measure Corr standard values. The question items as a whole have excellent quality for measuring reading literacy and numeracy skills based on AKM on high school plant and animal bioprocess materials, as shown by the item reliability value (0.92). The person's reliability value is 0.77, which states that the consistency of students' answers in solving reading literacy and numeracy problems according to the level of difficulty is sufficient. Thus, it can be concluded that the interaction between reading literacy and numeracy skills possessed by students and the overall question items is very high, which is seen in the alpha Cronbach value, which is 0.84. Question items based on the level of difficulty, including two items in the very difficult category, two others in the difficult category, eight items with medium difficulty, two easy questions, and one item for the very easy category. It can be concluded that overall, the items of reading literacy and numeracy based on AKM on plant and animal bioprocess materials in high school can measure what is to be measured.

Further research can implement AKM-based reading and numeracy literacy test instruments on plant and animal bioprocess materials, so as to evaluate the overall basic literacy abilities of high school students in Pekanbaru City. Therefore, the contribution of this research in the world of educational assessment produces a set of reading and numeracy literacy questions on plant and animal bioprocess materials that can be used throughout schools to train or hone and measure students' reading literacy and numeracy skills, as well as as a guideline for the use of instruments by educators and other researchers in developing AKM-based questions.

DISCLOSURE STATEMENT

The authors declare that they have no conflict of interest to disclose.

FUNDING STATEMENT

This research was independently funded by the author and did not receive funding from any agency, sponsor, or institution.

ETHICS APPROVAL

The research participants in this study were anonymized, all data collected during the study were used only for the purpose of research, and it is guaranteed that the results of the study will not cause any harm to the research participants.

REFERENCES

Aisah, H., Zaqiah, Q. Y., & Supiana, A. (2021). Implementasi kebijakan asesmen kemampuan minimum (AKM): Analisis implementasi kebijakan AKM). *Al-Affan Journal of Islamic Education, 1*(2), 128–135. https://doi.org/10.69775/jpia.v1i2.25

Andrich, D., & Marais, I. (2019). A course in Rasch measurement theory. Springer Singapore.

Bagiyono. (2017). Analisis tingkat kesukaran dan daya pembeda butir soal ujian pelatihan radiografi tingkat 1. *Widyanuklida, 16*(1), 1–12. https://lib.ui.ac.id/detail?id=20470998&lokasi=lokal

Boone, W. J. (2016). Rasch analysis for instrument development: Why, when, and how? *CBE Life Sciences Education, 15*(4). https://doi.org/10.1187/cbe.16-04-0148

Cahyana, A. (2020). Prospek AKM dan survei karakter: Memperkuat basis praliterasi dan pranumerasi usia dini. *Banpaudpnf Kemendikbud, 1*(1), 1–4.

Chan, S. W., Ismail, Z., & Sumintono, B. (2014). A Rasch model analysis on secondary students' statistical reasoning ability in descriptive statistics. *Procedia - Social and Behavioral Sciences, 129*, 133–139. https://doi.org/10.1016/j.sbspro.2014.03.658

Dwinata, A. (2019). Analisis kemampuan pemecahan masalah menggunakan pemodelan RASCH pada materi permutasi dan kombinasi. In *Prosiding Seminar Nasional Matematika*, 2, 124–131. https://journal.unnes.ac.id/sju/prisma/article/view/28899

Fazilah, N., Azhari, T., & Ardesi, R. P. (2023). Dampak penggunaan Wattpad terhadap kemampuan literasi membaca siswa SMA negeri. *Jurnal Ilmiah Pendidikan Bahasa dan Sastra Indonesia, 4*(2), 255-262. https://doi.org/10.29103/jk.v4i2.13448

Finbråten, H. S., Wilde-Larsson, B., Nordström, G., Pettersen, K. S., Trollvik, A., & Guttersrud, Ø. (2018). Establishing the HLS-Q12 short version of the European Health Literacy Survey Questionnaire: Latent trait analyses applying Rasch modelling and confirmatory factor analysis. *BMC Health Services Research, 18*(1), 1-17. https://doi.org/10.1186/s12913-018-3275-7

Fiskha, S. D., & Heswari, S. (2022). Analisis kemampuan numerasi siswa kelas VIII SMP se-Kota Sungai Penuh dalam menyelesaikan soal AKM. *Jurnal Muara Pendidikan, 7*(2), 232-237. https://doi.org/10.52060/mp.v7i2.919

Hasanah, H., & Aini, F. Q. (2025). Pengembangan instrumen tes keterampilan proses sains pada topik kesetimbangan kimia: Analisis dengan model Rasch. *JagoMIPA: Jurnal Pendidikan Matematika dan IPA, 5*(1), 68–82. https://doi.org/10.53299/jagomipa.v5i1.1043

Hikmah, F. N., Sukarelawan, Moh. I., Nurjannah, T., & Djumati, J. (2021). Elaboration of high school student's metacognition awareness on heat and temperature material: Wright map in Rasch model. *Indonesian Journal of Science and Mathematics Education, 4*(2), 172–182. https://doi.org/10.24042/ijsme.v4i2.9488

Jacob, E, R., Duffield, C., & Jacob, A, M. (2019). Validation of data using Rasch analysis in a tool measuring changes in critical thinking in nursing students. *Nurse Education Today, 76*, 196-199. https://doi:10.1016/j.nedt.2019.02.012

Jimam, N. S., Ismail, N. E., Dangiwa, D. A., Dapar, M. L. P., Sariem, C. N., Paul, L. A., Mohammed, S. G., & Dayom, D. W. (2021). Use of Rasch Wright map to understand the quality of Healthcare Workers' Knowledge, Attitudes, and Practices for Uncomplicated Malaria (HKAPIUM). *Journal of Pharmacy & Bioresources, 18*(3), 237–244. https://doi.org/10.4314/jpb.v18i3.8

Kurli, H., Haliqah, N., & Anekawati, A. (2021). Analisis kemampuan kognitif siswa pada mata pelajaran IPA SMP menggunakan Rasch model. *Journal of Medical Entrepreneurs, 1*(2), 74-79. https://doi.org/10.55748/bjel.v3i2.133

Leeming, P., & Wong, A. (2016). Using dictation to measure language proficiency: A Rasch analysis. *Papers in Language Testing and Assessment, 5*(2), 1-25. https://doi.org/10.58379/mbsw8958

Lestari, A. S., & Samsudin, A. (2020). Using Rasch model analysis to analyze students' scientific literacy on heat and temperature. In *Proceedings of the 7th Mathematics, Science, and Computer Science Education International Seminar (MSCEIS) 2019,* 1-8. https://doi.org/10.4108/eai.12-10-2019.2296483

Mardiani, N., & Wahyuni, S. (2022). Implementasi Gerakan Literasi Sekolah (GLS) sebagai upaya meningkatkan keterampilan membaca dan menulis di SMA Negeri 3 Batusangkar. *JIPIS: Jurnal Ilmu Perpustakaan dan Informasi Islam, 1*(1), 8-14. https://doi.org//10.31958/jipis.v1i1.5946

Mawaddah, Y. (2020). *Penggunaan model discovery learning dengan metode praktikum terhadap peningkatan partisipasi dan hasil belajar siswa pada materi sel di MAS Nurul Islam Blang Rakal*. Undergraduate Thesis, UIN Ar-Raniry Banda Aceh, Aceh. https://repository.ar-raniry.ac.id/id/eprint/11217/

Meriana, T., Murniarti, E., & Dasar Kanaan, S. (2021). Analisis pelatihan asesmen kompetensi minimum. *Journal of Educational Dynamics, 14*(2), 110-116. https://doi.org/10.51212/jdp.v14i2.7

Millah, E. S., Budipramana, L. S., & Isnawati. (2012). Pengembangan buku ajar materi bioteknologi di kelas XII SMA IPIEMS Surabaya berorientasi Sains, Teknologi, Lingkungan, dan Masyarakat (SETS). Berkala Ilmiah Pendidikan Biologi (BioEdu), 1(1), 19-24. https://ejournal.unesa.ac.id/index.php/bioedu/article/view/344

Ministry of Education and Culture. (2020). *AKM dan implikasinya pada pembelajaran*. Centre for Assessment and Learning of the Research and Development Agency and Books of the Ministry of Education and Culture.

Ngadi, N. (2023). Analisis model Rasch untuk mengukur kompetensi pengetahuan siswa SMKN 1 Kalianget pada mata pelajaran perawatan sistem kelistrikan sepeda motor. *Jurnal Pendidikan Vokasi Otomotif, 6*(1), 1-19. https://doi.org/10.21831/jpvo.v6i1.63479

Novita, N., Mellyzar, M., & Herizal, H. (2021). Asesmen Nasional (AN): Pengetahuan dan persepsi calon guru. *JISIP (Jurnal Ilmu Sosial dan Pendidikan), 5*(1), 172-179. https://doi.org/10.36312/jisip.v5i1.1568

Nurjanah, W. L., Sari, I. M., & Saepuzaman, D. (2024). Analisis pemahaman konsep peserta didik pada topik perambatan kalor menggunakan Rasch model. *Didaktika: Jurnal Kependidikan, 13*(2), 1361-1374. https://jurnaldidaktika.org/contents/article/view/442

OECD. (2019). *PISA 2018 assessment and analytical framework*. OECD. https://doi.org/10.1787/b25efab8-en

Qisthi, C. U., Abidin, Z., & Sulistyono, S. (2023). Pengembangan instrumen literasi numerasi biologi pada pembelajaran IPA dalam materi sistem pernapasan pada manusia. *Jurnal Ilmiah Wahana Pendidikan, 9*(22), 191-202. https://doi.org/10.5281/zenodo.10096812

Pereira, J., Tang, J., Soares, B., Prihandini, R, M., & Wijaya, T, T. (2022). Exploring the accuracy of mathematics students on the final semester assessment based on Racsh model analysis in Timor-Leste. In *Proceedings of the 2nd International Conference on Emerging Technologies and Intelligent Systems*, 416-425. https://doi.org/10.1007/978-3-031-20429-6_38

Purniasari, L., Masykuri, M., Sri, D., & Ariani, R. D. (2021). Analisis butir soal ujian sekolah mata pelajaran kimia SMA N 1 Kutowinangun tahun pelajaran 2019/2020 menggunakan model iteman dan Rasch. *Journal of Chemistry Education, 10*(2), 205–214. https://doi.org/10.20961/jpkim.v10i2.48244

Ridzuan, M. F., Lim, H. L., Ahmad Fozee, F. A., & Mohd Nasser, S. N. A. (2020). Rasch analysis model: Reliability and validity of superitem test instrument. *International Journal of Academic Research in Progressive Education and Development, 9*(4), 1-11. https://doi.org/10.6007/ijarped/v9-i4/8166

Rifqiawati, I., Ratnasari, D., Wahyuni, I., & Juwita, I. S. (2020). Penerapan biomagazine sebagai bahan ajar biologi terhadap literasi membaca dan motivasi belajar siswa kelas X di SMA Negeri 7 Pandeglang. *Biodidaktika: Jurnal Biologi dan Pembelajarannya, 15*(1), 87-93. http://dx.doi.org/10.30870/biodidaktika.v15i1.8205

Rintarti, E. W., & Dwi, M. K. (2021). Pengaruh model problem based learning berbantuan software Cabri 3D V2 terhadap kemampuan literasi numerasi siswa. *Jurnal Cendekia: Jurnal Pendidikan Matematika, 5*(2), 1687-1699. https://doi.org/10.31004/cendekia.v5i2.690

Rigianti, H. A., & Utomo, A. C. (2022). Asesmen kompetensi minimum ranah literasi membaca dan implikasinya di sekolah dasar. *Jurnal Education and Development, 11*(1), 133–137. https://doi.org/10.37081/ed.v11i1.4254

Rijal, M. M., & Imron, A. (2020). Strategi kepala sekolah dalam meningkatkan literasi membaca siswa di SMA Negeri 1 Kota Kediri. *Indonesian Journal of Islamic Education Studies, 3*(1), 16-30. https://doi.org/10.33367/ijies.v3i1.1138

Rizki, I. M., Suhendar, S., & Nuranti, G. (2022). Profil kemampuan literasi numerasi peserta didik SMA pada pembelajaran biologi kelas XII pada materi evolusi. *BIODIK: Jurnal Ilmiah Pendidikan Biologi, 8*(3), 36-42. https://online-journal.unja.ac.id/biodik/article/view/18978

Rokhim, D. A., Rahayu, B. N., Alfiah, L. N., Peni, R., Wahyudi, B., Wahyudi, A., Sutomo, S., & Widarti, H. R. (2021). Analisis kesiapan peserta didik dan guru pada asesmen nasional (Asesmen kompetensi minimum, survey karakter, dan survey lingkungan belajar). *Jurnal Administrasi dan Manajemen Pendidikan, 4*(1), 61-71. https://doi.org/10.17977/um027v4i12021p61

Rosidah, D. M., & Sabtiawan, W. B. (2024). Profil keterampilan berpikir tingkat tinggi siswa SMP pada materi ekosistem. *JIIC: Jurnal Intelek Insan Cendikia, 1*(7), 2893-2900. https://jicnusantara.com/index.php/jiic/article/view/997

Rosiqoh, R., & Suhendi, E. (2021). Using Rasch model analysis to analyse students' mastery of concept on Newton law. *Journal of Physics: Conference Series, 1731*(1), 1-6. https://doi.org/10.1088/1742-6596/1731/1/012077

Rusiyah, R., Eraku, S., & Supadmi, S. (2020). Analysis of geography subject final semester exam questions using Rasch modeling. *Swarnabhumi Journal, 5*(1), 11-18. https://doi:10.31851/swarnabhumi.v5i1.4136

Sari, E. D. K., & Mahmudi, I. (2024). *Buku analisis pemodelan Rasch pada asesmen pendidikan*. PT. Persada Kerta Utama Pen.

Sartika, S., & Mukhlis, M. (2023). Higher order thinking skills pada soal AKM literasi membaca di SMK Pertanian Pekanbaru. *GERAM (Gerakan Aktif Menulis), 11*(1), 39–47. https://doi.org/10.25299/geram.2023.vol11(1).12151

Sensus, M., Arifin, K., & Munir, A. (2022). Validitas soal pada asesmen kompetensi minimum materi ekologi SMA kelas X. Wahana Bio: Jurnal Biologi dan Pembelajarannya, 14(1), 1-10. https://ppjp.ulm.ac.id/journal/index.php/wb/article/view/14013

Sudihartinih, E., & Wahyudin, W. (2019). Analysis of students' self efficacy reviewed by geometric thinking levels and gender using Rasch model. *Journal of Engineering Science and Technology, 14*(1), 509-519. https://jestec.taylors.edu.my/Vol%2014%20issue%201%20February%202019/14_1_35.pdf

Sumintono, B. (2018). Rasch model measurements as tools in assessment for learning. *Advances in Social Science, Education and Humanities Research, 173*, 38-41. https://doi:10.2991/icei-17.2018.11

Sumintono, B., & Widhiarso, W. (2015). Aplikasi pemodelan Rasch pada asesmen pendidikan. Trim Komunikata.

Susilowati, N. I., Liliawati, W., & Rusdiana, D. (2023). Science process skills test instruments in the new Indonesian curriculum (Merdeka): Physics subject in renewable energy topic. *Indonesian Journal of Teaching in Science, 3*(2), 121–132. https://doi.org/10.17509/ijotis.v3i2.60112

Syadiah, A. N., & Hamdu, G. (2020). Analisis Rasch untuk soal tes berpikir kritis pada pembelajaran STEM di sekolah dasar. *Premiere Educandum: Jurnal Pendidikan Dasar dan Pembelajaran, 10*(2), 138-148. https://doi.org/10.25273/pe.v10i2.6524

Tesio, L., Caronni, A., Kumbhare, D., & Scarano, S. (2024). Interpreting results from Rasch analysis 1. The "most likely" measures coming from the model. *Disability and Rehabilitation, 46*(3), 591–603. https://doi.org/10.1080/09638288.2023.2169771

Tyas, E. H., Hamdu, G., & Pranata, O. H. (2020). Analisis soal pilihan ganda dengan menggunakan pemodelan RASCH untuk mengukur kemampuan siswa dalam mengurutkan bilangan pecahan di sekolah dasar. *Scientific Journal of Elementary School Teacher Education, 7*(2), 1-12. https://doi.org/10.17509/pedadidaktika.v7i2.24773

Uba, A. R., & Khairani, A. Z. (2024). Assessing item reliability, differential item functioning, and Wright map analysis of the GSP122 test at a public university in Nigeria. *Journal of Education for Sustainable Innovation, 2*(2), 107–120. https://doi.org/10.56916/jesi.v2i2.934

Widhiarso, B. S. (2013). *Aplikasi model RASCH untuk penelitian ilmu-ilmu sosial*. Trim Komunikata Publishing House.

Yulianto, A., & Widodo, A. (2020). Disclosure of difficulty distribution of HOTS-based test questions through Rasch modeling. *Indonesian Journal of Primary Education, 4*(2), 197–203. https://doi.org/10.17509/ijpe.v4i2.29318