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Analysis of Students' Chemical Literacy on Class X Electrolyte and Non-Electrolyte Solutions at SMAN 2 Batang Anai

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A B S T R A C T

The evaluation results on electrolyte and non-electrolyte solution materials at SMAN 2 Batang Anai still have not reached the Minimum Completeness Criteria (KKM). As many as 50% of the 130 students are still incomplete in the evaluation of learning on electrolyte and non-electrolyte solutions, so it is necessary to evaluate students so that the teacher knows the causes of students' scores being below the KKM. This study aims to analyze the chemical literacy level of class X students of SMAN 2 Batang Anai in electrolyte and non-electrolyte solution materials using the Rasch model with the Ministep application according to the level of scientific literacy developed by Bybee. This research is a descriptive research with a quantitative approach with a sample of 75 students. The results showed that students in class X SMAN 2 Batang Anai dominated at 2 levels of chemical literacy, namely nominal scientific literacy (52%) and functional scientific literacy (44%). Rasch analysis shows that 96% of students have a negative measurement value with an average student measurement value of -2.63 logit. This shows that the ability of students' chemical literacy in electrolyte and non-electrolyte solution materials is relatively low.

1. Introduction

Chemical literacy is part of scientific literacy. According to the Program for International Student Assessment (PISA), scientific literacy is the ability to connect issues related to science and scientific ideas (OECD, 2009). One of the problems of science education in Indonesia is the low scientific literacy of students. The low ability of students' scientific literacy is proven by the results of the 2018 PISA survey which shows that the level of achievement of scientific literacy of students in Indonesia is still below the average of the Organization for Economic Cooperation and Development (OECD) (OECD, 2018), this proves that the quality of science learning in Indonesia still needs to be improved.

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Chemistry is a science that plays an important role in improving the quality of education and in everyday life. However, chemistry is still a difficult subject to understand both in terms of concept and application (Priliyanti et al., 2021). Studying chemistry is very important because all of our living environment is influenced by chemistry and is filled with products from materials that contain chemical compounds (Gilbert & Treagust, 2009). The abstract characteristic of chemistry causes chemistry to be a difficult subject for most students. In general, students have difficulty connecting abstract chemistry with situations experienced in everyday life (Sirhan, 2007).

Chemical materials that are closely related to everyday life, one of which is the material of electrolyte and non-electrolyte solutions. This is reinforced by the opinion Masyida (2018) that many chemicals used in everyday life can conduct electricity and some cannot conduct electricity. Based on the results of an analysis of the Learning Implementation Plan (RPP) and teaching materials used by class X teachers of SMAN 2 Batang Anai on the material for electrolyte and non-electrolyte solutions, there is already a link between the material and its application in everyday life. By associating learning material with everyday life, the expected learning outcomes are more meaningful for students. However, based on the evaluation results on electrolyte and non-electrolyte solution materials at SMAN 2 Batang Anai, there are still many who have not reached the Minimum Completeness Criteria (KKM). As many as 50% of the 130 students have not yet completed the learning evaluation on electrolyte and non-electrolyte solutions, so it is necessary to analyze the chemical literacy of the students so that the teacher knows the causes of students' scores being below the KKM.

Meaningful learning for students can be achieved if students have good chemical literacy (Fitriani et al., 2014). Studying chemistry is not only about learning content contained in textbooks. In order for learning to be effective, students must be able to apply chemical knowledge in everyday life and be involved in activities involving chemical problems (Thummathong & Thathong, 2018). Learning by linking chemistry with the context of life can increase students' chemical literacy (Magwilang, 2016).

Students are said to have chemical literacy skills if they are able to apply chemical concepts learned at school to natural phenomena that occur in everyday life, so that students can solve problems that occur in everyday life based on scientific considerations. (Imansari & Sumarni, 2011). According to Shwartz et al., (2005), someone who has chemical literacy skills uses his understanding of chemistry in making decisions and solving problems in everyday life. The ability of students' chemical literacy is very important so that the quality of education in Indonesia can increase, because if students' chemical literacy is low, then the quality of education in Indonesia is also low, and vice versa (Pratiwi et al., 2019).

Analysis of measuring the chemical literacy of students at SMAN 2 Batang Anai has never been done, especially on the material for electrolyte and non-electrolyte solutions. Measurement of chemical literacy is carried out to determine students' understanding of chemistry in explaining phenomena that occur in everyday life as well as students' ability to apply chemistry to solve problems and make decisions (Hayat, 2010).

Based on the results of an interview with a class X chemistry teacher at SMAN 2 Batang Anai, evaluation or exams for chemistry subjects have never assessed students' chemical literacy abilities. Chemistry subject teachers do not know the causes of the low evaluation results on students because they have not yet gotten an overview of the level of understanding of students (Fausan & Pujiastuti, 2017). So it is necessary to do an analysis of student literacy mapping so that teachers know the causes of low evaluation results.

Mapping chemical literacy using test instruments that have been developed by Nisa & Yusmaita (2022) that is as many as 17 items. The 17 items are questions that are constructed using aspects of chemical literacy which include aspects of content, context, High Order Learning Skills (HOLS), and attitudes. The 17 questions have been tested for validity, reliability, index of difficulty and differentiation. Based on the tests that have been carried out, the instrument produces chemical literacy questions on electrolyte and non-electrolyte solutions that are "valid" with a value of 0.99 and "reliable" with a value of 0.88. The level of difficulty of the chemical literacy items for electrolyte and non-electrolyte solutions belongs to 4 groups, namely very difficult, difficult, easy and very easy. As for the different power of the items belonging to 3 groups, namely high, medium and low ability students.

Analysis of students' chemical literacy using chemical literacy-based items can be done using item response theory (IRT) called the Rasch model. The Rasch modeling fulfills the objective measurement requirements so that it can provide measurement precision and accuracy. The advantage of the Rasch Model compared to other methods, especially in classical test theory, is that it can predict missing data from individual response patterns. The Rasch model is able to see whether the ratings or rating options used are clear or confusing to respondents (Sumintono, Bambang dan Widhiarso, 2014). Analisis tersebut dilakukan dengan menggunakan aplikasi Ministep (Ardiyanti, 2017). Assessment of the chemical literacy level of students uses the scientific literacy level adapted by Shwartz et al., (2006) which consists of five levels: 1) Scientific illiteracy; 2) Nominal scientific literacy; 3) Functional scientific literacy; 4) Conceptual scientific literacy; 5) Multidimensional scientific literacy. This study aims to analyze the chemical literacy level mapping of class X students of SMAN 2 Batang Anai on electrolyte and non-electrolyte solutions using the Rasch model.

2. Methodology

The type of research used in this research is descriptive with a quantitative approach. Descriptive research is research conducted by digging up information about existing symptoms, articulating the goals to be achieved, planning how to achieve them, and collecting various data as a source of reporting. (Jayusman & Shavab, 2020).

Sample

The subjects in this study were class XI MIPA students at SMAN 2 Batang Anai. The sampling technique used is simple random sampling. The sample to be used in this study is 75 students.

Research Instruments

The research instrument used in this study was chemical literacy-based items on electrolyte and non-electrolyte solutions that had been developed by Nisa & Yusmaita (2022). The instrument consists of 5 question themes which are developed into 13 questions in the form of essay questions. Theme one is about electrolyte and non-electrolyte solutions based on their electrical conductivity, themes two and three are about types of electrolyte solutions, theme four is about ionization reactions in electrolyte solutions, and theme five is about ionic compounds and polar covalent compounds in electrolyte solutions. The tests carried out on students used the chemical literacy test answer rubric that had been developed previously.

Data analysis

The data analysis technique in this study used the Rasch model using the Ministep application. The outputs used in the Ministep application are Person measure, Person fit, Scalogram and Wright Map.

1. The person measure displays a table detailing the logit information of each individual.
2. Person fit displays subjects sequentially that have response patterns that do not fit.
3. The Wright map displays a map that illustrates the distribution of student abilities and the level of difficulty of an item with the same scale.

3. Results and Discussion

Each item of chemical literacy questions developed by Nisa & Yusmaita (2022) has an answer rubric with a score that corresponds to each description of the level of chemical literacy developed by Bybee. Each question item/item is given a specific label or name to shorten the mention. For example, question/item number 1 in theme 1 is labeled i1.1, for question/item number 1 in theme 2 is labeled i2.1, and so on. Based on the results of the chemical literacy test that has been carried out, the score obtained for each item is obtained. The results of the analysis of chemical literacy test items at SMAN 2 Batang Anai can be seen in Figure 1.

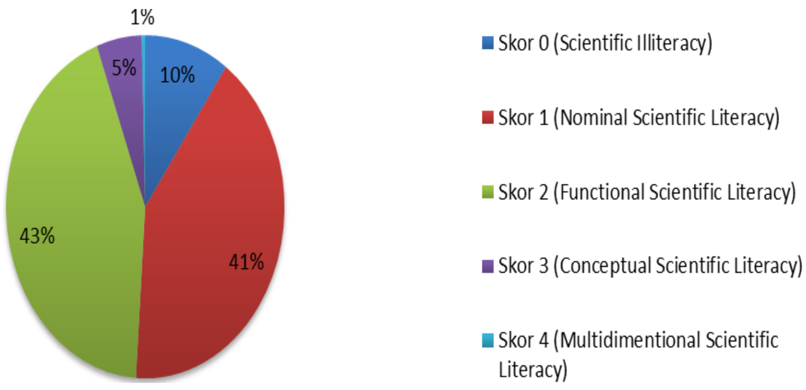

Figure 1. Mapping of Chemical Literacy Levels

It is known that as many as 10% of students get a score of 0, namely at the level of scientific illiteracy. As many as 41% of students got a score of 1, namely at the nominal level of scientific literacy. As many as 43% of students got a score of 2, namely at the level of functional scientific literacy. As many as 5% of students got a score of 3, namely at the conceptual scientific literacy level. As many as 1% of students got a score of 4, namely at the multidimensional scientific literacy level. It can be concluded that class X students of SMAN 2 Batang Anai dominate scores 1 and 2 on the chemical literacy test. Figure 2 is an example of students' answers to chemical literacy-based questions on electrolyte and non-electrolyte solutions:

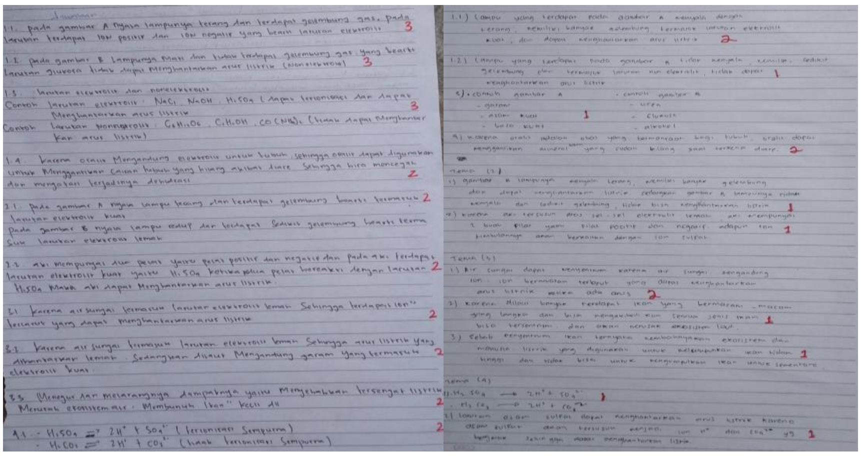

Figure 2. Student Answers

Based on these answers, it is known that students' answers in answering questions are still very limited so that most of the student answers get a value of 1 or 2. The items demand to analyze the causes of electrolyte solutions being able to conduct electric current. However, only a few students were able to connect the explanation of the answers obtained from the previous item or the information contained in the question discourse. Research data were analyzed using the Rasch model with the Misitep application. Based on the research results, the following results were obtained.

1. Person Measures

Based on the chemical literacy-based item answer rubric, the maximum raw score is 52. For students who get a perfect raw score, it can be concluded that they understand the material for electrolyte and non-electrolyte solutions on the chemical literacy test well, but how far does the participant's understanding students on the material of electrolyte and non-electrolyte solutions is unknown. Likewise with students who answered the chemical literacy test questions that received a score of 0, it can be seen that students did not know the material for electrolyte and non-electrolyte solutions on the test, but how little students' understanding of the material for electrolyte and non-electrolyte solutions is also unknown. . Information about the results of the person measure data analysis can be seen in the table 1.

Person measure data analysis shows that the higher the student's person measure score on a test, indicates that the student has a higher achievement. The measure column states the ability level of students in logit units. Student 11P in Table 1 has the highest person measure value of the other students, namely +4.18. 69L students have the lowest person measure value of -4.82.

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Table 1. Person Measure Data Analysis

Subject	Raw Score	Measure value
11P	38/52	4,18
01P	33/52	2,54
22L	27/52	-0,03
43P	25/52	-0,69
38P	24/52	-1,00
16P	23/52	-1,30
06P	22/52	-1,61
24P	21/52	-1,93
02L	20/52	-2,26
36P	19/52	-2,60
17P	18/52	-2,94
27L	17/52	-3,28
03P	16/52	-3,61
32P	15/52	-3,39
21P	14/52	-4,23
09L	13/52	-4,53
69L	12/52	-4,82

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Comparison of students' chemical literacy abilities can be seen through the person measure value. Subjects 11P and 01P had a difference in measure value of 1.64, while subjects 22L and 43P had a difference in measure value of 0.66, meaning that between 11P and 01P and 22L and 43P had different chemical literacy abilities. Through the difference in measure values, it was found that there was almost 2 times the difference in the level of chemical literacy obtained between subjects 11P and 01P, namely 1.64 logit with 22L and 43P, namely 0.66 logit, as well as for other subjects.

It can be concluded that the measure value can be used as a benchmark to determine the chemical literacy level of class X students of SMAN 2 Batang Anai in the material of electrolyte and non-electrolyte solutions. The higher the measure value obtained, the higher the chemical literacy of students.

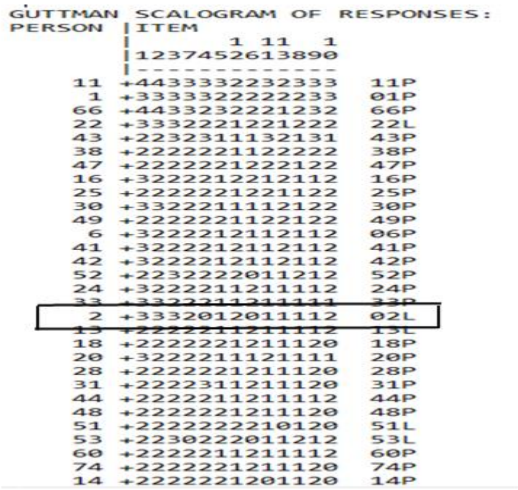
2. Person Fit

Analysis of person fit data can sequentially bring up subjects who have unfit criteria with inappropriate MNSQ infit and outfit values. Information on MNSQ infit and outfit values can be seen in table 2.

Table 2. Percentage of MNSQ Infit and Output Value

Infit and Outfit MNSQ	Percentage
>1,5	15%
<0,5	22%

The existence of inappropriate MNSQ infit and outfit values showed that 37% of the student population in this study had inappropriate response behavior. One of the subjects who had an inappropriate MNSQ infit and outfit response was 02L with an infit value of 3.28 and an outfit value of 4.53, these two values prove that the subject's response pattern does not match the expectations of the Rasch model, can be seen in Figure 3, Subject 02L's answer pattern gets 1 point on question number 2.2 which is more difficult than question 2.1, but 02L gets a score of 0 on question 2.1 which is relatively easy.



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GUTTMAN SCALOGRAM OF RESPONSES:
PERSON |ITEM
       |      1 11  1
       |12374526138 90
       |--------------
    11 +44333322232333  11P
     1 +33333222222233  01P
    66 +44332322221232  66P
    22 +33322221221222  22L
    43 +22323111132131  43P
    38 +22222221122222  38P
    47 +22222221222122  47P
    16 +32222122212112  16P
    25 +22222221221122  25P
    30 +33222211112122  30P
    49 +22222221122122  49P
     6 +32222121112112  06P
    41 +32222121112112  41P
    42 +32222121112112  42P
    52 +22322222011212  52P
    24 +32222112111112  24P
    33 +[illegible]     33P
     2 +33320120111112  02L
    13 +[illegible]     13L
    18 +22222221211120  18P
    20 +32222111121111  20P
    28 +22222221211120  28P
    31 +22223112111120  31P
    44 +22222112111112  44P
    48 +22222221211120  48P
    51 +22222222210120  51L
    53 +22302222011212  53L
    60 +22222112111112  60P
    74 +22222221211120  74P
    14 +22222221201120  14P
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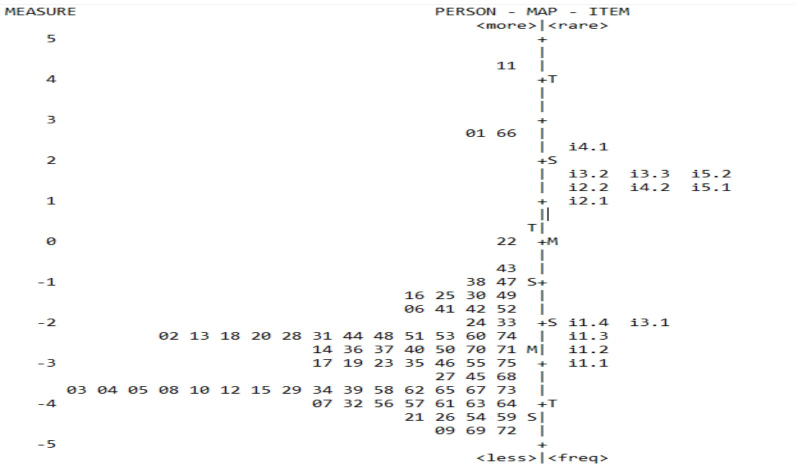
Figure 3. Scalograms

Figure 2 is a scalogram illustrating responses or items where the items are sorted by level of difficulty from left to right (easiest to most difficult), as well as subjects sorted by ability from top to bottom (from high to low).

3. Wright Map

The Wright map describes the distribution of students' abilities and the level of difficulty of an item with the same scale. The Wright map can be seen in Figure 4.



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MEASURE                                 PERSON - MAP - ITEM
                                             <more>|<rare>
   5                                               +
                                                   |
                                              11   |
   4                                               +T
                                                   |
                                                   |
   3                                               +
                                           01 66   |
                                                   |  i4.1
   2                                               +S
                                                   |  i3.2  i3.3  i5.2
                                                   |  i2.2  i4.2  i5.1
   1                                               +  i2.1
                                                   ||
                                                  T|
   0                                          22   +M
                                                   |
                                              43   |
  -1                                       38 47  S+
                                     16 25 30 49   |
                                     06 41 42 52   |
  -2                                       24 33   +S i1.4  i3.1
               02 13 18 20 28 31 44 48 51 53 60 74  |  i1.3
                              14 36 37 40 50 70 71 M|  i1.2
  -3                          17 19 23 35 46 55 75  +  i1.1
                                        27 45 68   |
       03 04 05 08 10 12 15 29 34 39 58 62 65 67 73 |
  -4                          07 32 56 57 61 63 64  +T
                                     21 26 54 59  S|
                                        09 69 72   |
  -5                                               +
                                             <less>|<freq>
```

Figure 4. Wright Map

On the left side of the Wright map is a map of students' abilities, while the map to the right of the Wright map is the level of difficulty of the test items. The easiest items are located at the bottom of the Wright map, while the most difficult items are located at the top, as well as for people who have the lowest ability are at the bottom of the Wright map while those with high level abilities are located at the very top.

Based on the results of the Wright map analysis, it was found that person 11 had the highest chemical literacy ability because he was able to answer questions up to the highest literacy level, namely Multidimensional scientific literacy. While persons 09, 69, and 72 are subjects with the lowest chemical literacy abilities. Person 01 and 66 have the same logit value (+2.54) meaning that both subjects have the same chemical literacy ability. Logit values above +2 indicate the subject has good abilities, logit +1 indicates the subject has medium abilities, while a logit value of -1 indicates the subject has low abilities (Ibnu et al., 2019). Research on chemical literacy analysis of class X students of SMAN 2 Batang Anai dominates score 1, which is 52%.

4. Conclusion

Conclusion Based on the results of the chemical literacy test, it is known that class X students of SMAN 2 Batang Anai dominate at 2 levels of chemical literacy, namely, nominal scientific literacy and functional scientific literacy. This shows that the chemical literacy of some class X students of SMAN 2 Batang Anai in the material of electrolyte and non-electrolyte solutions is classified as low. In order to improve chemical literacy skills, it is advisable to conduct research on learning models, methods and media that can be implemented to increase students' chemical literacy levels.

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