Quality Of Algebra Questions to Measure Mathematical Literacy Ability Using Partial Credit Model

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Abstract

Mathematical literacy skills require someone to understand, analyze, interpret, evaluate, and synthesize knowledge obtained from the problems faced by modeling them into appropriate solutions in solving a problem effectively. The need to develop questions according to students' daily problems can familiarize students with mathematical literacy. The research developed mathematical literacy test questions on tobacco farming in the Puger Jember area to measure students' mathematics literacy abilities at the high school level. The research method used is Research and Development (R&D) using the Thiagarajan model, which is modified into three stages: definition, planning, and development. Field trial results were analyzed using Ministep software with Rasch modeling using the Partial Credit Model (PCM) method. The results obtained from the ten questions developed can be said to be fit; with the reliability of 139 interactions between students and the question items, the quality is still poor, and 75 students' interactions between students and the question items are of good quality. The item reliability of the literacy questions developed was 0.80 in the first 75 samples, 0.95 in the following 75 samples, and 0.89 in the last 64 samples, indicating that the questions developed were excellent and could measure students' abilities well.

INTRODUCTION

Mathematical literacy is the ability of each individual to reason mathematically to formulate, use, and interpret mathematical knowledge related to problems in everyday life (Dinni, 2018; OECD, 2021). Mathematical literacy is an idea or notion that defines part of the mathematical knowledge and competencies needed in personal and social life to participate in the community as citizens who can apply, reflect, and contribute (Geiger & Dole, 2012). Mathematical literacy is the ability of each individual to reason mathematically to formulate, use, and interpret mathematical knowledge related to problems in everyday life (Fajriyah, 2018; OECD, 2021). Every individual can use literacy skills to face problems related to mathematics using appropriate strategy selection (Muslimah & Pujiastuti, 2020; Maharani, 2022). Mathematical literacy is about assigning material and using reasoning, concepts, facts, and mathematical tools to solve everyday problems (Genc & Erbas, 2019; Moschkovich, 2015; Sari, 2015; Sitopu et al, 2024). Someone who understands sorting out mathematical concepts relevant to the problems will have good mathematical literacy (Setiawan et al., 2014; Kusumawardani et al., 2018). In this case, the government supports education development for the benefit of the nation and state in the future by involving countries in taking literacy skills tests.

As a member country of the OECD, Indonesia has participated in establishing PISA since 2000 (Stacey, 2011). The latest data on the average score of the 2018 PISA test in the field of science shows that Indonesian students obtained an average score of 379, which is down from the previous one in the fifth round in 2015 was 402 (Balitbang, 2018). Indonesia is at the lowest level among several participating countries in the world. One of the reasons is students' limitations regarding literacy questions; they rarely give similar questions (Ate & Lede, 2022). Research conducted by Kurniati shows that students' ability to solve PISA questions shows that out of 30 students across several junior high schools in Jember Regency, 18 could carry out logical reasoning, analysis, evaluation, and creation well. The researcher suggests adding literacy questions at school, and it is also challenging to create instruments related to mathematical literacy (Kurniati et al., 2016).

The development of literacy questions in this research questions on algebra material, a branch of mathematics that studies structure, relationship, and quantity as a means of simplification and as a tool that helps solve problems (Hidayani, 2021). The development of questions in this research uses an agricultural theme around the students' environment, in line with Mardiyah's opinion that the use of themes found in real life allows students to find meaningful relationships with abstract ideas and their application to real-life problems (Mardiyah et al., 2021). Considering that there are still no students' mathematical literacy questions on algebra material on the theme of tobacco farming that can measure students' mathematical literacy abilities, Technology, and science are developing very rapidly, accompanied by information processing in such a way that it is causing changes in human lifestyle which is the third wave (Cintamulya, 2012)

The theme of tobacco farming in the Puger Jember area is the current conditions of society and can cause problems in real life (Bakker, 2018). The theme of tobacco farming is related to the mathematical literacy context, namely societal, with material that will be developed in the test questions, namely algebra, as part of the mathematical literacy content, namely change and relationship with competencies using the three different clusters according to PISA. Based on the description above, it can be seen that there is a need to develop mathematical literacy questions to measure students' literacy abilities. The development of questions in this research is aimed at upper-secondary students. Using the partial credit model, the questions that have been prepared can explain the quality of the questions, which can later be used to measure students' mathematical literacy abilities.

METHODS

Mathematical literacy questions on algebra material were tested on 214 research subjects. Research on students was carried out because they had studied algebra material. The selected research subjects had various levels of mathematical literacy abilities. The first step in using the Partial Credit Model (PCM) is a summary. Prepare raw data from algebra test results with different maximum scores. Then, the raw data from Excel will be formatted into prn. Next, the data will be explained using the Ministep application. The final step is to interpret the quality of the algebra mathematical literacy question instrument. The following summary of the research method can be seen in the figure 1.
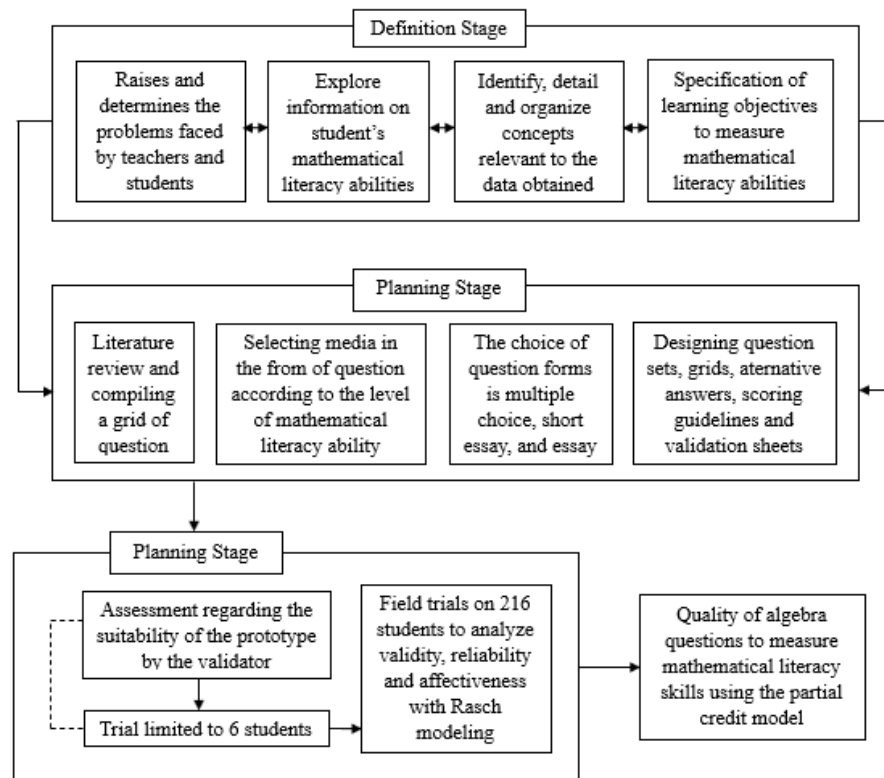
Figure 1. Research Procedure

Measure

Items are checked based on the following conditions.
1) OutfitMean Square ($MNSQ$) value received $0,5 < MNSQ < 1,5$;
2) valueAccepted Outf it Z-Standardcarrefour $-2,0 < ZSTD < +2,0$;Point Meaure correlfourn value $0 you 4 < Pt\ Measure < 0,85$.
(Bambang Sumintono, 2015)

Statistical Analysis

The test questions in this study were evaluated based on reliability, validity, descriptive statistics, and the Rasch modeling index. The assessment focuses on checking items by considering the ease of identifying sources of anxiety during measurement (Harvani et al., 2023). Literacy test questions were examined based on Cronbach's alpha value, item reliability, and separation index. By looking at Cronbach's alpha value, item reliability, and person reliability, information can be obtained that shows the quality of the instrument's reliability. ZSTD Clothing, MNSQ Score Clothing, and Pt Mean Coor will indicate the validity of the test instrument. The results of measuring mathematical literacy abilities can be seen through the separation value.

RESULTS & DISCUSSION

Activities began with limited trials and field trials. Limited trials were tested on a limited basis on 6 class XI students of SMA Negeri 1 Kencong, and field trials were carried

out on 216 class XI students of SMA Negeri 1 Kencong. The purpose of conducting limited trials is to measure the readability of the questions.

Meanwhile, field trials aim to measure the reliability and validity of the questions and their effectiveness. The ten questions are arranged according to indicators of students' level of mathematical literacy abilities. The problems in this test are presented by students' daily problems around tobacco farming. The developing agricultural theme requires students to know the importance of literacy skills for their future progress. What they need to know about making cigars made from Puger Jember tobacco leaves includes the planting process, land area, fertilizer required, workers, overall costs, and sales in the form of algebraic mathematics, which is very useful for them in the future.

Raw scores will be processed according to scoring guidelines. The student scores obtained will be input and processed with the help of Ministep software to predict students' mathematical literacy abilities in completing the given agricultural theme literacy test. This program will analyze using Rasch modeling. The Summary Statistics table displays all information related to the quality of the instruments used and the subjects' quality.

Validity Analysis

Field trial results were analyzed using Ministep software with Rasch modeling and the Partial Credit Model (PCM) method. Validity analysis is the first carried out; three questions meet the three validity criteria. The rest only meet two and one criterion, but the items can still be said to be fit because they meet one criterion. The following is information about the fit of a question item.

```
TABLE 13.1 DATA 1-75                          ZOU969WS.TXT  Dec 21 2023 19:25
INPUT: 75 Person  10 Item  REPORTED: 75 Person  10 Item  2 CATS MINISTEP 5.6.3.0
--------------------------------------------------------------------------------
Person: REAL SEP.: .00  REL.: .00 ... Item: REAL SEP.: 1.83  REL.: .77

         Item STATISTICS:  MEASURE ORDER

-------------------------------------------------------------------------------
|ENTRY   TOTAL  TOTAL    JMLE   MODEL|  INFIT  |  OUTFIT  |PTMEASUR-AL|EXACT MATCH|        |
|NUMBER  SCORE  COUNT  MEASURE   S.E. |MNSQ  ZSTD|MNSQ  ZSTD|CORR.  EXP.| OBS%  EXP%| Item |
|------------------------------------+----------+----------+-----------+-----------+------|
|    3      1     75    67.51   11.26|1.46   .75| .71   .24| .21   .29| 97.1  97.1| S3   |
|    6      1     75    67.51   11.26|1.33   .63| .32  -.20| .27   .29| 97.1  97.1| S6   |
|    7      1     75    67.51   11.26|1.33   .63| .32  -.20| .27   .29| 97.1  97.1| S7   |
|    9      1     75    67.51   11.26| .40  -.63| .05  -.87| .44   .29| 97.1  97.1| S9   |
|   10      1     75    67.51   11.26| .40  -.63| .05  -.87| .44   .29| 97.1  97.1| S10  |
|    1      4     75    48.33    6.04| .96   .05|1.19   .49| .45   .45| 91.4  90.5| S1   |
|    8      5     75    45.01    5.48|1.06   .28|1.62  1.09| .42   .48| 88.6  87.8| S8   |
|    2     13     75    28.73    3.95| .99   .02|1.00   .08| .63   .63| 74.3  73.3| S2   |
|    4     14     75    27.20    3.89| .79 -1.28| .71 -1.09| .72   .64| 71.4  71.7| S4   |
|    5     23     74    13.17    3.96|1.17  1.20|1.59  1.19| .68   .74| 67.6  67.8| S5   |
|------------------------------------+----------+----------+-----------+-----------+------|
| MEAN    6.4   74.9    50.00    7.96| .99   .10| .76  -.01|           | 87.9  87.6|      |
| P.SD    7.3    .3     19.72    3.36| .35   .72| .55   .75|           | 11.4  11.4|      |
-------------------------------------------------------------------------------
```

Figure 2. Suitability of Question Items

1) Questions S1, S2, and S4 meet the criteria for Outfit MNSQ, Oufit ZSTD, and Pt Mean Corr
2) Question S3 meets the criteria for Outfit MNSQ and Oufit ZSTD
3) Questions S5, S8, S9 and S10 meet the Oufit ZSTD and Pt Mean Corr criteria
4) Questions S6 and S7 meet the Oufit ZSTD criteria

So, all the questions are categorized as fit questions, and no questions need to be changed or replaced.

Reliability Analysis

Reliability shows that the value for the first 75 students is 0.61; this shows that the interaction between students and the questions is still poor. The next 75 students showed a value of 0.81, which means that the quality of the interaction between students and the questions was excellent. In comparison, the following 64 students had a value of <0.5, which shows that the quality of the interaction between students and the questions was still poor. The following is a summary of field trial statistics.

```
TABLE 3.1 DATA 1-75                           ZOU969WS.TXT  Dec 21 2023 19:25
INPUT: 75 Person  10 Item  REPORTED: 75 Person  10 Item  2 CATS MINISTEP 5.6.3.0
-------------------------------------------------------------------------------

       SUMMARY OF 35 MEASURED (NON-EXTREME) Person
-------------------------------------------------------------------------------
|          TOTAL                     MODEL      INFIT       OUTFIT     |
|          SCORE    COUNT   MEASURE   S.E.    MNSQ  ZSTD   MNSQ  ZSTD  |
|-----------------------------------------------------------------------------|
| MEAN      1.8     10.0     23.15   11.16    .97  -.06    .75   .00   |
| SEM        .2      .0       2.03     .22    .11   .17    .18   .13   |
| P.SD      1.2      .2      11.82    1.30    .64  1.01   1.08   .78   |
| S.SD      1.2      .2      11.99    1.32    .65  1.03   1.09   .79   |
| MAX.      7.0     10.0     65.86   12.30   3.07  2.66   5.01  2.87   |
| MIN.      1.0      9.0     13.92    8.13    .32 -1.52    .15  -.80   |
|-----------------------------------------------------------------------------|
| REAL RMSE  12.58 TRUE SD    .00  SEPARATION  .00  Person RELIABILITY  .00 |
|MODEL RMSE  11.23 TRUE SD   3.67  SEPARATION  .33  Person RELIABILITY  .10 |
| S.E. OF Person MEAN = 2.03                                                |
-------------------------------------------------------------------------------

Person RAW SCORE-TO-MEASURE CORRELATION = .98 (approximate due to missing data)
CRONBACH ALPHA (KR-20) Person RAW SCORE "TEST" RELIABILITY = .61  SEM = .77
STANDARDIZED (50 ITEM) RELIABILITY = .00

       SUMMARY OF 10 MEASURED (NON-EXTREME) Item
-------------------------------------------------------------------------------
|          TOTAL                     MODEL      INFIT       OUTFIT     |
|          SCORE    COUNT   MEASURE   S.E.    MNSQ  ZSTD   MNSQ  ZSTD  |
|-----------------------------------------------------------------------------|
| MEAN      6.4     74.9     50.00    7.96    .99   .10    .76  -.01   |
| SEM       2.4      .1       6.57    1.12    .12   .24    .18   .25   |
| P.SD      7.3      .3      19.72    3.36    .35   .72    .55   .75   |
| S.SD      7.7      .3      20.79    3.54    .37   .76    .58   .80   |
| MAX.     23.0     75.0     67.51   11.26   1.46  1.20   1.62  1.19   |
| MIN.      1.0     74.0     13.17    3.89    .40 -1.28    .05 -1.09   |
|-----------------------------------------------------------------------------|
| REAL RMSE   9.45 TRUE SD  17.32  SEPARATION 1.83  Item  RELIABILITY  .77 |
|MODEL RMSE   8.64 TRUE SD  17.73  SEPARATION 2.05  Item  RELIABILITY  .81 |
| S.E. OF Item MEAN = 6.57                                                  |
-------------------------------------------------------------------------------

TABLE 3.1 DATA 76-150                         ZOU093WS.TXT  Dec 13 2023 19:43
INPUT: 75 Person  10 Item  REPORTED: 75 Person  10 Item  2 CATS MINISTEP 5.6.3.0
-------------------------------------------------------------------------------

       SUMMARY OF 33 MEASURED Person
-------------------------------------------------------------------------------
|          TOTAL                     MODEL      INFIT       OUTFIT     |
|          SCORE    COUNT   MEASURE   S.E.    MNSQ  ZSTD   MNSQ  ZSTD  |
|-----------------------------------------------------------------------------|
| MEAN      1.9     10.0     36.85   17.27    .70  -.30    .52  -.32   |
| SEM        .1      .0       3.78     .35    .28   .20    .30   .23   |
| P.SD       .8      .0      21.36    1.95   1.57  1.15   1.72  1.32   |
| S.SD       .8      .0      21.70    1.98   1.59  1.17   1.74  1.34   |
| MAX.      3.0     10.0     64.52   19.37   7.52  4.86   9.90  6.76   |
| MIN.      1.0     10.0     13.14   14.65    .13  -.94    .07  -.78   |
|-----------------------------------------------------------------------------|
| REAL RMSE  20.23 TRUE SD   6.86  SEPARATION  .34  Person RELIABILITY  .10 |
|MODEL RMSE  17.38 TRUE SD  12.43  SEPARATION  .72  Person RELIABILITY  .34 |
| S.E. OF Person MEAN = 3.78                                                |
-------------------------------------------------------------------------------
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```
Person RAW SCORE-TO-MEASURE CORRELATION = 1.00
CRONBACH ALPHA (KR-20) Person RAW SCORE "TEST" RELIABILITY = .57  SEM = .72
STANDARDIZED (50 ITEM) RELIABILITY = .85

      SUMMARY OF 5 MEASURED Item
--------------------------------------------------------------------------------
|          TOTAL                      MODEL      INFIT        OUTFIT   |
|          SCORE    COUNT   MEASURE    S.E.    MNSQ   ZSTD   MNSQ   ZSTD |
|------------------------------------------------------------------------------|
| MEAN     12.6     75.0     50.00     7.63     .93   -.29   2.10    .48 |
|  SEM      5.6       .0     17.36     1.17     .12    .48    .69    .64 |
| P.SD     11.3       .0     34.72     2.33     .25    .95   1.38   1.29 |
| S.SD     12.6       .0     38.81     2.61     .28   1.06   1.54   1.44 |
| MAX.     31.0     75.0     87.14    10.26    1.13    .43   3.41   1.58 |
| MIN.      1.0     75.0     -4.39     5.01     .52  -1.97    .31  -1.35 |
|------------------------------------------------------------------------------|
| REAL RMSE   8.39 TRUE SD   33.69  SEPARATION  4.02  Item   RELIABILITY  .94 |
|MODEL RMSE   7.98 TRUE SD   33.79  SEPARATION  4.24  Item   RELIABILITY  .95 |
| S.E. OF Item MEAN = 17.36                                                   |
--------------------------------------------------------------------------------

TABLE 3.1 DATA 151-214                      ZOU656WS.TXT  Dec 15 2023 18:30
INPUT: 64 Person  10 Item  REPORTED: 64 Person  10 Item  2 CATS MINISTEP 5.6.3.0
--------------------------------------------------------------------------------

      SUMMARY OF 36 MEASURED (NON-EXTREME) Person
--------------------------------------------------------------------------------
|          TOTAL                      MODEL      INFIT        OUTFIT   |
|          SCORE    COUNT   MEASURE    S.E.    MNSQ   ZSTD   MNSQ   ZSTD |
|------------------------------------------------------------------------------|
| MEAN      1.1     10.0     30.43    20.68    1.01   -.19    .62   -.40 |
|  SEM       .0       .0      1.30      .36     .38    .18    .22    .14 |
| P.SD       .3       .0      7.69     2.15    2.24   1.05   1.31    .85 |
| S.SD       .3       .0      7.80     2.18    2.28   1.06   1.33    .87 |
| MAX.      2.0     10.0     55.92    21.33    7.24   2.46   4.20   1.77 |
| MIN.      1.0     10.0     28.11    13.54     .11   -.97    .07   -.79 |
|------------------------------------------------------------------------------|
| REAL RMSE  27.53 TRUE SD    .00  SEPARATION   .00  Person RELIABILITY  .00 |
|MODEL RMSE  20.79 TRUE SD    .00  SEPARATION   .00  Person RELIABILITY  .00 |
| S.E. OF Person MEAN = 1.30                                                  |
--------------------------------------------------------------------------------

  Person RAW SCORE-TO-MEASURE CORRELATION = 1.00
  CRONBACH ALPHA (KR-20) Person RAW SCORE "TEST" RELIABILITY = .00  SEM = .58
  STANDARDIZED (50 ITEM) RELIABILITY = .00

      SUMMARY OF 4 MEASURED (NON-EXTREME) Item
--------------------------------------------------------------------------------
|          TOTAL                      MODEL      INFIT        OUTFIT   |
|          SCORE    COUNT   MEASURE    S.E.    MNSQ   ZSTD   MNSQ   ZSTD |
|------------------------------------------------------------------------------|
| MEAN      9.8     64.0     50.00     7.89     .97    .24    .62   -.13 |
|  SEM      7.5       .0     14.71     1.48     .11    .17    .28    .32 |
| P.SD     12.9       .0     25.48     2.57     .19    .29    .48    .55 |
| S.SD     15.0       .0     29.43     2.97     .21    .34    .56    .64 |
| MAX.     32.0     64.0     70.61    10.46    1.26    .74   1.25    .67 |
| MIN.      1.0     64.0      8.20     5.31     .81    .04    .15   -.64 |
|------------------------------------------------------------------------------|
| REAL RMSE   8.41 TRUE SD   24.06  SEPARATION  2.86  Item   RELIABILITY  .89 |
|MODEL RMSE   8.30 TRUE SD   24.09  SEPARATION  2.90  Item   RELIABILITY  .89 |
| S.E. OF Item MEAN = 14.71                                                   |
--------------------------------------------------------------------------------
```

Figure 3. Summary Statistics

The reliability values of the respondents obtained showed that the first 75 students and the remaining 64 students were unreliable (Aprillia et al., 2021). Meanwhile, the item reliability of the numeracy questions developed was 0.80 in the first 75 samples, 0.95 in the following 75 samples, and 0.89 in the last 64 samples, indicating that the questions developed were excellent and could measure students' abilities well.

```
TABLE 13.1 DATA 1-75                           ZOU969WS.TXT  Dec 21 2023 19:25
INPUT: 75 Person  10 Item  REPORTED: 75 Person  10 Item  2 CATS MINISTEP 5.6.3.0
--------------------------------------------------------------------------------
Person: REAL SEP.: .00  REL.: .00 ... Item: REAL SEP.: 1.83  REL.: .77

        Item STATISTICS:  MEASURE ORDER

-------------------------------------------------------------------------------------
|ENTRY  TOTAL  TOTAL   JMLE   MODEL|  INFIT  |  OUTFIT  |PTMEASUR-AL|EXACT MATCH|      |
|NUMBER SCORE  COUNT  MEASURE  S.E. |MNSQ ZSTD|MNSQ ZSTD|CORR.  EXP.| OBS%  EXP%| Item |
|------------------------------------+---------+---------+-----------+-----------+------|
|    3     1     75   67.51  11.26|1.46  .75| .71  .24|  .21   .29| 97.1  97.1| S3   |
|    6     1     75   67.51  11.26|1.33  .63| .32 -.20|  .27   .29| 97.1  97.1| S6   |
|    7     1     75   67.51  11.26|1.33  .63| .32 -.20|  .27   .29| 97.1  97.1| S7   |
|    9     1     75   67.51  11.26| .40 -.63| .05 -.87|  .44   .29| 97.1  97.1| S9   |
|   10     1     75   67.51  11.26| .40 -.63| .05 -.87|  .44   .29| 97.1  97.1| S10  |
|    1     4     75   48.33   6.04| .96  .05|1.19  .49|  .45   .45| 91.4  90.5| S1   |
|    8     5     75   45.01   5.48|1.06  .28|1.62 1.09|  .42   .48| 88.6  87.8| S8   |
|    2    13     75   28.73   3.95| .99  .02|1.00  .08|  .63   .63| 74.3  73.3| S2   |
|    4    14     75   27.20   3.89| .79 -1.28| .71 -1.09|  .72   .64| 71.4  71.7| S4   |
|    5    23     74   13.17   3.96|1.17 1.20|1.59 1.19|  .68   .74| 67.6  67.8| S5   |
|------------------------------------+---------+---------+-----------+-----------+------|
| MEAN    6.4  74.9   50.00   7.96| .99  .10| .76 -.01|           | 87.9  87.6|      |
| P.SD    7.3   .3   19.72   3.36| .35  .72| .55  .75|           | 11.4  11.4|      |
-------------------------------------------------------------------------------------

TABLE 13.1 DATA 76-150                         ZOU093WS.TXT  Dec 13 2023 19:43
INPUT: 75 Person  10 Item  REPORTED: 75 Person  10 Item  2 CATS MINISTEP 5.6.3.0
--------------------------------------------------------------------------------
Person: REAL SEP.: .94  REL.: .47 ... Item: REAL SEP.: 2.27  REL.: .84

        Item STATISTICS:  MEASURE ORDER

-------------------------------------------------------------------------------------
|ENTRY  TOTAL  TOTAL   JMLE   MODEL|  INFIT  |  OUTFIT  |PTMEASUR-AL|EXACT MATCH|      |
|NUMBER SCORE  COUNT  MEASURE  S.E. |MNSQ ZSTD|MNSQ ZSTD|CORR.  EXP.| OBS%  EXP%| Item |
|------------------------------------+---------+---------+-----------+-----------+------|
|    3     0     75   99.79  18.12| MAXIMUM MEASURE  |  .00   .00|100.0 100.0| S3   |
|    7     0     75   99.79  18.12| MAXIMUM MEASURE  |  .00   .00|100.0 100.0| S7   |
|    8     0     75   99.79  18.12| MAXIMUM MEASURE  |  .00   .00|100.0 100.0| S8   |
|    9     0     75   99.79  18.12| MAXIMUM MEASURE  |  .00   .00|100.0 100.0| S9   |
|   10     0     75   99.79  18.12| MAXIMUM MEASURE  |  .00   .00|100.0 100.0| S10  |
|    1     1     75   87.14  10.26|1.13  .43|3.41 1.58|  .13   .22| 97.0  96.8| S1   |
|    6     1     75   87.14  10.26|1.13  .43|3.41 1.58|  .13   .22| 97.0  96.8| S6   |
|    5    12     75   47.50   5.08| .52 -1.97| .31 -1.35|  .79   .73| 93.9  84.4| S5   |
|    4    18     75   32.61   5.01| .77 -.74| .57 -.81|  .85   .82| 87.9  84.1| S4   |
|    2    31     75   -4.39   7.54|1.12  .39|2.81 1.38|  .84   .86| 93.9  93.8| S2   |
|------------------------------------+---------+---------+-----------+-----------+------|
| MEAN    6.3  75.0   74.90  12.87| .93 -.29|2.10  .48|           | 93.9  91.2|      |
| P.SD   10.2   .0   34.96   5.50| .25  .95|1.38 1.29|           |  3.3   5.8|      |
-------------------------------------------------------------------------------------

TABLE 13.1 DATA 151-214                        ZOU656WS.TXT  Dec 15 2023 18:30
INPUT: 64 Person  10 Item  REPORTED: 64 Person  10 Item  2 CATS MINISTEP 5.6.3.0
--------------------------------------------------------------------------------
Person: REAL SEP.: .00  REL.: .00 ... Item: REAL SEP.: 1.14  REL.: .57

        Item STATISTICS:  MEASURE ORDER

-------------------------------------------------------------------------------------
|ENTRY  TOTAL  TOTAL   JMLE   MODEL|  INFIT  |  OUTFIT  |PTMEASUR-AL|EXACT MATCH|      |
|NUMBER SCORE  COUNT  MEASURE  S.E. |MNSQ ZSTD|MNSQ ZSTD|CORR.  EXP.| OBS%  EXP%| Item |
|------------------------------------+---------+---------+-----------+-----------+------|
|    1     0     64   83.46  18.32| MAXIMUM MEASURE  |  .00   .00|100.0 100.0| S1   |
|    3     0     64   83.46  18.32| MAXIMUM MEASURE  |  .00   .00|100.0 100.0| S3   |
|    6     0     64   83.46  18.32| MAXIMUM MEASURE  |  .00   .00|100.0 100.0| S6   |
|    8     0     64   83.46  18.32| MAXIMUM MEASURE  |  .00   .00|100.0 100.0| S8   |
|    9     0     64   83.46  18.32| MAXIMUM MEASURE  |  .00   .00|100.0 100.0| S9   |
|   10     0     64   83.46  18.32| MAXIMUM MEASURE  |  .00   .00|100.0 100.0| S10  |
|    4     1     64   70.61  10.46| .81  .04| .15 -.64|  .30   .21| 97.2  97.2| S4   |
|    7     1     64   70.61  10.46| .81  .04| .15 -.64|  .30   .21| 97.2  97.2| S7   |
|    5     5     64   50.58   5.31|1.26  .74|1.25  .67|  .30   .39| 83.3  88.2| S5   |
|    2    32     64    8.20   5.34|1.00  .14| .92  .09|  .84   .84| 88.9  88.9| S2   |
|------------------------------------+---------+---------+-----------+-----------+------|
| MEAN    3.9  64.0   70.08  14.15| .97  .24| .62 -.13|           | 91.7  92.8|      |
| P.SD    9.5   .0   22.99   5.36| .19  .29| .48  .55|           |  5.9   4.3|      |
-------------------------------------------------------------------------------------
```

Figure 4. Logit measure

Analysis of the Difficulty Level of Questions

The logit value for each question has been sorted from highest to lowest and is presented in Figure 3. Item S10 has the highest logit value throughout the analysis of 214 samples, namely + 67.51, +99.79, +83.46. This value shows that question S10 is the most challenging question, followed by questions S3, S8, and S9. Figure 4.8 shows the distribution of scores on S10 questions. No students could answer the questions correctly, or 100% of students got a score of 0. Questions S2, S4, and S5 had the lowest relative logit values , with the lowest in question S2, namely -4.39. This value shows that these three questions are the most straightforward questions students can answer. Of the 214 students, 147 of them were able to solve the three questions correctly.

```
TABLE 13.1 DATA 1-75                         ZOU969WS.TXT  Dec 21 2023 19:25
INPUT: 75 Person  10 Item  REPORTED: 75 Person  10 Item  2 CATS MINISTEP 5.6.3.0
-----------------------------------------------------------------
Person: REAL SEP.: .00  REL.: .00 ... Item: REAL SEP.: 1.83  REL.: .77

          Item STATISTICS:  MEASURE ORDER

-------------------------------------------------------------------------------
|ENTRY   TOTAL  TOTAL   JMLE   MODEL|  INFIT  |  OUTFIT |PTMEASUR-AL|EXACT MATCH|      |
|NUMBER  SCORE  COUNT  MEASURE  S.E. |MNSQ ZSTD|MNSQ ZSTD|CORR.  EXP.| OBS%  EXP%| Item |
|-----------------------------------+---------+---------+-----------+-----------+------|
|    3      1     75   67.51  11.46|1.46  .75| .71  .24| .21   .29| 97.1  97.1| S3   |
|    6      1     75   67.51  11.26|1.33  .63| .32 -.20| .27   .29| 97.1  97.1| S6   |
|    7      1     75   67.51  11.26|1.33  .63| .32 -.20| .27   .29| 97.1  97.1| S7   |
|    9      1     75   67.51  11.26| .40 -.63| .05 -.87| .44   .29| 97.1  97.1| S9   |
|   10      1     75   67.51  11.26| .40 -.63| .05 -.87| .44   .29| 97.1  97.1| S10  |
|    1      4     75   48.33   6.04| .96  .05|1.19  .49| .45   .45| 91.4  90.5| S1   |
|    8      5     75   45.01   5.48|1.06  .28|1.62 1.09| .42   .48| 88.6  87.8| S8   |
|    2     13     75   28.73   3.95| .99  .02|1.00  .08| .63   .63| 74.3  73.3| S2   |
|    4     14     75   27.20   3.89| .79 -1.28| .71 -1.09| .72   .64| 71.4  71.7| S4   |
|    5     23     74   13.17   3.96|1.17 1.20|1.59 1.19| .68   .74| 67.6  67.8| S5   |
|-----------------------------------+---------+---------+-----------+-----------+------|
| MEAN   6.4   74.9   50.00   7.96| .99  .10| .76 -.01|           | 87.9  87.6|      |
| P.SD   7.3    .3   19.72   3.36| .35  .72| .55   .75|           | 11.4  11.4|      |
-------------------------------------------------------------------------------

TABLE 13.1 DATA 76-150                       ZOU093WS.TXT  Dec 13 2023 19:43
INPUT: 75 Person  10 Item  REPORTED: 75 Person  10 Item  2 CATS MINISTEP 5.6.3.0
-----------------------------------------------------------------
Person: REAL SEP.: .94  REL.: .47 ... Item: REAL SEP.: 2.27  REL.: .84

          Item STATISTICS:  MEASURE ORDER

-------------------------------------------------------------------------------
|ENTRY   TOTAL  TOTAL   JMLE   MODEL|  INFIT  |  OUTFIT |PTMEASUR-AL|EXACT MATCH|      |
|NUMBER  SCORE  COUNT  MEASURE  S.E. |MNSQ ZSTD|MNSQ ZSTD|CORR.  EXP.| OBS%  EXP%| Item |
|-----------------------------------+---------+---------+-----------+-----------+------|
|    3      0     75   99.79  18.12| MAXIMUM MEASURE  | .00   .00|100.0 100.0| S3   |
|    7      0     75   99.79  18.12| MAXIMUM MEASURE  | .00   .00|100.0 100.0| S7   |
|    8      0     75   99.79  18.12| MAXIMUM MEASURE  | .00   .00|100.0 100.0| S8   |
|    9      0     75   99.79  18.12| MAXIMUM MEASURE  | .00   .00|100.0 100.0| S9   |
|   10      0     75   99.79  18.12| MAXIMUM MEASURE  | .00   .00|100.0 100.0| S10  |
|    1      1     75   87.14  10.26|1.13  .43|3.41 1.58| .13   .22| 97.0  96.8| S1   |
|    6      1     75   87.14  10.26|1.13  .43|3.41 1.58| .13   .22| 97.0  96.8| S6   |
|    5     12     75   47.50   5.08| .52 -1.97| .31 -1.35| .79   .73| 93.9  84.4| S5   |
|    4     18     75   32.61   5.01| .77 -.74| .57 -.81| .85   .82| 87.9  84.1| S4   |
|    2     31     75   -4.39   7.54|1.12  .39|2.81 1.38| .84   .86| 93.9  93.8| S2   |
|-----------------------------------+---------+---------+-----------+-----------+------|
| MEAN   6.3   75.0   74.90  12.87| .93 -.29|2.10  .48|           | 93.9  91.2|      |
| P.SD  10.2    .0   34.96   5.50| .25  .95|1.38 1.29|           |  3.3   5.8|      |
-------------------------------------------------------------------------------

TABLE 13.1 DATA 151-214                      ZOU656WS.TXT  Dec 15 2023 18:30
INPUT: 64 Person  10 Item  REPORTED: 64 Person  10 Item  2 CATS MINISTEP 5.6.3.0
-----------------------------------------------------------------
Person: REAL SEP.: .00  REL.: .00 ... Item: REAL SEP.: 1.14  REL.: .57

          Item STATISTICS:  MEASURE ORDER

-------------------------------------------------------------------------------
|ENTRY   TOTAL  TOTAL   JMLE   MODEL|  INFIT  |  OUTFIT |PTMEASUR-AL|EXACT MATCH|      |
|NUMBER  SCORE  COUNT  MEASURE  S.E. |MNSQ ZSTD|MNSQ ZSTD|CORR.  EXP.| OBS%  EXP%| Item |
|-----------------------------------+---------+---------+-----------+-----------+------|
|    1      0     64   83.46  18.32| MAXIMUM MEASURE  | .00   .00|100.0 100.0| S1   |
|    3      0     64   83.46  18.32| MAXIMUM MEASURE  | .00   .00|100.0 100.0| S3   |
|    6      0     64   83.46  18.32| MAXIMUM MEASURE  | .00   .00|100.0 100.0| S6   |
|    8      0     64   83.46  18.32| MAXIMUM MEASURE  | .00   .00|100.0 100.0| S8   |
|    9      0     64   83.46  18.32| MAXIMUM MEASURE  | .00   .00|100.0 100.0| S9   |
|   10      0     64   83.46  18.32| MAXIMUM MEASURE  | .00   .00|100.0 100.0| S10  |
|    4      1     64   70.61  10.46| .81  .04| .15 -.64| .30   .21| 97.2  97.2| S4   |
|    7      1     64   70.61  10.46| .81  .04| .15 -.64| .30   .21| 97.2  97.2| S7   |
|    5      5     64   50.58   5.31|1.26  .74|1.25  .67| .30   .39| 83.3  88.2| S5   |
|    2     32     64    8.20   5.34|1.00  .14| .92  .09| .84   .84| 88.9  88.9| S2   |
|-----------------------------------+---------+---------+-----------+-----------+------|
| MEAN   3.9   64.0   70.08  14.15| .97  .24| .62 -.13|           | 91.7  92.8|      |
| P.SD   9.5    .0   22.99   5.36| .19  .29| .48   .55|           |  5.9   4.3|      |
-------------------------------------------------------------------------------
```

Figure 5. Logit measures

The third analysis is related to the level of difficulty of the questions. The results show that three questions are included in the easy category, three questions are included in the medium category, and four questions are included in the difficult category.

Table 1. Distribution of Question Difficulty Levels

Question Difficulty level	Question items
Easy	S2, S4, and S5
Currently	S1, S6, and S7
Difficult	S3, S8, S9, and S10

Questions in the problematic category measure high-level mathematical literacy skills, namely levels 4, 5, and 6. Overall, students can answer questions well on low-level questions, which shows that most students have medium to lower mathematical literacy abilities.

Subject Ability Analysis

Figure 5 displays information related to the logit for each student. The measured column is the logit measure for each respondent. Students with code P009 have a logit value of +65.86, which means that these students often answer questions correctly compared to other students. Meanwhile, students with code P150 have the lowest logit value, namely -12.90, which means that these students answer questions incorrectly more often. The overall student logit value is more than 0.00, meaning that students tend to answer more questions correctly on the test.

Figure 6. Person Measure

In Figure 5, the separation value = 2.05 is obtained, so the value H=H= [(4×2.05) + 1]:3=3.06, which if rounded to 3. In Figure 4.2, the separation value = 4.24 is obtained. value H=H= [(4×4.24) + 1]:3=5.98 if rounded to 6. This means that there are six groups of questions. In Figure 5, the separation value = 2.90 is obtained, so the value H=H= [(4×2.90) + 1]:3=4.2. So, based on the upper and lower limits of the logit value, students can be divided into six groups with the same logit interval.

Table 2. of Frequency and Percentage of Student Ability Groups

Ability Group	Logit Interval	Frequency	Percentage
Level 1	$-1,64 \leq P < 13,92$	110	51,4%
Level 2	$13,92 \leq P < 23,29$	65	30,3%
Level 3	$23,29 \leq P < 26,24$	21	9,8%
Level 4	$26,24 \leq P < 36,00$	16	7,4%
Level 5	$36,00 \leq P < 44,65$	1	0,5%
Level 6	$44,65 \leq P < 65,86$	1	0,5%

```
TABLE 22.1 DATA 1-75                        ZOU969WS.TXT  Dec 21 2023 19:25
INPUT: 75 Person  10 Item  REPORTED: 75 Person  10 Item  2 CATS MINISTEP 5.6.3.0
--------------------------------------------------------------------------

GUTTMAN SCALOGRAM OF RESPONSES:
Person |Item
       |          1
       |5428136790
       |----------
     9 +1111100011  P009
    68 +0101001100  P068                         16 +0000000000  P016
     2 +1100100000  P002                         18 +0000000000  P018
     4 +1010100000  P004                         20 +0000000000  P020
    10 +1110000000  P010                         21 +0000000000  L021
    31 +1110000000  P031                         23 +0000000000  P023
    39 +1010010000  P039                         24 +0000000000  P024
    72 +1110000000  P072                         26 +0000000000  P026
     7 +1010000000  P007                         27 +0000000000  P027
    12 +1100000000  P012                         28 +0000000000  P028
    14 +1100000000  P014                         29 +0000000000  L029
    17 +0110000000  L017                         33 +0000000000  L033
    22 +1010000000  P022                         34 +0000000000  P034
    36 +1100000000  P036                         37 +0000000000  P037
    41 +0110000000  P041                         38 +0000000000  P038
    52 +0101000000  P052                         40 +0000000000  L040
    47 + 100000000  P047                         42 +0000000000  L042
     1 +0000100000  L001                         43 +0000000000  P043
    13 +1000000000  P013                         44 +0000000000  L044
    19 +1000000000  P019                         45 +0000000000  P045
    25 +1000000000  P025                         49 +0000000000  P049
    30 +1000000000  P030                         50 +0000000000  P050
    32 +1000000000  P032                         53 +0000000000  P053
    35 +1000000000  P035                         55 +0000000000  P055
    46 +1000000000  P046                         56 +0000000000  L056
    48 +1000000000  P048                         57 +0000000000  L057
    51 +1000000000  P051                         59 +0000000000  P059
    54 +1000000000  P054                         61 +0000000000  P061
    58 +1000000000  P058                         62 +0000000000  P062
    60 +0010000000  P060                         64 +0000000000  P064
    63 +0100000000  P063                         65 +0000000000  P065
    69 +0010000000  P069                         66 +0000000000  L066
    70 +0001000000  P070                         67 +0000000000  P067
    71 +0001000000  P071                         73 +0000000000  P073
    75 +0010000000  L075                         74 +0000000000  L074
     3 +0000000000  P003                            |----------
     5 +0000000000  P005                            |          1
     6 +0000000000  L006                            |5428136790
     8 +0000000000  L008           •TABLE 22.2 DATA 1-75                        ZOU969WS.TXT  Dec 21 2023 19:25
    11 +0000000000  P011           INPUT: 75 Person  10 Item  REPORTED: 75 Person  10 Item  2 CATS MINISTEP 5.6.3.0
    15 +0000000000  P015           --------------------------------------------------------------------------
```
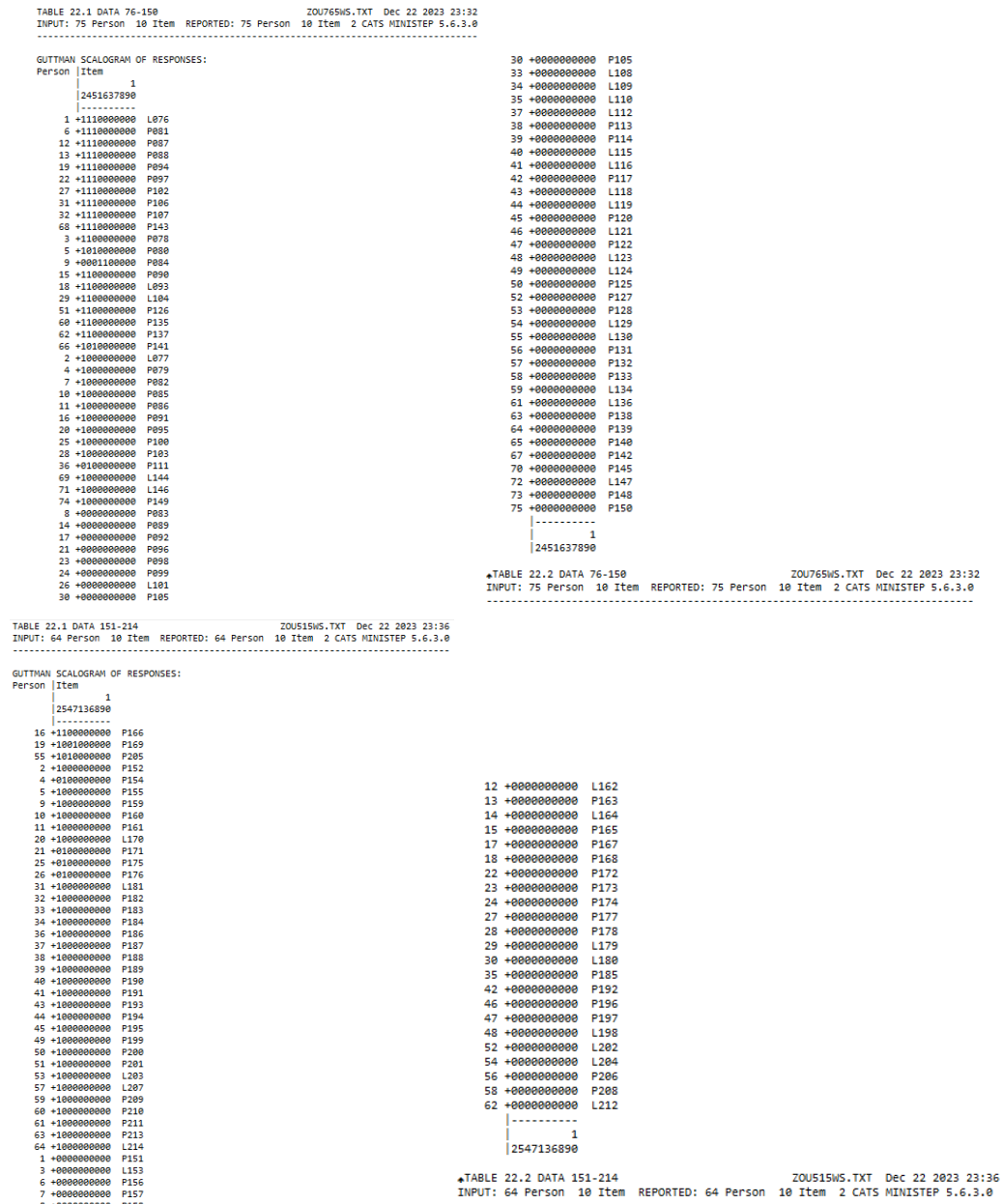
Figure 7. Scalogram

Scalograms sort students' abilities from the highest level to level 6. From left to right, they show the student's score from the lowest level questions to the highest level. The answer pattern shows that student P009 has the highest literacy skills and the highest score.

CONCLUSIONS

The ten questions developed can be used as an instrument to measure students' mathematical literacy abilities because (1) they are valid as seen from the fulfillment of the MNSQ, ZSTD, and Pt Mean Corr categories, (2) they show item reliability of 0.82 which means they are included in the excellent category and can measure ability students'

mathematical literacy; (3) effective because based on analysis of student abilities 51.4 percent of students are at level 1; 30.3% of students are at level 2; 9.8% of students are at level 3; 7.4% of students are at level 4; and 0.5% of students are at levels 5 and 6 respectively which are the highest.

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