The estimation of mathematics literacy ability of junior high school students with partial credit model (PCM) scoring on quantity

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Abstract. An ability needed by students in the 21st century to deal with an unexpected conditions. Mathematical literacy is one of an ability that students needed to face that situation. This study aims to measure the mathematical literacy ability of students in 1 Tempel Junior High School. This research uses quantitative survey methods. Random sampling will be done on all grade 7th students with total 63 students with high, medium, and low ability. Data collection done by a test that consist ten items about mathematical literacy on quantity content. The scoring model used in this study is the partial credit model (PCM). Data analysis that used here included construct validity, content validity, instrument reliability, items difficulty and estimation of student literacy abilities. Data analysis uses Quest software and Microsoft Excel 2010. The construct validity of the instrument proved valid, which was proven using EFA items difficulty and the content validity was 0.85. Test item reliability was 0.63 and the level of lies at an interval of -0.5 to 0.42. The result shows that the mathematics literacy ability of students on quantity content in the medium category is in the range of -1.77 to +0.33.

1. Introduction
The world will always change after the human development that increasingly advanced. It is the same as education that will also become highly advanced with the increasingly expensive information technology. Therefore we humans must prepare for it, starting with the competencies needed to deal with such circumstances. The competencies needed by humans to deal with complex problems in the current development such as 1) the changing types of job demands globally, 2) unprecedented migration from local to international scale, and 3) the advertisement instability that occurs [1]. These three are some of the things that we must prepare to face the rapidly changing world.

We must consider the education sector to deal with these increasingly uncertain conditions. So that the implementation of education must be planned, implemented, and evaluated thoroughly so that Indonesian education quality becomes better. Therefore, the educational organization must develop and improve the student's ability to able to face competition in social life. In reality, all activities in the educational development cannot be separated from a measurement.

The level of success of an educational program can be known by a measurement [2]. Measurement itself is an activity in quantifying symptoms or objects [2]. Symptoms of objects here states a measurement of encouragement, confidence, or even achievement. So in this process measurement is an important part of educational that is happening now.
In organizing education must align with national education goals. Where students must hone their ability and adapted to the development of the 21st century. The 21st century ability is commonly known as "4Cs" where students must hone their critical thinking skills and problem solving with communication, collaboration and creativity, and innovation. These capabilities are in line with the aims of national education which explain important of the ability to think logically, analytically, systematically, critically and innovatively. These abilities can be mastered by students in mathematics literacy abilities. Where the literacy ability is an ability used to deal with problems around us with mathematical abilities, this ability relate to mathematical thinking that is simultaneously with the context in the use of mathematics [3].

Mathematical literacy according to the OECD is people ability to formulate, use and interpret mathematics in various contexts in their lives. This includes the ability to explain arguments using concepts, ways, facts and mathematical tools to predict a phenomenon [4]. This relates to the real context in the daily lives of students or students can imagine the things they will face. The ability of mathematical literacy is the ability of students to solve problems in society by using mathematics [5].

It should be noted that the assessment model that also influences in knowing students' abilities. Mathematical literacy can also develop analytical skills, solve problems, and make decisions [6]. Therefore, literacy ability provides many benefits for students to develop other abilities that are in it, and not only that literacy ability can also be used to solve problems in society. Therefore literacy ability is used to prepare students to engage directly in society and as a tool to solve problems using mathematics.

Stacey & Turner [7] stated that literacy in the context of mathematics is a force used to use mathematical knowledge to solve everyday problems that are also used to prepare someone to jump into society or face the life. Literacy is closely related to mathematical modeling because the relationship of each process is an important process [8] not only that, mathematical literacy ability also helps clarify the processes that are important in the person ability itself [9]. In the process of mathematical modeling also there is a process of formulation in context and using mathematics to solve problems [10], so that literacy is a process that starts from real problems to the decision-making and description and analysis of the real situations.

The research [11] states that students' mathematical literacy ability is still in a condition that needs to improve more. Just like the mathematics literacy ability of high school students in Yogyakarta city that is still in a very low ability, where in the process of understanding, using and interpreting problems is still in the low category. Therefore, measurement of mathematical literacy ability in this case with quantity content needs to measure because this content is one of the contents that is influential in measuring mathematical literacy ability.

In addition, the assessment model also influences the estimation results of a person's abilities, therefore in practicing this literacy ability uses descriptive questions so that the scoring model uses the polytomous model. We can see the assessment of student exam results from the stages achieved by students. Every process of completion by students will get a score. In this case the developed polytomous assessment is partial credit model (PCM).

The scoring pattern used is a partial credit pattern in which a person's higher ability expected to get a higher score [12]. In addition, according to Wright & Maters, PCM is adapted to response analysis in measuring the understanding of concepts [13][14]. PCM is developed for test items that need several steps to solve problems, so that PCM is suitable for tests of mathematical literacy skills which need a stage of understanding to interpret and provide final decisions. PCM is the development model of logistics parameter 1 IRT (1-PL) where this model can determine the level of difficulty of the questions. The use of special samples for the model 1-PL is the Rasch family is in between 30-300 with an INFIT t limit of -2 to +2 [15].

From the explanation result above, this research is conducted to measure the mathematics literacy ability of junior high school students in Tempel area by using the partial Credit Model (PCM) scoring model in quantity content.
2. Research method

This research is a type of survey research. This research was conducted at 1 Tempel Junior High School for grade 7 with various abilities from low, medium and high. The sample used for research was 63 students from eight classes. This researcher conducts this research to estimate the grade 7 ability in mathematics literacy, where students work on 10 items of mathematics literacy questions. Data analysis techniques used are descriptive qualitative analysis and quantitative analysis. Qualitative analysis techniques are used to see the instrument validity content by expert judgment.

This research uses quantitative analysis to see the validity and reliability, sample suitability and model compatibility, item difficulty level, item character, and estimation ability of grade 7 students' literacy. To test sample compatibility and construct validity using EFA (Exploratory Factor Analysis) [16]. Estimating Classic Reliability by using Cronbach Alpha and by knowing the value of the information function. Then to determine the level of difficulty using the partial credit model and the ICC curve obtained by classical estimation. In determining the content validity using V Aiken. Based on [17] if the Aiken index value is less than or equal to 0.4, then the validity category is low. If the Aiken index value is 0.4 - 0.8, the validity is moderate. If the Aiken index value is more than 0.8 then the validity is high or very valid.

Furthermore, to determine the model suitability in this study with PCM. The PCM model is a logistics development parameter 1 IRT model (1-PL) where this model can determine the level of difficulty of the questions. The use of special samples for the 1-PL model in the form of the Rasch Model family is between 30-300 with an INFIT t limit of -2 to +2 [15]. Therefore an analysis uses PCM. In addition, PCM also does not require a level of difficulty of the (k + 1) category higher than the category, but in the k + 1 category it is not always greater than the k category.

Estimating mathematical ability literacy can be seen from θ theta output from PCM in the Estimate column. Then the estimation results are grouped for high, medium, or low abilities.

3. Result and Discussion

The results of research conducted at 1 Tempel Junior High School to estimate mathematics literacy ability of 7th grade students. Measurements were made to figure students ability in understanding problem that present. Literacy ability which is a tool to prepare students to face problems in society is one of the abilities that students must develop. The instruments given to measure literacy ability are presented in problems example that all students can imagine or they might already experienced it.

3.1 Aspects of Mathematical Literacy Ability

Based on [4] [5] [18], students' mathematical literacy abilities are divided into 3 indicators which are presented in table 1 as follows.

| Aspect                                      | Content | Indicator            | Description                                                                 |
|---------------------------------------------|---------|----------------------|-----------------------------------------------------------------------------|
| Junior highschool students mathematics literacy skills | Quantity | Formulate a problem | Able to formulate problems mathematically from the problems presented        |
|                                              |         | Using mathematics    | Able to use and imprint concepts, facts, procedures and use tools in mathematics |
|                                              |         | Interpret the problems | Able to interpret and evaluate the results of the mathematical process in providing decisions. |
There are three indicators used to make questions from comparison material. Each indicator has two to three questions. The instruments used are 10 questions in the form of descriptions and the students have 80 minutes to work on it (2x lesson hours).

3.2 Content Validity

Content validity is determined based on expert judgment. The analysis of expert judgment result using the Aiken equation and the results are in the range of 0.8 - 0.9. Based on [15], if the Aiken index value is less than or equal to 0.4, then the validity category is low. If the Aiken index value is 0.4 - 0.8, the validity is moderate. If the Aiken index value is more than 0.8 then the validity is high or very valid. Based on the calculation of Aiken's validity, the Instrument with 10 items used to measure students' literacy skills are in the valid category. In addition to content validity, there is also empirical validity. Calculation results are presented in table 2.

| items | Aiken validity with 2 Raters |
|-------|-----------------------------|
| 1,2,3,4,5,7,8 | 0.85 |
| 6,9,10 | 0.75 |

Furthermore, content validity is empirically demonstrated by looking at the matching items (fit model based on the partial credit model) presented in Figure 1. Where we can also see it from the results of INFIT MNSQ located in the range of 0.77 to 1.33 [19][20].

![Figure 1. Item Compatibility](image1.png)

Based on the partial credit model, where the PCM model is to figure the level of difficulty of the items. Analysis of the items difficulty levels are at intervals 0 to 1. If the item has a difficulty level that is getting closer to 1, it means that the item has a low level of difficulty or commonly known as a very easy items [21]. Based on the results of the analysis that has been done, the level of items difficulty lies at an interval of -0.5 to 0.42. The item is good if the level of difficulty is at an interval of -2.00 to +2.00 [20]. It is clear that the items that are in the good category are based on the level of difficulty presented in Figure 2 below.

![Figure 2. Difficulty Level](image2.png)
Items information are presented on the ICC curve based on the results of the analysis using classical test theory and Microsoft Excel 2010. Items information are presented in Figure 3 as follows.

3.3 Adequacy Sample
Sampling adequacy in this research is important. Based on the analysis, the sampling adequacy can be seen in the Chi-square value in the Bartlett test of 457,446 with 45 degrees of freedom and a significance value of less than 0.01. and supported by the value of the Kaiser Mayer-Olkin Measure of Sampling Adequacy showing results of more than 0.5 that is equal to 0.641. Based on these results it is clear that the sample used in this study is enough.

3.4 Construction Validity
Construction validity uses EFA (exploratory factor analysis). The results shown are 1 dominant factor. Based on [16] [22] states that the output of results produced by the first factor is able to explain variances of more than 20%. It can also be interpreted that the instrument measures one ability or is usually called a unidimension. Unidimension results from this study show that the variance can explain 42.4%. From these results it shows that the instrument measures one ability, namely mathematical literacy ability. Unidimension assumptions can be seen in Figure 4 below.
Addition, besides that the analysis shows that the instrument can also measure three aspects marked by the eigenvalues of the EFA results above 1. The results of the analysis are agree with the aspects used to measure mathematical literacy abilities. The instrument is able to measure the total variance of 73.2%. EFA analysis results to explain the number of factors can be seen in Figure 5.

![Screen Plot of factor analysis](image)

**Figure 4.** Screen plot of factor analysis

The results of the analysis with classical test theory, information functions and SEM. These results show that the instrument is suitable for measuring mathematical literacy skills in the range of students' abilities between -2 to +2 shown in Figure 6.

![Information Function and SEM](image)

**Figure 6.** Information function and SEM

3.5 Instrument Reliability

Instrument reliability uses classic estimation with Cronbachs Alpha with a score of 0.63. By category either [23] for use in a class or group. From the results of the analysis with classical test theory, information functions and SEM. These results show that the instrument is suitable for measuring mathematical literacy skills in the range of students' abilities between -2 to +2 shown in Figure 6.

3.6 Ability Estimation

Estimation of mathematical literacy abilities using classical test theory estimation with the partial credit model (PCM) which can be seen in the output of theta. The estimation capability according to
[16] is said to be good if it is in the range of -4 to +4. The analysis results of the literacy ability of 7th grade students in 1 Tempel Junior High School are in the range of -1.77 to +0.33 which is in the medium category. The literacy ability results of each person can be seen in Figure 7 below.

In mathematics literacy skills still need to be developed in the teaching and learning process at school. The literacy ability of grade VII students is still in the medium and low categories, where the difficulty of students in working on math literacy problems lies in applying concepts, procedures, and facts to solve various problems given. This is also in line with research [11] stating the process of understanding and using mathematics in solving problems is still in a very low category. The difficulty of solving problems is closely related to the mastery of mathematical material. Difficulties applying mathematical processes and modelling in solving math and physics problems also occur in high school [24]. Mastery of mathematics is very important to solve problems so that it requires a strategy and delivery of material sequence to improve the learning process so that it will have an impact on improving the mastery of student material [24].

Improving the learning process will also help students in mastering mathematics. The success of a learning is supported by good planning as well [24] [25]. Mastery of the material is also supported by the delivery of a good material sequence [25]. Learning planning with a good learning sequence gives attention to the prerequisite material that students must master before entering into the learning material [25]. The learning process by utilizing ICT in the learning process and on student tests. The use of ICT will help in effective student assessment, and help students to work in groups [25] [26].

4. Conclusion
The results of this study show that the measurement of literacy ability based on three aspects carried out by the literacy ability test for 7th grade junior high school students in 1 Tempel Junior High School are formulating, using and interpreting. Mathematical literacy ability instrument is valid and reliable to use in estimating mathematical literacy abilities of 7th grade junior high school students. Analysis of mathematical literacy ability of students of 1 Tempel Junior High School, 7th grade in quantity content lies in the range -1.77 to +0.33 in the medium category. Literacy ability of students can be presented in the conversion of scores lies in the range 323-533, where students' mathematical literacy ability is still in the category of low and moderate so that they still need an increase in literacy skills in mathematics.

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