Revised Bloom’s taxonomy to analyze the final mathematics examination problems in Junior High School

W I Himmah¹, A Nayazik², and F Setyawan³

¹IAIN Salatiga, Jl. Lingkar Salatiga KM.02, Salatiga 50716, Indonesia
²IKIP Veteran Semarang, Jl. Pawiyatan Luhur IV No.17, Semarang 50233, Indonesia
³Universitas Ahmad Dahlan, Jl. Pramuka Kav.5, Umbulharjo, Yogyakarta 55161, Indonesia

E-mail: wulan_himmah@iainsalatiga.ac.id

Abstract. This research aims to analyze the final semester examination using revised Bloom’s taxonomy and to classify problem’s contextuality. This research is a descriptive study using documents analysis. The problem, which was analyzed, is a final examination problem of mathematics subject in the odd semester of 7th SMP N 12 Semarang period 2017/2018. The 40 multiple choice problems are used in this study. Based on the revised Bloom’s taxonomy, the problems are classified into six categories, there are remembering (C1), understanding (C2), applying (C3), analyzing (C4), evaluating (C5), and creating (C6). Based on contextuality, the problem is classified to contextual and non-contextual problems. The result of the study shows that most problem is in the understanding category (C2) as many as 25 items and the other is remembering (C1), applying (C3), and analyzing (C4). There is no problem in evaluating (C5) and creating (C6) category. Most of the problem is non-contextual problems.

1. Introduction

Classroom assessment is very important for a student’s learning [1]. Assessment is a crucial step that provides an overview of the effectiveness of teaching and the learning process [2]. The assessment is a determination process to know how far did the students have learned [3]. By assessment, the teacher knows what material which known and unknown by the students then improving the teaching and learning quality [4]. Through assessment, teachers can find out information about their students’ skills and levels of understanding to make decisions about further instruction [1]. In teaching and learning process, the assessment is known as the process to collect and information processing to determine the result of the study of the students [5].

The assessment is not only designed by the teachers but also the educational unit such as the final semester examination. In curriculum 2013, one of the assessment designs is a cognition assessment [5]. Learning outcomes of cognition assessment in curriculum 2013 refer to Bloom’s taxonomy which revised by Lorin Anderson and Krathwohl. The realm of cognition is the combination of known dimensions which are classified to be factual, conceptual, procedural, and metacognition which hierarchically forms remembering, understanding, applying, analyzing, evaluating, and creating [6-8]. The whole structure of Bloom’s revised taxonomy is seen as a hierarchy, where the lower level is needed to get higher level. For example, to get the students used to have cognitive competence as analyzing, the students should use their knowledge in remembering, understanding, and applying the skill [9]. The purpose of education in the present era must be directed to fulfill the future competencies, such as critical
thinking to make a decision, solving the complex problems, creative thinking, communicative, and collaborative [10]. Problem-solving, creative thinking, and critical thinking classified as high order thinking skills [11-13]. To encourage higher order thinking skills, the student should have got used to solving the non-routine problems and unusual problems which can facilitate students to do analysis, synthesis, and or think more creatively [13]. A problem that is categorized as higher order thinking skills by Lindstrom is defined as a problem that requires a large number of principles that should be combined to solve problems and requires a productive thinking and discovery a previously unknown relation [14]. A problem is seen as the high order thinking, in revised Bloom’s taxonomy if the problem categorized as analyzing, evaluating and creating level [6].

In mathematics teaching and learning, the teacher should pay attention to the meaning of the lesson for the students in daily life, one of them is using contextual problems in the assessment. The context of real life is increasingly used in mathematics classes [15]. By using context, students get used to reinforcing, broadening, and implementing their knowledge in school through real life [16]. Mathematics will be more meaningful when students have faced demands from "the real world" [17]. The context which is given can be categorized as (1) personal, (2) societal, (3) occupational, and (4) scientific [16, 18]. Personal context is focused on the problems related to daily life as individuals such as the context in family, colleagues, and friends. Societal context is a problem related to the relationship of an individual in society, the neighborhood, nationality, and global. Occupational context is a context which occurs in work life. In the case for students, the occupational context can be identified as the problems which occur from the student’s life in school and all activity of the students in the class. Scientific context is a context which occurs based on the phenomenon and substance that related to the mathematics itself including the application of mathematics to the other subject such as science and technology [18]. Giving problems in assessments related to everyday life situations or fantasy situations that students can imagine is a powerful way to get meaningful and informative assessment problems [19]. Therefore, giving high order thinking question and context in question is very important.

But the fact, through interviews with teachers, the teachers haven’t designed the final mathematics examination problems based on the cognitive level and the problem contextuality. The teachers, who have the same subject in the same grade, designed the final examination problems for the students consist of the material distribution for one semester based on the material given to the students before. It implies that the percentage of the problems haven’t determined as how much is the percentage of the high order thinking problems and how much is categorized as contextual problems. Based on the explanation, this research will analyze the question in final semester examination using revised Bloom’s taxonomy and the problem’s contextuality in mathematics examination.

2. Method
This study investigated the mathematics final examination problems and categorize it based on revised Bloom’s taxonomy and the problem’s contextuality. This research is a descriptive research using document analysis. The documents that have been analyzed is confidential, that is the final semester examination of mathematics subject grade 7th in period 2017/2018 SMP Negeri 12 Semarang. There are 40 problems in multiple choice.

The documents are analyzed based on (1) Bloom’s revised taxonomy by Anderson & Krathwohl in cognitive domain by categorizing it into remembering (C1), understanding (C2), applying (C3), analyzing (C4), evaluating (C5), or creating (C6) and (2) the problem’s context, which is classified into two categories such as contextual or non-contextual. The instrument which is used is an item of analysis sheet. The analysis sheet is an essay where the researcher categorized it based on Bloom’s revised taxonomy and the problem’s context.

The validation of data is derived from peer debriefing [20]. The data is validated by colleagues and discussed to get the same perception if there occurs debate so that the data is valid. Based on the analysis result, the researchers determine the percentage in each category. The analysis of data using Miles and Huberman model, that is data reduction, data presentation, and making a conclusion.
3. Result and Discussion

Based on the problem analysis using revised Bloom’s taxonomy in the cognitive domain, the researchers derive some result as presented in Table 1.

| Revised Bloom’s Taxonomy level | Item | Quantity (problem) | Percentage (%) |
|--------------------------------|------|--------------------|----------------|
| Remembering (C1)               | 6,13,14,32,33,34 | 6                 | 15%            |
| Understanding (C2)             | 2,3,4,9,11,12,15,16,17,20,21,22,23,24,25,26,27,28,29,30,31,37,38,39,40 | 25              | 62.5%          |
| Applying (C3)                  | 5,7,18,35,36    | 5                 | 12.5%          |
| Analysing (C4)                 | 1,8,10,19       | 4                 | 10%            |
| Evaluating (C5)                | -               | 0                 | 0%             |
| Creating (C6)                  | -               | 0                 | 0%             |

Most problems are in remembering level C1 (15%), understanding level C2 (62.5%), applying level C3 (12.5%), and analyzing level C4 (10%) of 40 given problems (see Table 1). There is no problem in evaluating level (C5) and creating level (C6). It can be said that the final semester examination problems have not stimulated the students to reach higher order thinking skill due to there is only 10% of the problem is in analyzing level (C4).

Based on the problem’s context, the problem is categorized as presented in Table 2.

| Problem’s context | The problem (number) | Quantity (problem) | Percentage (%) |
|-------------------|----------------------|--------------------|----------------|
| Contextual        | 5,7,8,10,18,35       | 6                  | 15%            |
| Non-contextual    | 1,2,3,4,6,9,11,12,13,14,15,16,17,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,36,37,38,39,40 | 34              | 85%            |

In the final semester examination of 7th grade, 15% of all given problems are categorized as contextual problems and 85% of all given problems are categorized as non-contextual problems (see Table 2). Some contextual problems are categorized as occupational context, personal context, and societal context.

Occupational context occurs in the 5th and 35th item. For the 5th item, there is a problem related to the arithmetic operation which was linked with the learning environment in class, such as the assessment of a written test of the class. Besides, the 8th item in the given problem is related to the set which was linked with the competition result. The personal context occurs in 10th item of the given problem. That is the awareness of number, such as the Least Common Multiple of the student’s hobby.

Societal context occurs in the three items such as 7th, 8th, and 18th. The 7th item is about the arithmetic operation which was linked to the selling and buying activity. The 8th item is about the arithmetic operation which was linked to the fraction and the division of breed using a fraction. Besides, the 18th item is about the linear equation of one variable which was linked to the selling and buying activity.

There are two items which are categorized as higher order thinking problems which use context, they are an 8th item and 10th item. The example of a problem in analyzing level and use context is given as in problem number 10.
**Problem number 10**

Andi dan Toni mempunyai hobby yang sama yaitu berenang. Andi latihan renang setiap 5 hari sekali dan Toni latihan renang setiap 4 hari sekali. Jika pada tanggal 12 November 2017 mereka berenang bersama-sama, maka mereka latihan berenang bersama-sama lagi pada tanggal ....

A. 1 Desember 2017  
B. 2 Desember 2017  
C. 3 Desember 2017  
D. 4 Desember 2017

**Figure 1. Problems in analyzing level (C4)**

The 10th item as presented in Figure 1 is an analyzing level (C4). The solution of it ask students to understand the concept of Least Common Multiple (LCM), then they determine the LCM of 4 and 5. The calculation of the LCM is not the answer. The students should determine the date of Andi and Toni such that they are training to swim together. To answer this question, the students should understand how many days in November. The 10th item is a personal context, where the situation of the problems was related to the hobby of a friend. In other than, one example of the problem in understanding level (C2) and not using context are given in problem number 3.

**Problem number 3**

3. Hasil dari operasi $7 \times 6 + (-42) : 6 + 10$ adalah ....  
   A. 41  
   B. 42  
   C. 43  
   D. 45

**Figure 2. Problem in understanding level (C2)**

The 3rd item as presented in Figure 2 is an understanding level (C2). To answer that question the students should understand the arithmetic operation and calculate the number. There is no context of daily life which is linked to problem number 3. The problems distribution in the cognitive domain and the material is presented in Table 3.

**Table 3. The problem distribution based on the cognitive domain and the material**

| Material                  | C1   | C2   | C3   | C4   | C5   | C6   |
|---------------------------|------|------|------|------|------|------|
| Numbers                   | 2,3,4,9,  
                           | 6    | 11,12,21,  
                           | 22   | 5,7  | 1,8,10 | -    | -    |
| Set                       | -    | 37,38,39,  
                           | 40   | 35,36 | -    | -    | -    |
| Algebraic form            | 13,14,32,  
                           | 33,34 | 26,27,28,  
                           | 40   | 29,30,31 | -    | -    | -    |
| Equality and inequality of one | 15,16,17,  
                           | 25   | 20,23,24,  
                           | 18   | 19   | -    | -    |

Note: C1 = remembering, C2 = understanding, C3 = applying, C4 = analysing, C5 = evaluating, C6 = creating

Four items are in evaluating level, three of them are Number material, such as 1st, 8th, 10th (see in Table 3). Besides one problem is related to the linear equation of one variable. For one semester there are 4 topics, such as numbers, set, algebraic form, equality and inequality of one variable. It implies
that the distribution of the problem is not equitable to get students used to the material with high order thinking skill. On the other hand, in algebraic form, there is no applying level.

Research on the categorization of test questions based on Bloom's taxonomy was carried out by several other researchers and the results were not much different. On the National Mathematics Examination for Academic Year 2011/2012, the problem has not been able to encourage high-level thinking skills because the problem is only at the level of remembering (10%), understanding (50%), and applying (40%) without any questions that are at the level of analyzing, evaluating, or creating [21]. In the 2011 National Mathematics Exams the questions were spread out at the level of knowing (5%), understanding (62.5%), applying (7.5%), and analyzing (25%) for the science program and spread out at the level of remembering (7.5%), understanding (72.5%), and applying (20%) to the IPS program [22]. Giani's research, et al. also found that there was no problem at the level of evaluating and creating, where the problems percentage in cognitive domain are: remembering (3.23%), understanding (30.97%), applying (61.93%), and analyzing (3.87%) [23]. The other research shows that the classification of the problem is remembering (13.3%); understanding (46.7%); and applying (40%) [24]. It is really urgent to provides a learning environment where mathematical ideas and discussions are in accordance with their human and social behavior. Teacher and student have to understand that mathematical are about ideas. the ideas of mathematics are based on our bodily experience as social animals that why the ideas of mathematics are really meaningful [25]. In this study, it can be seen that giving the problem context is still very minimal. Research on problems context has also been done by others who concluded that the teacher need for knowledge, not only on teachers' knowledge of children's mathematical thinking but also on their knowledge of the social, interactive, and discursive processes that underlie the creation of appropriate contexts for children's conceptual development in mathematics [26]. Other research highlights that there have been improvements in contextualized questions in recent years [18].

In making assessment questions a teacher should have the art of skillful questioning if they want to produce effective questions that will involve students in high-level cognitive processes such as problem-solving and critical thinking [27-28]. The assessment must focus on feedback that is beneficial to student performance which is embedded in everyday learning and utilizing the improved balance of technology assessment that measures student mastery of 21st-century skills [29-30].

4. Conclusion
The final examination problems in odd semester spread on four levels, namely remembering (C1), understanding (C2), applying (C3), and analyzing (C4). Most of the questions are questions at the level of understanding (C2). In term of problem’s context, most of the final semester examination problems used are not contextual questions. The context found in the question is the occupational context, personal context, and societal context. The results of this study can be used as a basis for consideration in making problems in the future.

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