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## The 5th International Conference on Research, Implementation, & Education of Mathematics and Sciences

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## PREFACE

The fifth International Conference on Research, Implementation, and Education of Mathematics and Science (ICRIEMS) is an annual conference organized by the Faculty of Mathematics and Natural Science, Yogyakarta State University, Yogyakarta, Indonesia and successfully held from 7 to 8 May, 2018. The theme of the 5<sup>th</sup> ICRIEMS is revitalizing research and education on mathematics and science for innovations and social development. The conference was a forum for researchers, educators, students, policy makers, and practitioners to achieve the innovation and social development through research and education on mathematics and science, as it is accentuated by the theme of this conference. The scope of this conference covers the area of mathematics, chemistry, physics, biology, mathematics education, chemistry education, physics education, and science education. This proceeding contains 157 that have been carefully peer reviewed and selected from 575 papers submitted to the conference.

We would like to express our gratitude to the reviewers of these manuscripts, who provided constructive criticism and stimulated comments and suggestions to the authors. We are extremely grateful as organizers, technical program committee and editors and extend our most sincere thanks to all the participants of the conference for their fruitful work and their excellent contribution to the development of this conference proceedings. Our sincere gratitude also goes to the IOP Publishing editors and managers for their helpful cooperation during the preparation of the proceedings.

On behalf of the Organizing Committee of the 5<sup>th</sup> ICRIEMS  
Agung Wijaya Subiantoro, Ed.D.

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divergent mathematical problems, students are often confused when they do test items in TIMSS and PISA models that require students to use all cognitive levels of Bloom's taxonomy [5].

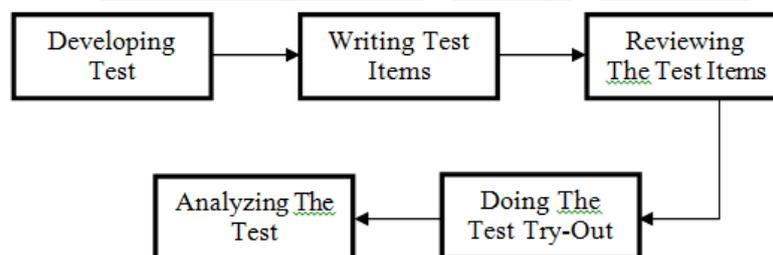
The differences between the problems that the teachers provide and TIMSS and PISA problems, according to Drollinger-Vetter *et al.*[9], leads to students' different perspectives and ways of learning. Some researchers have also examined the relationship between the teacher's perspectives and practices in the classroom with student achievement [10-12]. The results agree to a conclusion that teacher's perspectives and classroom practices colour students' achievement. Therefore, the important task of a mathematics teacher is to build students' divergent way of thinking so they are not confined with a rigid convergent mindset. It is thus important to develop mathematical problems requiring high order thinking skills (HOTS) as stimuli to develop students' cognitive abilities that enable them to have HOTS to perform mathematical thinking process.

There have been a number of studies on the development of instrument to measure students' HOTS [13-15]. These studies strongly indicate that the development of students' HOTS require learning strategies that can actively involve students and that can focus more on the learning process, not on the content. Despite the above findings from previous studies, so far there has not been any instrument developed to assess students' mathematical HOTS that integrates Islamic context.

In fact, the integration of Islamic context on mathematical problems can develop students' reasoning and build their critical awareness of the ultimate truth that comes from Islamic values and teachings. Moreover, the integration of HOTS mathematical problems and Islamic context can minimize students' assumption that it is difficult to associate mathematics to Islamic context [16]. Mathematics will also be a particularly interesting lesson for *madrasah* students because they feel that mathematics is indeed a part of their lives and religion.

## 2. Research Methods

This research is a developmental study adapted from Mardapi development model [17], emphasizing the development of HOTS test items as assessment instruments that integrate Islamic context in each of the stems and options. Figure 1 describes the development stages. The development initially began with determining the test specifications. At this stage, a grid is developed as a guide for writing the test items. The thinking dimensions developed in this domain are directed to three aspects of ability: analyzing (C4), evaluating (C5) and creating (C6). The items consist of 5 items of analyzing (C4) domain, 2 items of evaluating (C5) domain and 1 item of creating (C6) domain.



**Figure 1.** The Instrument Development Stages.

Question items number 1 and 3 are aimed to assess student's ability in doing operation with integers taking the context of *Eid alFitr* festival in which a group of children in train wagons are reciting some short chapters of Qur'an. Question item number 2 is about equality and speed comparison using the context of the regulation in doing combined (*jama'*) prayers. Question item number 4 asks the students to determine the geometrical angles formed by the body movements in prayers. In question item number 5 the students were asked to identify the mode from the data of children's Qur'an recital tests. For question item number 6, the students must analyze *musahamah* and plan a charity program based on the profit from *musahamah*. Question item number 7 asks about

empirical and theoretical chances of embark schedules for pilgrimage on *haji* while question item number 8 is related to the pattern in seating arrangement in an *iftar*.

From the grid, the HOTS mathematical problems were constructed, emphasizing the ability of deep thinking and the context of real cases in *muamalah*, *fiqhandaqidah*. The deep thinking ability is related to the reasoning built on the context of the questions, the stems and the homogeneity of the options. Under these consideration, 8 (eight) HOTS items of mathematical problems were developed. Although the use of multiple-choice items is generally considered as low-level thinking measurement, a careful construction of multiple-choice items in this study can potentially stimulate students' HOTS process [18]. This brings the challenge in the development of question items and the uniqueness of the items developed. The options constructed also present contexts relevant to the question items. The students must analyze and evaluate the options in order to best determine and select the correct option relevant to the contexts of the questions.

A review to determine the quality of test item was conducted before the test items were tried out. *MTs* mathematic teachers, lecturers and an expert in Islamic jurisprudence reviewed the items. The involvement of jurisprudence experts was intended to evaluate the Islamic context used in the question items. The try out was conducted in four State Islamic Junior Secondary Schools (*MTsN*) in East Java, involving 165 students of grade IX. The schools for piloting the items were selected based on the level and quality of the result of National Examination in 2016 and were categorized as high, moderate and low. The results of the try out were analyzed using Three-Parameter Logistic (3PL) model of BILOG-MG software in order to know the characteristics of the items including discrimination level, difficulty level, and guessing level of the developed items. In addition to software analysis, descriptive analysis was also conducted to identify students' problems in solving the mathematical problems that integrate Islamic context in the question items.

### 3. Result and Discussion

Hulinet *al.* [19] suggests that the good quality of the result of item analysis is indicated by the matching level of the item with the model with the index of difficulty of -2 to 2, the index of discrimination level between 0 to 2, and the guessing level not exceeding 0.2. Figure 2 presents result of instrument analysis and different biserial correlation values.

ITEM	NAME	#TRIED	#RIGHT	PCT	LOGIT/1.7	ITEM*TEST CORRELATION	
						PEARSON	BISERIAL
1	MATH1	165.0	84.0	50.9	-0.02	0.519	0.650
2	MATH2	165.0	49.0	29.7	0.51	0.359	0.474
3	MATH3	165.0	65.0	39.4	0.25	-0.012	-0.016
4	MATH4	165.0	65.0	39.4	0.25	0.196	0.249
5	MATH5	165.0	47.0	28.5	0.54	0.081	0.107
6	MATH6	165.0	72.0	43.6	0.15	0.187	0.236
7	MATH7	165.0	65.0	39.4	0.25	0.388	0.493
8	MATH8	165.0	110.0	66.7	-0.41	0.408	0.530

**Figure 2.** The Statistical Calculation of the Result of Instrument Development Analysis.

Item number 3 has a negative biserial correlation of -0.016. This negative biserial value is because the item has a poor discrimination level and falls into the category of difficult item [20]. This question item number 3 take the material of number, asking students to determine the number of chapters (*surahs*) memorized by female students. To determine the number of the chapters, the students must understand every statement in the problem because they are related. It seems that the students find this problem difficult because of the following possible causes: (1) the stimulus on the item is too complicated and long so it is confusing for the students to understand the context of *fiqh* and (2) the students are lack of knowledge related to the context of *fiqh*. Thus, item number 3 was excluded or was not used in the next analysis phase. Figure 3 presents the result of instrument analysis after item number 3 was excluded.

ITEM STATISTICS FOR SUBTEST PRETEST							
ITEM	NAME	#TRIED	#RIGHT	PCT	LOGIT/1.7	ITEM*TEST CORRELATION	
						PEARSON	BISERIAL
1	ITEM1	165.0	84.0	50.9	-0.02	0.544	0.682
2	ITEM2	165.0	49.0	29.7	0.51	0.414	0.547
3	ITEM3	165.0	65.0	39.4	0.25	0.216	0.275
4	ITEM4	165.0	47.0	28.5	0.54	0.072	0.095
5	ITEM5	165.0	72.0	43.6	0.15	0.197	0.248
6	ITEM6	165.0	65.0	39.4	0.25	0.411	0.521
7	ITEM7	165.0	110.0	66.7	-0.41	0.392	0.509

**Figure 3.**The Revised Result of Instrument Analysis.

The results of the second stage analysis bring two interesting items of mathematical problems worth further analysis; those are item number 1 and item number 5. Item number 1 has low discrimination level (5.407) while item number 5 has high difficulty level (2.448). The other 5 items share the characteristics of good question items for mathematical problems.

Item number 1 deals with the concept of numbers and is associated with the context of *fiqh*. Students must understand the context of Islamic jurisprudence presented on the problem because there is important information that is useful to determine the correct answer. Students, regardless of their ability (either high or low), seem to have difficulty in understanding the problem and determining the correct answer. Item number 1, thus, cannot discriminate students with high ability from those with low ability. It is highly possible that the students who understand the material in item number 1 thought that there is incorrect information in the item. In terms of the stem and options, question item number 1 has long stems and options that bring students' confusion in understanding the context of Islamic jurisprudence. This finding confirmed previous findings [3-5] in that students are not accustomed to answering questions that require reasoning and to the presentation of problems that begins with long elaboration of context as stimulus. This is because they are used to answering questions from their teachers that mostly require the application of formula and procedures.

Question item number 5 discusses the concept of arithmetic with the context of *muamalah* as the stem. The mathematical problem presented requires the students to understand the context of *muamalah*. The results of the analysis show that this question item can be categorized as difficult, indicated by students' difficulty in answering the question, even for students with high mathematical ability. The correct answer given by students with low ability indicates the guessing factor. Students' lack of understanding toward the context of *muamalah* seems to be the contributing factor toward students' difficulty in providing the correct answer to this question item number 5.

In this context, it is true that students tend to have difficulty in solving a complex mathematics problem that involves varied information [7]. This happens since teachers focus on item that demands the ability in applying formula, procedure and algorithm [3-5]. As a result, student will be confused when they have an item that requires critical thinking and HOTS from taxonomy Bloom [6-7].

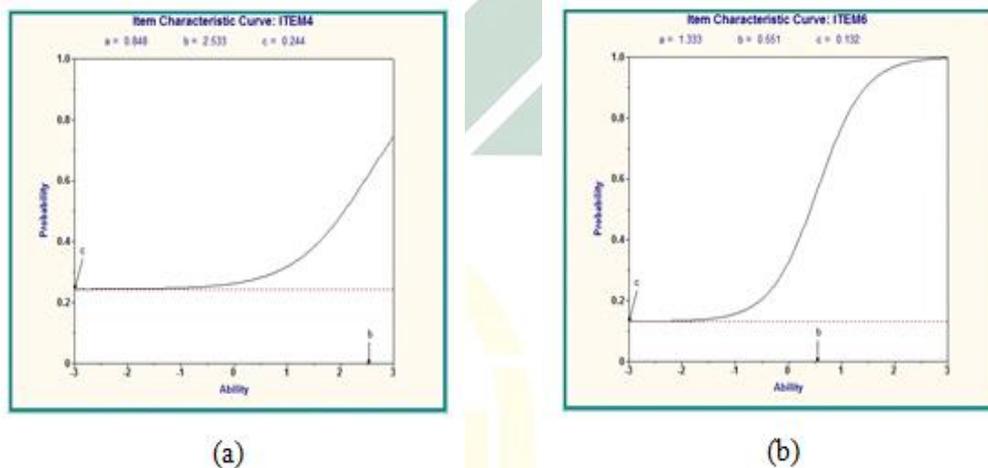
Actually, teachers have willingness to implement HOTS but they don't have knowledge and experience about HOTS and how to implement HOTS in the context of mathematics learning [22]. Also, most of teachers still have thinking to follow the teaching based on the textbook when they teach in the class. Therefore, they have to finish the materials without necessarily considering how to give mathematics problems according to the current context.

The other five items share the good characteristics of question items in terms of their difficulty, discrimination and guessing levels. The five items has the discrimination level (parameter  $a$ ) in the range of  $0 \leq a \leq 2$ , the difficulty level (parameter  $b$ ) in the range of  $0 \leq b \leq 2$ , and the guessing level (parameter  $c$ ) at the intervals of  $0.124 \leq c \leq 0.276$ . In terms of the Islamic context used, 2 out of these 5 items use the context of *aqidah*. This context has been studied by students since their Islamic primary education (MI), so the students are already familiar with the terms used in the context. This brings ease to the students in answering the questions.

Examined from Item Characteristic Curve (ICC), the above 7 items can be put into 2 categories. Item number 1 has low discrimination level, item number 3 has the highest difficulty level and the rest

five items are presented in Figure 4. The ICC graphic clearly show the differences among the two categories of the question items.

The shape of ICC in Figure 4 depends on the magnitude of the discrimination and difficulty levels. The discrimination level is shown by the slope in the graphic, the more vertical the curve of the corresponding item, the better the item in discriminating students with high ability from students with lower level of ability. Figure 4 (a) represents ICC item number 1 which has low discrimination level and item number 5 with high difficulty level. This is because the slope in Figure 4 (a) goes along with the difficulty level of the item, the more sloping the higher the ability is. This results in the higher probability of correct answer and the minute difference between students with high and lower level abilities. Figure 4 (b) represents the 5 with have good item characteristics shown in an S-shape ICC [21].



**Figure 4.** (a) ICC of Item with Low Discrimination Level and High Difficulty Level.

**Figure 4.** (b) ICC of Item with Good Item Characteristics.

Figure 4 indicates that a number of students are able to solve complex items that are different from their real ability, and it happens because of guessing [23]. This description doesn't occur in Figure 4 (b). Relating to ICC, only items that have good characteristic that can be used in the context of learning.

#### 4. Conclusion

Based on the previous analysis and discussion, it can be concluded that of the seven question items of HOTS mathematical problems developed, 5 items have good discrimination, difficulty, and guessing levels while the other two items has either low discrimination level (item number 1) or high difficulty level (item number 5). In regards to the Islamic context used as the stimulus in the HOTS mathematical problems developed, most students find difficulty with the contexts of *fiqh* and *muamalah* but find it easy with the context of *aqidah*. It can be assumed that this is because *aqidah* has been instilled since they were born and is always practiced in their daily lives.

#### 5. Acknowledgments

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