

## THE EFFECT OF OPTION NUMBERS ON THE ITEM INSTRUMENTS OF BELIEF ABOUT MATHEMATICS FOR JUNIOR HIGH SCHOOL STUDENTS TOWARD THE MAXIMUM RELIABILITY

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### ABSTRACT

*This study aims to find out the effect of option numbers on the item instruments of belief about mathematics toward the maximum reliability. The method used was experimental method with one-way analysis of variants (ANOVA) design 3x1. The population is all students of state Junior High School in Medan academic year 2014/2015. Sampling was done by multi-stage random sampling in order to obtain a sample 1,050 students of three state Junior High Schools in Medan. Study hypotheses were tested using one way ANOVA. Study results conclude that: (1) The maximum reliability of the instrument of belief about mathematics with five options is higher than the maximum reliability of the instrument of belief about mathematics with four options and three options; and (2) The maximum reliability of the instruments of belief about mathematics with four options is higher than the maximum reliability of the instruments of belief about mathematics with three options. Therefore, the more option numbers on the item instrument are, the higher the maximum reliability will be.*

**Keywords:** *belief about mathematics, option numbers, maximum reliability*

Mathematics is an essential knowledge used to improve human resources. Everyone must get in touch with mathematics in their jobs. In the application, mathematics is also regulated to be a students' subject, it is the subject in Junior High School for instance.

In learning mathematics, students' *belief* affects their learning process a lot. *Belief* about mathematics is a students' belief on that they could learn mathematics well. Their *belief* contributes their better model and concept in learning mathematics (Schoenfeld, 1992: 68). Students' model and concept in learning mathematics will be different if their belief is different one another. Therefore, it is necessary to measure students' belief about mathematics when they learn it.

To measure the students' *belief* about mathematics needs some instruments to determine their belief about it. The instruments will be used to collect the data. The instruments can consist of test and non-test instruments, but non-test instruments in *Likert* scale will be used in measuring the belief.

Basically, *Likert* scale consists of five options; they are Very Approved, Approved, Doubtful, Disapproved, and Very Disapproved. But in this case, Mueller (1986: 12) stated that some scale makers have seven options, and some others have four or five options (*without any midpoints*). Therefore, *Likert* scale can be modified only on the same base.

This study uses scales with three kinds of option numbers; they are scales with three options, four options, and five options that are still based on *Likert* scale. The measurement scale with three options has the model that is really closed to *Likert* scale. Both of the scales have a midpoint of the attitude but they are different in the option numbers, the measurement scale with three options has fewer options than *Likert* scale. The measurement scale with four options has the model with four options that have no midpoints. And the measurement scale with five options is an original scale of *Likert* scale that has five options with midpoints.

Choosing the option numbers definitely affects the quality of the instruments. And the quality of the instruments shows reliability and consistency from those instruments. The numbers of the available options will affect the instrument reliability levels. The

bigger numbers of the options will produce the higher instrument reliability levels, and the smaller numbers will produce the lower ones (Mueller, 1986: 382).

Relating with reliability, both researchers and practitioners use uni-dimensional reliability more and they use alpha Cronbach the most. But this study uses multidimensional reliability because the latent variables are used as the instrument variables. Therefore, the compatible reliability is the multidimensional reliability, and in this case, it is a maximum reliability. Thus, this study will analyze how big the option numbers affect the belief about Junior High School mathematics toward the maximum reliability. The options in this study consist of five, four, and three option numbers which are compared with one another.

In etymology, *Reliable* means “*andal*”. And “*andal*” in Indonesian formal dictionary means “*trusted*”. Reliability in the measurement means that the result of the measurement will be trusted if it is repeatedly used to the measured objects. The result is always constant and never changed even it is repeatedly used to the measured objects. Reliability refers to the scores the same person achieves when he is repeatedly examined with the same test on different situations or different equivalent items. In other words, reliability is the consistency of the measurement (Anastasi dan Urbina, 1997: 63; Wiersma dan Jurs, 1990: 155).

A coefficient of the maximum reliability was introduced by Li, Rosenthal, dan Ubin in 1996 which is an expansion of Spearman-Brown’s coefficient on  $k$  component. This coefficient is called a maximum coefficient because the estimations on reliability are based on a calculating combination for set of items in a linier explaining optimally the measurement construct. The estimations on reliability are carried out by correlating a linier combination (X) to its latent construct ( $\eta$ ). By using the algebra manipulation, this concept is finally reduced to be an equality to count the maximum reliability below (Widhiarso, 2014).

$$\rho_{\max} = \frac{\sum_{i=1}^k \frac{\lambda_i^2}{\theta_i}}{1 + \sum_{i=1}^k \frac{\lambda_i^2}{\theta_i}}$$

Note:

$\lambda_i$  = Standardized factor loading the ... (i) indicator

$\theta_i$  = error variance of the ... (i) indicator

According to Oxford dictionary, *belief* is a power to feel that it is true; to believe that it is true. *Belief* in Indonesia Language is “*keyakinan*” or “*kepercayaan*” (*faith*). *Belief* or *faith* is not easy to identify, because someone’s *belief* is not the same as others’ *belief* even though they state that their *beliefs* on something are the same. It matches what Matic (2014) stated that *Beliefs are highly subjective, and they change according to someone’s feelings*. It shows that *belief* can change someone’s consideration, so *belief* that is changed is really possible to make someone change too. In other words, *belief* can change someone’s attitude toward something.

Mathematics is a subject everyone learns since they do not school yet until they are in a university. Mathematics has a much closed relation to the daily life because it is

always available in every activity. In knowledge, mathematics has an important role because most of the philosophers' backgrounds are from mathematics.

Students' *Belief* on mathematics is a self-condition in every student's thought affecting them to think and learn the subject. Schoenfeld (1992: 47) stated that students' *belief* about mathematics is formed by students' metacognition; it is stated so because learning mathematics depends on the logic thinking of the thought on mathematics itself; then it will affect students' *belief* about mathematics toward the knowledge of mathematics in the facts.

In learning mathematics, *belief* affects students in developing their knowledge. The higher students' *belief* on mathematics subject is, the higher students' result on that subject will be, and on the contrary, the lower students' *belief* is, the lower students' result will be. Like Schreiber's statement by Fatade and friends (2014) on students' mathematics, that the students whose *belief* about the success on mathematics is high will get the higher result than the students whose *belief* about the success on mathematics is low.

In doing the assessment and study, the researcher needs an instrument. The instrument is a tool to collect the data of the analyzed object. Generally the instrument consists of two big components; they are test and non-test components. Non-test components are an instrument to collect students' data, and the data here is students' affective. In non-test components, students are tending to choose answers or options about their personalities. Non-test components are usually called scales.

One of the techniques used the most in the scale measurement is *Likert* scale, which is followed with five continuum responses showing attitude levels or feeling intensity from the felt statements (Kirkendall, 1980: 382). It means that given statements and options represent respondents' feeling and attitude. *Likert* scale is a scale that can be used to measure someone's or communities' attitudes, opinions, and perceptions about an educational symptom or phenomenon (Djaali dan Muljono, 2008: 28). Therefore, *Likert* scale can measure attitudes, opinions, and perceptions whose statements and options touch respondents' feeling and attitude so the respondents are expected to choose the options honestly.

The statements of attitude scales certainly have options following the given statements. According to Mueller (1986: 12), *Likert* items use the category of responses or options that have an interval from Very Approved to Very Disapproved. It means that *Likert* scale respondents are demanded to make a decision or to give an assessment on their attitudes. *Likert* scale generally has five options given to respondents; they are Very Approved, Approved, Doubtful, Disapproved, and Very Disapproved (Naga, 2013: 61).

As mentioned above, the option numbers in *Likert* scale are usually five options. But Mueller (1986: 12) stated that some scale makers use seven options, and some others use four or six options (*without any midpoints*). It means that the options in *Likert* scale can be modified.

## METHOD

This study is carried out to the seventh grade in State Junior High School 6 Medan (SMP N 6 Medan), State Junior High School 36 Medan (SMP N 36 Medan), and State Junior High School 4 Medan (SMP N 4 Medan). This study is carried out in the even semester of academic year 2014/2015. This study is included to the experimental study with a one-way ANOVA design or one-way ANOVA 3 x 1. The design used in this study can be seen in this table.

Table 1. The Instrument of *Belief* about Mathematics with ANAVA One-Way Study Design

5 options ( $X_1$ )	4 options ( $X_2$ )	3 options ( $X_3$ )
$\rho_{\max 1.1}$	$\rho_{\max 2.1}$	$\rho_{\max 3.1}$
$\rho_{\max 1.2}$	$\rho_{\max 2.2}$	$\rho_{\max 3.2}$
$\rho_{\max 1.3}$	$\rho_{\max 2.3}$	$\rho_{\max 3.3}$
$\rho_{\max 1.4}$	$\rho_{\max 2.4}$	$\rho_{\max 3.4}$
$\rho_{\max 1.5}$	$\rho_{\max 2.5}$	$\rho_{\max 3.5}$
...	...	...
...	...	...
...	...	...
$\rho_{\max 1.20}$	$\rho_{\max 2.20}$	$\rho_{\max 3.20}$

Note:

$\rho_{\max 1.x}$  = maximum reliability value with five options

$\rho_{\max 2.x}$  = maximum reliability value with four options

$\rho_{\max 3.x}$  = maximum reliability value with three options

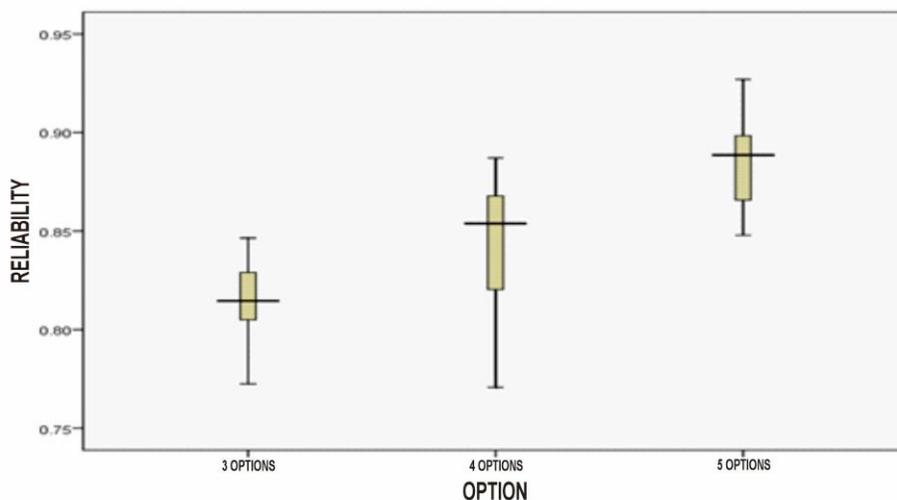
A free variable in this study is the numbers of the test options for belief about mathematics. And the option numbers of *belief* about mathematics are three, four, and five test options whereas the banded variable is the coefficient value of the maximum reliability.

The population in this study is all students of State Junior High School in Medan. The population reached in this study is all students responding the instruments of *belief* about mathematics. Students given the instruments of *belief* about mathematics are all students of the seventh grade in three State Junior High Schools in Medan. The number of the compared students filling the three instruments of *belief* about mathematics is 1050 students, and each instrument of *belief* about mathematics is filled by 350 students. The sampling technique in this study is *multistage random sampling*. To choose the school in district levels is also carried out randomly. The procedures in this study are: (1) Three groups of the respondents are given the instruments of *belief* about mathematics with different option numbers; they are 350 students for five options, 350 students for four options, and 350 students for three options, (2) The results of students' responses for the instruments are given the score, and (3) From the results of the numbers of the respondents in each group, 200 respondents are randomly taken in each group and then the coefficient of the reliability is counted, for instance the value of  $\rho_1$ . After that, the data of 200 respondents will be returned again to the groups. The 200 respondents are randomly taken again, and the coefficient of the reliability is also counted, for instance the value of  $\rho_2$ , this action will be carried out again and again until it is repeated for 20 times. Therefore, the analysis unit in this study is the reliability coefficient instrument. The instruments used in this study are the instruments of *belief* about mathematics.

## RESULT

Data descriptions consist of three groups; they are the group of reliability coefficient for the instruments of maximum *belief* about mathematics with five options, the group of reliability coefficient for the instruments of maximum *belief* about mathematics with four options, and the group of reliability coefficient for the instruments of maximum *belief* about mathematics with three options.

Those three groups will be presented in the form of descriptive statistics in the picture of boxplot, so that data distribution, homogeneity, and data tendency will be identified well. It is shown on the picture below:



**Picture 1.** Boxplot of the Maximum Reliability

From the picture of boxplot above, we can interpret that the data distribution of reliability coefficient with three options is more homogeneous than the data distribution of reliability coefficient with four and five options; the data distribution of reliability coefficient with five options is more homogeneous than the data distribution of reliability coefficient with four options; the data distribution of reliability coefficient with five options is mostly collected in a low score so the data distribution of reliability coefficient is positive; the data distribution of reliability coefficient with four options is mostly collected in a low score so the data distribution of reliability coefficient is positive; the data distribution of reliability coefficient with three options is mostly collected in a high score so the data distribution of reliability coefficient is negative; the *mean* of reliability coefficient with five options is 0.88497, the *mean* of reliability coefficient with four options is 0.843895, the *mean* of reliability coefficient with three options is 0.82161; the *variant* of reliability coefficient with five options is 0.0004, the *variant* of reliability coefficient with four options is 0.001, the *variant* of reliability coefficient with three options is 0.0006.

As the requirements to examine the inferential statistical hypotheses, examining the distribution of the normal and homogeneous data is carried out. Examining the normality is carried out to identify that the samples are from the population with a normal distribution. In the data analysis of this study, the normality test of Liliefors is carried out on the level of  $\alpha = 0.05$ . To calculate the normality, the criteria of the test is accepting  $H_0$  if  $L_{\text{counting}} < L_{\text{table}}$ . It means that the data is from the population with a normal distribution.

To calculate the normality of the reliability coefficient data for the instruments of *belief* about mathematics with five options shows that  $L_{\text{counting}} = 0.1319$  whereas  $L_{\text{table}}$  on the level of  $\alpha = 0.05$  with the data number of 20 is 0.19. It means that  $L_{\text{counting}} < L_{\text{table}}$ . Therefore, accepting  $H_0$  means that the data is from the population with a normal distribution. To calculate the normality of the reliability coefficient data for the instruments of *belief* about mathematics with five options shows that  $L_{\text{counting}} = 0.1406$  whereas  $L_{\text{table}}$  on the level of  $\alpha = 0.05$  with the data number of 20 is 0.19. It means that  $L_{\text{counting}} < L_{\text{table}}$ .

Therefore, accepting  $H_0$  means that the data is from the population with a normal distribution. To calculate the normality of the reliability coefficient data for the instruments of *belief* about mathematics with three options shows that  $L_{\text{counting}} = 0.0656$  whereas  $L_{\text{table}}$  on the level of  $\alpha = 0.05$  with the data number of 20 is 0.19. It means that  $L_{\text{counting}} < L_{\text{table}}$ . Therefore, accepting  $H_0$  means that the data is from the population with a normal distribution.

The result of examining the homogeneity of the reliability coefficient groups for the instruments of *belief* about mathematics shows that  $\chi^2_{\text{counting}} = 3.914$  whereas  $\chi^2_{\text{table}}$  on the level of  $\alpha = 0.05$  dk 2 is 5.591. Therefore,  $\chi^2_{\text{counting}} < \chi^2_{\text{table}}$ . It means that the variant groups have a homogeneous data.

Examining the hypotheses of the study is carried out by one-way analysis of variants (ANOVA) technique; it aims to identify the reliability coefficient difference between the instruments of *belief* about mathematics with five, four, and three options. The result of calculating data analysis of one-way ANOVA test can be seen in the following table:

**Table 2.** One-Way ANOVA

Variant Souces	JK	Db	RJK	$F_{\text{counting}}$	$F_{\text{table}} (\alpha = 0.05)$	Note
Between	0.041	2	0.02066089	30.767	3.16	Significant
In	0.038	57	0.000672			
Total	0.079	59				

Based on the result of calculating one-way ANOVA, it shows that  $F_{\text{counting}} = 30.767$  whereas  $F_{\text{table}}$  with db the numerator of 2 and the denominator of 57 on the level of  $\alpha = 0.05$  or  $F_{\text{table}} (0.05; 2,57)$  is 3,16. Therefore,  $F_{\text{counting}} > F_{\text{table}}$ . It means that there is an average difference of the reliability coefficient value for the instruments with five, four, and three options. So, it is continued with examining *tukey*, and this examining aims to identify which group is higher.

Based on the *tukey* test of the reliability coefficient for the instruments of *belief* about mathematics with five and four options, it shows that  $Q_{\text{counting}} = 7.08$  whereas  $Q_{\text{table}} = 3.406$ . So,  $Q_{\text{counting}} > Q_{\text{table}}$ . Therefore,  $H_0$  is rejected. It means that there is an average difference of the reliability coefficient value for the instruments of *belief* about mathematics with five and four options. The average of  $\rho_{\text{max1}} = 0.88497$  whereas the average of  $\rho_{\text{max2}} = 0.843895$ . It means that the reliability coefficient for the instruments of *belief* about mathematics with five options is higher than the reliability coefficient for the instruments of *belief* about mathematics with four options.

Based on the *tukey* test of the reliability coefficient for the instruments of *belief* about mathematics with five and three options, it shows that  $Q_{\text{counting}} = 10.93$  whereas  $Q_{\text{table}} = 3.406$ . So,  $Q_{\text{counting}} > Q_{\text{table}}$ . Therefore,  $H_0$  is rejected. It means that there is an average difference of the reliability coefficient value for the instruments of *belief* about mathematics with five and three options. The average of  $\rho_{\text{max1}} = 0.88497$  whereas the average of  $\rho_{\text{max3}} = 0.82161$ . It means that the reliability coefficient for the instruments of *belief* about mathematics with five options is higher than the reliability coefficient for the instruments of *belief* about mathematics with three options.

Based on the *tukey* test of the reliability coefficient for the instruments of *belief* about mathematics with four and three options, it shows that  $Q_{\text{counting}} = 3.84$  whereas  $Q_{\text{table}} =$

3.406. So,  $Q_{\text{counting}} > Q_{\text{table}}$ . Therefore,  $H_0$  is rejected. It means that there is an average difference of the reliability coefficient value for the instruments of *belief* about mathematics with four and three options. The average of  $\rho_{\text{max}2} = 0.843895$  whereas the average of  $\rho_{\text{max}3} = 0.82161$ . It means that the reliability coefficient for the instruments of *belief* about mathematics with four options is higher than the reliability coefficient for the instruments of *belief* about mathematics with three options.

## DISCUSSION

The result of this study shows that there is a difference between the instruments of *belief* about mathematics with different option numbers; they are five, four, and three option numbers. The difference of the varied *belief* option numbers affects the difference of the reliability. Thus, the more the option numbers are, the higher the variants will be and the higher the variants are, the higher the reliability coefficients will be. It matches things Siti Muslihah Hadi (2013) found; they are (1) there is an effect on the numbers of response categories toward the reliability of mathematics instruments, (2) the reliability of mathematics disposition instruments with seven response categories is higher than the reliability of mathematics disposition instruments with five response categories, (3) the reliability of mathematics disposition instruments with seven response categories is higher than the reliability of mathematics disposition instruments with four response categories, (4) the reliability of mathematics disposition instruments with six response categories is higher than the reliability of mathematics disposition instruments with four response categories. It means that the more the option numbers are, the higher the instruments of the reliability coefficients will be. It matches what Mueller stated from Guilford's statement (1986: 386) that the reliability will increase if the option numbers increase.

In this study, it is found that there is no significant effect in using the midpoint choice. It can be seen from the difference between the mean reliability with the midpoints (three and five options) and the mean reliability without the midpoints (four options). The mean of five options = 0.88497, the mean of four options = 0.843895, and the mean of three options = 0.822. Thus, there is no decreasing significant reliability coefficients by using the midpoint options, it is different from what Rungson stated (2010: 399) in his invention that an options with the midpoint options will affect the variants, the variants are smaller because respondents will have more midpoints and they do not have to read or think the instruments they fill. Therefore, the reliability will decrease.

## CONCLUSION

The average of the reliability coefficients for the instruments of *belief* about mathematics with five option numbers is higher than the reliability coefficients for the instruments of *belief* about mathematics with four option numbers. The average of the reliability coefficients for the instruments of *belief* about mathematics with five option numbers is higher than the reliability coefficients for the instruments of *belief* about mathematics with three option numbers. The average of the reliability coefficients for the instruments of *belief* about mathematics with four option numbers is higher than the reliability coefficients for the instruments of *belief* about mathematics with three option numbers. Thus, the more the option numbers are, the higher the reliability of the instrument will be.

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