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Evaluating Anxiety, Self-Efficacy and Positive Attitude Correlation Towards Mathematics Through Fuzzy Correlation Utilization

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Abstract: Three factors that have been considered to influence mathematics learning outcomes are anxiety, self-efficacy and positive attitudes. Those have correlation each other. The analysis between the three factors is usually carried out using the pearson correlation concept where the data used is the crisp data. The fuzzy correlation is an attempt to provide an alternative in analyzing the correlation between two variables and the data used is fuzzy data. The data was collected from 1063 respondents through fuzzy instruments. The advantage of this instrument is that crisp and fuzzy data can be obtained immediately. Data analysis is done using pearson and fuzzy correlation. The results reveal several facts, those are: fuzzy data provides a more flexible and real conception, anxiety with self-efficacy has a negative correlation at a low level, anxiety with a positive attitude of students have a negative correlation at a low level, self-efficacy with a positive attitude has a moderate positive correlation, fuzzy correlation coefficients in the form of fuzzy interval numbers provide an advantage in decision making.

Key words: Anxiety, self-efficacy, positive attitude, mathematics, fuzzy correlation, decision

INTRODUCTION

A marriage between psychological factors and mathematics is still an inspired or even minor issue in education. Some of the psychological factors which influence mathematics learning are first, math anxiety (Ashcraft and Kirk, 2001; Ashcraft, 2002). Further, the negative effects caused by the anxiety can result in a reduction of student's memory. Then, it effectuates the test they face. They will be difficult to use the obtained information in completing the tests. Secondly, mathematics self-efficacy (Kundu and Aditi, 2016). Self-efficacy is an individual's belief in the ability to solve problems faced. Good self efficacy can reduce the anxiety arising in students (McGrath *et al*., 2015; Lee, 2009; Hoffman, 2010). Third, the attitude of students towards mathematics (Zan and Martino, 2007). The attitudes toward mathematics can be either a positive or negative emotions towards mathematics (Zan and Martino, 2007). A positive attitude towards mathematics has a positive influence on mathematics learning outcomes while a negative attitude is vice versa. As such these three factors have a close correlation to each other (Recber *et al*., 2018; Akin and Kurbanoglu, 2011). The researches have reached the conclusion that the anxiety has a negative correlation with the self-efficacy and has positive attitudes towards mathematics as well as a positive correlation to negative attitudes. Furthermore, self-efficacy has a positive correlation with a positive attitude and has a negative correlation with a negative attitude. These three factors were analyzed using analytical pearson correlation (Recber *et al*., 2018; Akin and Kurbanoglu, 2011).

Pearson correlation is a probability concept based statistical analysis. It is not able to explain the correlation between detailly analyzed variables (Coppi, 2008). Therefore, the fuzzy concepts provide an alternative to be used in the process of data analysis because of its several advantages statistics do not have (Chi *et al*., 1996), those are not dependent upon randomization, able to analyze the crisp and fuzzy data able to explain in which statistics cannot, able to model problems easily, more flexible to easify the use of expert knowledge.

Fuzzy correlation develops as an alternative to pearson correlation analysis. Fuzzy correlation with the expected interval method (Hung and Wu, 2001) uses interval data. While fuzzy correlation with centroid method (Hanafy *et al*., 2013) uses fuzzy neutrosophic

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data. Fuzzy correlation is developed by generalizing the form of fuzzy pearson correlation (Cheng and Yang, 2013). The data used are fuzzy interval data, trapezoidal data, and triangle. Cheng and Yang (2013) fuzzy correlations easify the data analysis practitioners to use them compared to the two earlier mentioned fuzzy correlations.

Pertaining to the background in what follows, we will discuss the main application of fuzzy correlation in evaluating the correlation among mathematical anxiety, mathematics self-efficacy and student's positive attitudes towards mathematics using Cheng and Yang correlation (2014) as well as pearson correlation as a displayed comparison. The data used is collected through fuzzyc instruments. The two types of data can be immediately obtained using this instrument, namely fuzzy interval data and crisp data.

MATERIALS AND METHODS

Participant: Participants were 1063 of high school students and vocational students, class 10 and 11. The ages of the participants were between 15 and 17 years old.

Instrument: The instruments with fuzzy Likert scale are used to measure mathematical anxiety, self-efficacy and attitudes towards mathematics. Each scale consists of 15 items. The choice of language terms on each item is strongly disagree, disagree, neutral, agree and strongly agree. This instrument is filled with two steps, first, the respondent chooses the answer as in the classic Likert scale and the two respondents determine the confidence interval for the choice in the first step. The crisp data is obtained from the first step and fuzzy data is obtained from the second step of filling the instrument. The scoring on each language term on each item is by giving a score of 10 to strongly disagree, 20 to disagree, 30 to neutral, 40 to agree and 50 to strongly agree.

Correlation between two variables: The correlation between mathematical anxiety and self-efficacy as well as a positive attitude towards mathematics was determined using pearson correlation analysis for the crisp data. Meanwhile, the fuzzy data is determined using fuzzy correlation analysis. Previously, the basic operation of fuzzy interval data was given before applying the fuzzy correlation formula.

Fuzzy data: Fuzzy data in the form of interval data based on the need to be able to use Cheng and Yang (2013). Fuzzy interval data can be written with $x_i^* = [a_{1i} + a_{2?e}]$. Fuzzy interval data can be transformed into triangular fuzzy data $x_i^* = \left[a_{1i}\, \frac{a_{1i} + a_{1i}}{2}, a_{2i}\right]$. Addition operation and deviation in fuzzy interval data. Let there be given two fuzzy data dan:

$$x_1^* = [a_{11},\ a_{21}] \text{dan} x_2^* = [a_{12},\ a_{22}]$$

$$(\beta)_1^* + {}_2^x = [a_{11},\ a_{21}] + [a_{12},\ a_{22}]$$

$$[a_{11} + a_{12},\ a_{21},\ a_{22}]$$

$$x_1^* - x_2^* = [a_{11},\ a_{21}] - [a_{12},\ a_{22}]$$

$$[a_{11} - a_{12},\ a_{21} - a_{22}]$$

Fuzzy interval data mean: Given n fuzzy interval $x_i^*[a_{1i}, a_{2i}], i = 1, 2, \ldots, n$ data, then the mean of these data can be written as follows:

$$\overline{x}^* = \left[\frac{\sum_{i=1}^{n} a_{1i}}{n}, \frac{\sum_{i=1}^{n} a_{2i}}{n}\right]$$

Fuzzy interval data median

$$Me^* = [Me\{a_1, a_2, \ldots, a_n\},\ Me\{b_1, b_2, \ldots, b_n\}]$$

Pearson correlation: Let, $X = \{x_{1\text{-}3}, \ldots, x_n\}, Y = X = \{y_{1\text{-}3}, \ldots, y_n\}$ be a sequence of paired data sample on populations Ω. Lets:

$$r_{xy} = \frac{\sum_{i=1}^{n}(x_1 - \overline{x})(y_i - \overline{y})}{\sqrt{\sum_{i=1}^{n}(x_i - \overline{x})^2}\sqrt{\sum_{i=1}^{n}(y_i - \overline{y})^2}},\ i = 1, 2, 3, \ldots,$$

Pearson correlation coefficient has a correlation r_{xy} coefficient located at intervals [1, -1]. the level of correlation between variables is determined by the standard in Table 1 and 2.

Fuzzy correlation: Fuzzy correlations developed by Cheng and Yang (2013) use the following definitions: let $x_{ji}^* = [a_{1j}, a_{2i}]$, $y_i^* = [b_{1j,} b_{2i}]$, be a sequence of paired fuzzy sample on populations Ω. Let:

$$r_{jk} = \frac{\sum_{i=1}^{n}(a_{ji} - \overline{a_j})(b_{ki} - \overline{b_k})}{\sqrt{\sum_{i=1}^{n}(a_{ji} - \overline{a_j})^2}\sqrt{\sum_{i=1}^{n}(b_{ki} - \overline{b_k})^2}},$$

$$j = 1,\ 2,\ 3 \text{ dan } k = 1,\ 2$$

Then fuzzy correlation is $[r_{low}, r_{up}]$ with $r_{low} = \overline{r} - s_r$ and $u_p = \overline{r} + s_r$ where (Fig. 1):

Table 1: Descriptive statistic of fuzzy and crisp data

	Crisp data			Fuzzy interval data		
Variables	Anxiety	Self-efficacy	Attitude	Attitude	Self-efficacy	Anxiety
Min data	160	150	150	[0 168]	[0 140]	[0 168]
Max data	730	730	980	[617 766]	[656 870]	[816 900]
Median data	470	450	490	[411 502]	[403 494]	[445 533]
Mean data	464,5	450,3	494,2	[402, 54 500, 68]	[399, 38 494, 63]	[444, 33 539, 44]

Table 2: Results of combined data fuzzy correlation analysis

Correlations between			
Variables	Anxiety and self-efficacy	Anxiety and attitude	Attitude and self efficacy
Pearson correlation	-0.259	-0.160	0.710
Fuzzy correlation	[-0, 278 -0,275]	[-0, 185 -0,183]	[0,665 0, 663]
N	1063	1063	1063

$$\bar{r} = \frac{\sum_{j=1}^{2}\sum_{k=1}^{2} r_{jk}}{4} \text{ and } s_r \frac{\sum_{j=1}^{2}\sum_{k=1}^{2}(r_{jk}-\bar{r})^2}{4}$$

The definition has a correlation coefficient value at intervals [-1, 1] and the correlation level between observed variables can be determined by the following definitions:

- When $[r_{low}, r_{up}] \in [-0.10, 0.10]$, the fuzzy correlations is not significant
- When $[r_{low}, r_{up}] \in [-0.39, 0.11]$ or $[0.11, 0.39]$, the fuzzy correlations is low
- When $[r_{low}, r_{up}] \in [-0.69, 0.40]$ or $[0.40, 0.69]$, the fuzzy correlations is middle
- When $[r_{low}, r_{up}] \in [-0.99, 0.70]$ or $[0.70, 0.99]$, the fuzzy correlations is high

RESULTS AND DISCUSSION

The fuzzy data is required to use Cheng and Yang correlation which is fuzzy interval data. The data is obtained from the data collection process through the fuzzy anxiety and attitude scale. The score of mathematical anxiety and attitudes toward mathematics are the sum of fuzzy interval data scores using the formulas.

Data analysis: Explaining the concept and the advantages of fuzzy data (Table 2), it can be seen that each correlation method provides indifferent results pertaining to the correlation among anxiety and self-efficacy, anxiety with a positive attitude and self-efficacy with a positive attitude. The fuzzy correlation coefficient is in the interval form while the pearson correlation coefficient is a crisp value.

The three correlation coefficients are obtained from the results of data analysis, those are the correlation coefficient between anxiety and self-efficacy in Table 2 shows that these two variables have a negative correlation at a low level. In conformity with the the previous research (Lee, 2009; Hoffman, 2010; Akin and Kurbanoglu, 2011; McGrath *et al*., 2015; Recber *et al*., 2018), the higher the condition of student's self-efficacy is the minimized student's anxiety in learning mathematics becomes at a low effect the correlation coefficient between anxiety and positive attitudes towards mathematics in Table 2 illustrates that the two variables have a negative correlation at a low level. These results are in line with the previous research of Recber *et al*. (2018), Akin and Kurbanoglu (2011). The more positive of the student's positive attitude is the more reduced student's anxiety in learning mathematics becomes with a low effect the correlation coefficient between self-efficacy and positive attitudes toward mathematics in Table 3 clarifies the results of the study (Recber *et al*., 2018; Akin and Kurbanoglu, 2011), namely that these two variables have a moderate correlation each other. The higher the condition of self-efficacy is the higher the student's positive attitude towards mathematics becomes with a moderate effect. The correlation between these three factors is described as follows.

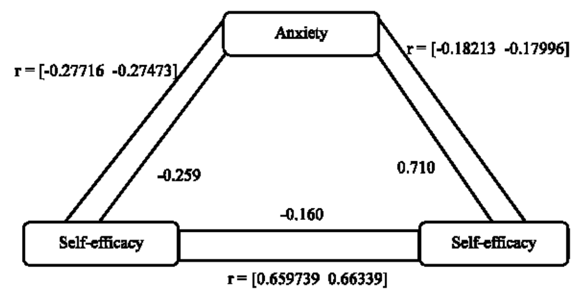

Fig. 1: The correlation between anxiety, self-efficacy and positive attitude

Fuzzy data in the interval form has their own uniqueness, namely, a student can have a level of anxiety, self-efficacy or a positive attitude at the same level or two levels immediately. For instance, the level of these factors can be high to very high or very low to low and so on. These characteristics prove that fuzzy interval numbers can indicate the transition level of the condition of each variable in students. Unfortunately, the crisp data obtained from the classic instrument cannot reveal the transition level of each variable because respondents are forced to choose options being closed to their conditions. Based on these findings, fuzzy numbers provide flexible results when compared to the crisp numbers. Further, fuzzy numbers are able to describe the more clear condition of each variable when compared to the crisp numbers (Muhith *et al*., 2018; Mallongi *et al*., 2018). The correlation coefficient in Table 2 conceptualizes that the three variables have correlation each other. The possible correlation level between two variables when using pearson correlation analysis are having no correlation, low correlation, moderate correlation and high correlation. These levels are also very likely to occur when applying fuzzy correlation. Like fuzzy interval numbers, fuzzy correlation coefficients can be at several levels immediately, namely not significant until having a low correlation, having a low to moderate correlation, having a moderate to high correlation. These conditions are impossible in the classical correlation analysis, even though contextually possible.

The concept of fuzzy correlation was developed by Cheng and Yang (2013) by adopting the Pearson correlation the principle. It easifies practitioners to analyze correlation data using the fuzzy data. The advantage of correlation coefficients in the form of intervals is that researchers or experts have a subjectivity in determining the correlation coefficient used from the analysis results. Whereas in the pearson correlation coefficient, researchers cannot determine the subjectivity of the obtained crisp coefficient.

CONCLUSION

Returning to the question posed at the beginning of this research, it is now possible to state that the interval numbers provide a very large role in explaining obscurity which is not clarifiable from the crisp numbers. Fuzzy numbers can explain the psychological condition of students, in this case, anxiety, self-efficacy and positive attitudes of students with more flexible and tangible contexts. For instance, the students can be at a different level at the same time.

The analysis of pearson and fuzzy correlation in this research provides the same conception, namely the anxiety has a negative correlation with self-efficacy at a low level anxiety has a negative correlation with student's positive attitudes towards mathematics at a low level and self-efficacy has a positive correlation at a moderate level. Both of these analyses are distinguished by the form of the correlation coefficient which is in the crisp and fuzzy interval data.

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