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Using Fuzzy Statistics to Determine Mathematics Attitude and Anxiety

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Abstract: The purpose of this study is to determine primary school students' mathematics anxiety by using fuzzy statistics. In addition, it also studies whether there is a relation between the scores of anxiety and attitude. A 10-item mathematics anxiety scale for primary school children and a 20-item mathematics attitude scale have been carried out during the spring semester of the academic year 2007-2008. By considering the variety of this study's environment, this study has been applied on 280 students studying in Ankara at a private training institution and 269 of them have been assessed. In the data analysis, Excel and SPSS 13.0 programs were used. Operations carried out with fuzzy statistics, in this study, are referred to as "fuzzy method" and operations with normal numbers as "classical method". By determining the anxiety and attitude through classical method, the results show that the students' anxiety towards mathematics courses is low and their attitudes are statistically meaningful. In addition, in order to determine the attitudes through fuzzy method, the "fuzzy expected values" on grade level for every item was calculated and compared with the arithmetic mean.

Key words: Fuzzy Statistics · Fuzzy Expected Value (FEV) · Mathematics · Anxiety · Attitude

INTRODUCTION

The main purpose of this study is to use fuzzy sets and fuzzy statistics, which are already used in various matters, to identify Mathematics Anxiety. The Fuzzy Sets concept was first introduced by Zadeh in [1]. It is widely known that many articles and books related to fuzzy sets and their application in fields such as statistics, information processing and linguistics. In addition, fuzzy sets have been applied in many fields within science and technology. However, the use of fuzzy statistics in education has not been sufficiently studied yet.

As education is an essential factor in affecting anxiety, teachers knowing what anxiety their students feel towards the course and towards what other concepts are within social life as well as knowing how to measure it is a major impact in increasing the quality of education. For this reason, studies focusing on measuring anxiety of students regarding a certain course subject or course have gained great importance today. Accordingly, it is important to reach the method for measurement to reach the most realistic results. This is why it is thought that using Fuzzy statistics would be beneficial in many areas.

Fuzzy set statistics should be carried out in a broad sense. Average, standard deviation, variance analysis and regression analysis are the methods used within the set [2].

It is thought that FEV provides a more reliable result when calculating the class' average in success. This point of view can be interpreted as such; among the studies previously carried out, FEV has statistically provided the best result in majority. Arithmetic mean has provided a better result when the students' success showed normal range. When calculating an arithmetic mean, the class is considered as a whole, extreme values are not taken into consideration. A class being successful or not means the majority of students are successful or not. One or two intelligent or slow student(s) should not affect the class' average. These should be accepted as exceptions because the information the teacher can provide them is limited. Such situations lead to the results of FEV being close to realistic [3].

Individuals generally assign meanings to events happening around them and from these meanings occur personal experiences. The beliefs and approaches developed through these experiences are referred to as *attitude.* Attitudes shape the individual's behavior. While

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feeling of inadequacy due to the attitude leads to lack of trust, this lack of trust leads to the individual experiencing some sort of experiences referred to as *anxiety*. Starting from this point, attitude and anxiety can be defined in more detail.

Attitude is attributed to the individual and it is the tendency of forming thoughts, emotions and behavior towards a psychological event. The strength of attitude is equal to the sum of cognitive, affective and psychomotor elements, which are high in imbedded attitudes [4].

Anxiety, on the other hand, is described as an emotion that fosters the person to sometimes creative and constructive behavior and sometimes to behaviors that prevent these and generally leads to uneasiness [5].

Anxiety can be experienced in a specific area as much as it can be experienced in various areas. One of these specific areas that anxiety can be experienced is mathematics anxiety. *Mathematics anxiety* is defined as experiencing anxiety and tension when solving mathematical problems or using numbers in daily or academic life [6].

Definition: May X be any kind of a set. A fuzzy set A in X would be defined as $\mu_A(x)$ membership function defined to the count by I=[0,1] from X. Elements of I^x are defined as a fuzzy set on X [1].

To decrease the effect of extreme end values on the average, the "fuzzy expected value" (FEV), which is used in calculating fuzzy statistics, is used [3].

The most important factor sets FEV aside from the central tendency measures is it not being affected from extreme end values [3].

Dubois and Prade [7] put forward a special kind of L-R type fuzzy number. This number consists of center, dispersion to left and dispersion to right. The A fuzzy number provided below shows a symmetrical triangular number whereas the B fuzzy number shows a nonsymmetrical triangular number.

$A = (\alpha_1,\alpha_2,\alpha_3)$ and $B = (b_1,b_2,b_3)$, α_1 is the central value, α_2 the value of dispersion to left and α_3 the value of dispersion to right. Same condition is valid for number B as well.

When Dubois and Prade's method, which is the easiest as operation for fuzzy expected value, is adopted, it turns out to be quite practical operation wise with triangular numbers. The used formula:

$$(m,\alpha,\beta)+(n,\gamma,\delta)=(m+n,\alpha+\gamma,\beta+\delta)$$

If a real number is a scalar product:

$$\forall\lambda>0,\lambda\in R,\lambda.(m,\alpha,\beta)=(\lambda m,\lambda\alpha,\lambda\beta)$$
$$\forall\lambda<0,\lambda\in R,\lambda.(m,\alpha,\beta)=(\lambda m,-\lambda\beta,\lambda\alpha)$$

[7].

Purpose: It is aimed to use fuzzy sets and fuzzy statistics, which are already used in various fields today, to identify mathematics anxiety and attitude. Identifying the attitude and anxiety of students especially towards mathematics and figuring out if the course reaches its goal is very essential in education. For this reason, it is necessary to determine methods that reach the most realistic result. According to this point of view, the purpose of this study is to identify attitude and anxiety of primary school 4th, 5th, 6th, 7th and 8th grade students towards Mathematics by using FEV and to compare the arithmetic mean of their answers on the anxiety scale with the FEVs.

Problems:

- At which level is the mathematics anxiety of the primary school 4th, 5th, 6th, 7th and 8th grade students calculated according to the FEV and classical method?
- At which level is the mathematics attitude of the primary school 4th, 5th, 6th, 7th and 8th grade students calculated according to the FEV and classical method?
- On levels of primary school 4th, 5th, 6th, 7th and 8th grade classes, is there a meaningful difference between the means of the mathematics anxiety scores calculated one by one through FEV and classical method?
- How is the Mathematics anxiety of the primary school 4th, 5th, 6th, 7th and 8th grade students according to the items?
- How is the Mathematics attitude of the primary school 4th, 5th, 6th, 7th and 8th grade students according to the items?

Assumptions:

- The used assessment instruments are valid and reliable.

- Students replied the assessment instruments sincerely.
- Voluntary students took part in the research.

Restrictions: The research is limited with

- 280 students that continue to a private training institution at primary level in Ankara,
- Primary school 4th, 5th, 6th, 7th and 8th grade students,
- The Spring semester of the academic year 2007-2008 and
- The assessment tools used in this research and their sub dimensions.

MATERIALS AND METHODS

Forming the Study Group: The study was carried out on 280 students studying at a private teaching institution in Ankara that provides the variety of the data within the spring semester of the academic year 2007-2008 and 269 of them were considered to be evaluated.

RESULTS AND DISCUSSION

Data Collection Tool: The 10-item "Mathematics Anxiety Scale" developed by [8] for primary school students and a 20-item "Mathematics Attitude Scale" by [9]. Were carried out. The Cronbach Alpha coefficient for the internal reliability of the mathematics anxiety scale is 0,84. It is stated that according to the result of the factor analysis carried out for the scale's structure validity, the scale is gathered in one dimension and the structure validity is high. The Cronbach Alpha coefficient for the reliability of the mathematics course attitude scale is 0,96. It is stated that according to the result of the factor analysis carried out for the validity, the scale is gathered in one dimension. 10 items of the scale is positive whereas the other 10 is negative.

Data Analysis: Operations carried out with fuzzy statistics, in this study, are referred to as "fuzzy method" and operations with normal numbers as "classical method". The SPSS 13.0 was used to analyze the data of the Mathematics anxiety scale and Mathematics Course

Table 1: FEV's of Mathematics anxiety scale items based on grade level

Item	4th grade	5th grade	6th grade	7th grade	8th grade
1	3	3	3	3	2.92
2	3	4	2.97	2.88	2.99
3	3	3	3	3	2.93
4	3	3.17	3	3	2.82
5	2.40	4	3	3	2.90
6	2.99	3	2.87	3	2.97
7	2.53	4	3	3	2.98
8	3	2.97	3	3	2.83
9	2.71	3	3	3	2.92
10	3	4	3	2.65	2.90

Table 2: FEV's and Arithmetic Means of Mathematics anxiety scale items based on grade level

	4th grade		5th grade		6th grade		7th grade		8th grade	
Item	FEV	$\bar{x}$	FEV	$\bar{x}$	FEV	$\bar{x}$	3	$\bar{x}$	FEV	$\bar{x}$
1	3	2.26	3	2.00	3	2.20	2.88	2.11	2.92	2.64
2	3	2.42	4	1.22	2.97	1.94	3	2.20	2.99	2.20
3	3	1.95	3	1.78	3	1.80	3	1.91	2.93	2.10
4	3	1.84	3.17	1.67	3	2.37	3	2.46	2.82	2.84
5	2.40	2.32	4	1.11	3	2.09	3	1.83	2.90	2.11
6	2.99	1.95	3	1.67	2.87	2.09	3	1.66	2.97	1.84
7	2.53	1.90	4	1.11	3	1.49	3	1.46	2.98	1.54
8	3	2.05	2.97	1.89	3	2.20	3	2.03	2.83	2.54
9	2.71	2.47	3	1.78	3	1.91	2.65	2.11	2.92	2.56
10	3	1.42	4	1.11	3	1.57	3	2.03	2.90	1.98

$\bar{x}$: Arithmetic mean FEV: Fuzzy Expected Value

Grey colored chart: FEV is lower than the arithmetic mean; however, it shows a grade level close to a value

Other charts: Shows grade levels that have provided a better result in FEV than arithmetic means. According to the table, FEV's of all items have provided better results than their arithmetic means among the primary school 4th, 5th, 6th, 7th and 8th grade students. However, the 4th item's FEV of the 8th graders is lower than its arithmetic mean but still close in value.

Table 3: Comparison between the arithmetic means and FEV's of the students' answers in the anxiety scale

	Mean	Std. Deviation	t	dt	sig
4th grade mean- FEV	-.807	.446	-5.717	9	.000
5th grade mean- FEV	-1.881	.855	-6.960	9	.000
6th grade mean- FEV	-1.018	.292	-11.041	9	.000
7th grade mean- FEV	-.973	.320	-9.614	9	.000
8th grade mean- FEV	-.683	.448	-4.819	9	.001

t-test

Paired Samples Statistics

	Mean	N	Std. Deviation	Std. Error Mean
Pair 1 Mean4	2.05790	10	.319213	.100944
FEV4	2.86450	10	.227638	.071986
Pair 2 Mean5	1.53340	10	.354614	.112139
FEV5	3.41440	10	.506875	.160288
Pair 3 Mean6	1.96570	10	.282754	.089415
FEV6	2.98370	10	.041537	.013135
Pair 4 Mean7	1.98000	10	.283168	.089546
FEV7	2.95320	10	.112349	.035528
Pair 5 Mean8	2.23450	10	.404471	.127905
FEV8	2.91700	10	.058298	.018435

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	Mean 4 & FEV4	10	-.312	.380
Pair 2	Mean 5 & FEV5	10	-.968	.000
Pair 3	Mean 6 & FEV6	10	-.142	.695
Pair 4	Mean 7 & FEV7	10	-.152	.676
Pair 5	Mean 8 & FEV8	10	-.712	.021

Table 4: Item Based Student Mathematics Anxiety

Item1	(20.24.29)
Item2	(18.21.26)
Item3	(17.20.25)
Item4	(22.26.31)
Item5	(18.20.25)
Item6	(16.18.23)
Item7	(14.15.20)
Item8	(20.23.28)
Item9	(20.24.29)
Item10	(16.28.23)

Terms of Mathematics anxiety scale items with fuzzy numbers
Never=(10,10,15), Almost Never=(14,20,25), Sometimes=(24,30,35), Almost Always=(34,40,45),
Always=(44,50,50) Table 5. Item Based Students' Mathematics Attitudes

Attitude Scale through classical method analysis. For the fuzzy method analysis of Mathematics anxiety scale and Mathematics Course Attitude Scale, Excel and SPSS 13.0 were used. The arithmetic means and FEV's of all items on the scales, the anxiety points of the Primary school 4th, 5th, 6th, 7th and 8th grade students were calculated. In addition, t-test was applied to compare the arithmetic means and FEV's of the students' answers in the anxiety scale.

In the table shown above, the FEV's of Mathematics anxiety scale items based on grade level are provided.

Table 5: Item Based Students' Mathematics Attitudes

Item1	(69.75.85)
Item2	(70.75.85)
Item3	(63.68.78)
Item4	(62.67.77)
Item5	(35.39.49)
Item6	(33.36.46)
Item7	(68.72.82)
Item8	(68.73.83)
Item9	(65.71.81)
Item10	(64.70.70)
Item11	(63.68.78)
Item12	(66.70.80)
Item13	(49.54.64)
Item14	(58.64.74)
Item15	(68.74.84)
Item16	(68.73.83)
Item17	(65.70.80)
Item18	(63.69.79)
Item19	(67.72.81)
Item20	(55.61.71)

Terms of Mathematics attitude scale items with fuzzy numbers
Very Inappropriate=(20,20,30), Inappropriate=(29,40,50),
Not Sure=(49,50,70),
Appropriate=(69,80,90),
Very Appropriate=(89,90,100)

According to this table, the level of the students' mathematics anxiety level is not high.

According to the table above, the FEV's and arithmetic means of all items replied by the primary school 4th, 5th, 6th, 7th and 8th grade students have been compared and for all grade levels the difference has resulted in favor of FEV.

According to the table above, the fuzzy expected value scale of the 269 students has been determined as (18,21,26). This situation shows that the students experience anxiety during Mathematics class from almost never to sometimes.

According to the table above, the fuzzy expected value scale of the 269 students has been determined as (61,66,76). This situation shows that the students' attitude towards Mathematics class is from not being sure to being appropriate

CONCLUSION AND SUGGESTIONS

Conclusions: The purpose of this study has been to determine mathematics anxiety and attitudes towards mathematics course of primary school students by using classical and fuzzy methods. Within the light of the carried out analyses, the obtained results have been summarized as follows:

- FEV's have been calculated on grade level of mathematics anxiety scale items. According to these calculations, it has been determined that students do not have high-level anxiety towards mathematics.
- For all of the items of the mathematics anxiety scale, the arithmetic mean and FEV's of the primary school 4th, 5th, 6th, 7th and 8th grade students have been calculated. FEV's of all items have provided better results than their arithmetic means. However, the 4th item's FEV of the 8th graders is lower than its arithmetic mean but still close in value.
- The FEV's and arithmetic means of all items replied by the primary school 4th, 5th, 6th, 7th and 8th grade students have been compared and for all grade levels the difference has resulted in favor of FEV.

Suggestions: Identifying the attitude and anxiety of students especially towards mathematics and figuring out if the course reaches its goal is very essential in education. For this reason, it is necessary to determine methods that reach the most realistic result.

According to these results, necessary studies can be carried out by using the fuzzy method in order to bring mathematics, a difficult and important branch, to a better teachable condition

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