

Mathematical Success with Fuzzy Logic Modeling

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Abstract

In this paper, the effect of high school students on mathematics achievement by taking active participation and absent of high school students was investigated by using fuzzy logic modeling. The questionnaire prepared by the researcher is applied to the students to determine the active participation of the students. These written exam scores are used in order to evaluate the absences and achievements of the students until the end of the 1st semester written exam. In this study, inputs are active participation and absent, and output is mathematics achievement. These data were tabulated, graded and transferred to Matlab and the model is obtained by using fuzzy logic toolbox. The actual results obtained from this model with the output values R^2 review by making the similarity rate is found to be 80%.

Keywords: Mathematics Achievement, Fuzzy Logic, Education

Bulanık Mantık Modellemesi ile Matematik Başarısı

Öz

Lise öğrencilerinin derse aktif katılımları ve yapmış oldukları devamsızlıklar ele alınarak matematik başarısına olan etkisi modern optimizasyon tekniklerinden bulanık mantık modellemesi kullanılarak incelenmiştir. Öğrencilerin derse aktif katılımlarını saptamak için araştırmacı tarafından hazırlanan anket öğrencilere uygulanmıştır. Öğrencilerin 2018-2019 öğretim yılı 1. dönem 1. matematik yazılı sınav tarihine kadar olan devamsızlıkları ve başarılarının değerlendirilebilmesi için bu yazılı sınav puanları kullanılmıştır. Bu çalışmada girdiler aktif katılım ve devamsızlık, çıktı ise matematik başarısıdır. Elde edilen değerler ile veriler oluşturulmuştur. Bu veriler tabloleştirilip derecelendirilmiştir ve matlab programına aktararak fuzzy logic araç kutusu kullanılarak model elde edilmiştir. Bu modelden elde edilen çıktı değerleriyle var olan gerçek sonuç değerleri R^2 incelemesi yapılarak benzerlik oranı %80 olarak bulunmuştur.

Anahtar Kelimeler: Matematik Başarısı, Bulanık Mantık, Eğitim.

1. Introduction

Mathematical modeling is the process of considering and interpreting a real-life problem mathematically. The problem is defined, the data is collected and analyzed, then mathematically formulated and a mathematical model is created. The found result is adapted to real life and interpreted [1]. In this study, using the fuzzy toolbox in the Matlab program on the computer, one of the mathematical models, the input variables are the active participation and absent of the students, and the output variable is the mathematical success, then fuzzy logic modeling method is applied. The concept of fuzzy logic was introduced by Zadeh [2]. In fuzzy logic, it is desired to measure the degree of accuracy by determining how much the expressions are realized by creating membership degrees to the expressions used in daily life [3]. Today, fuzzy logic is used in economics, health, engineering, education, etc. It is preferred in many fields such as In the fuzzy logic system, the input variables are blurred and the data obtained within the rules are defuzzified and converted into numerical output values [4-7]. In this study, a surface is obtained depending on the input and output variables in the fuzzy logic system and the correlation percentages are calculated by comparing the system output data with the existing data.

2. Material and Methods

The importance active participation of students in the lesson and the effects of their absence from school on their mathematics achievement are discussed. The 'Active Participation Questionnaire in Mathematics Lesson' was created by the researcher to determine the active participation of the students. Absent was determined by evaluating the attendance documents of student until the 1st Term 1st Mathematics written exam date. The study was carried out by considering the scores they received in the 1st Term 1st Mathematics written exam applied to the students with mathematics achieve obtained from the data, It was transferred to the excel program, tabulated and evaluated.

The membership degree, $\mu(x)$, is specified for each value in the range of the variable X , which has lower and upper bounds such as X_a and X_b . Membership rating is between 0 and 1. As seen in the graph, this curve, which changes with the values of the cluster members, is called the membership function [8].

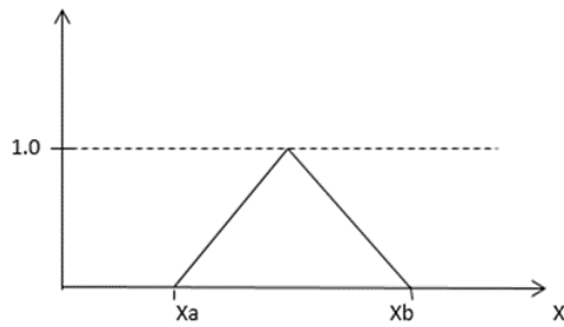


Figure 1. Fuzzy Set

Fuzzy systems are systems in which fuzzy set principles are used in order to reach output variables thanks to existing data and input variables. In the fuzzy model, the logical relations between input and output take place by applying if-then rules.

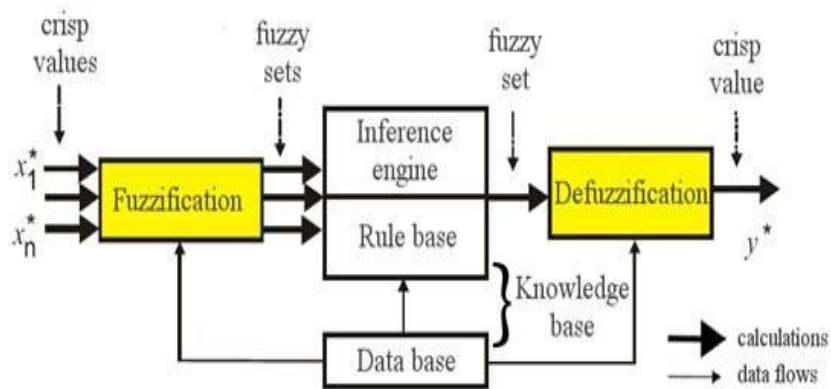


Figure 2. General Fuzzy System

Fuzzifier: It is the processor that enables to obtain fuzzy data by converting numerical input values into linguistic variables, that is, verbal expressions.

Fuzzy Rule Base Unit: It contains rules with if-then commands that enable to examine the logical relationships between input and output variables in the database.

Fuzzy Inference Engine Unit: It provides the inferences of the rules between the input and output fuzzy sets to determine what kind of output the system will give depending on its inputs.

Clarifier: It transforms the fuzzy results found as a result of fuzzy processes into clear digital output values [9-11].

3. Results and Discussion

The data obtained for the research are as follows.

Active Participation	Discontinuity	Success
89	5,5	46
100	2,5	77
100	1	91
88	1	92
55	1,5	66
93	2	92
26	1	73
54	3	47
92	2	85
74	8,5	10
61	5	27
38	0.5	52
71	2	30
96	4	42
68	2.5	10
74	8,5	15
69	2	14
58	7,5	20
76	4,5	36
66	1	70
87	1,5	62
80	4,5	68
67	1	81
72	3,5	50

72	3,5	64
84	1,5	78
86	2,5	84
63	6,5	24
85	3,5	52
80	5,5	64
90	1,5	97
53	1,5	55
94	3	77
72	3,5	50
72	1,5	58
88	5	50
71	2	22
98	1,5	100
86	0,5	86
86	0,5	100
78	0,5	85
75	1	81
57	2,5	28
82	0,5	92
81	8	26
69	6,5	50
67	12	43
95	1,5	100
80	1	91

84	1,5	100
94	2	90
80	0	90
89	0,5	85
96	0	90
85	1	87

82	0	98
85	3	82
82	3	44

Obtained values are modeled by fuzzy logic method. In this study, while active participation and absent constitute the input variables of the study, success also constitutes the output variable. Thus, a two-input and output model was obtained.

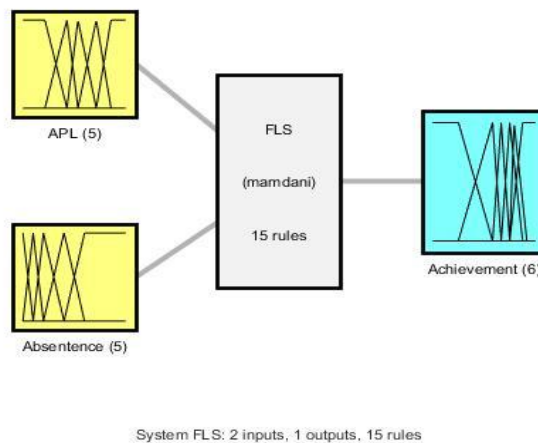


Figure 3. Main Diagram of Fuzzy Logic System

Thus, in the fuzzy logic model, a surface was obtained that determines the relationship between active participation of students in the lesson and their absent from school and their mathematics achievement.

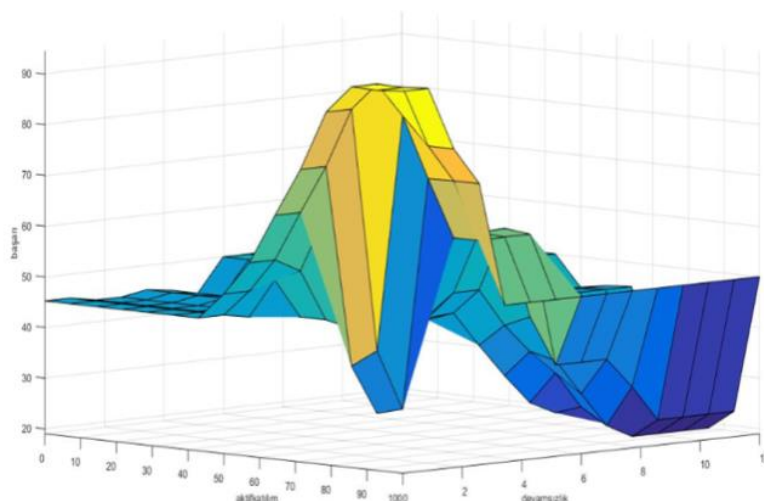


Figure 4. Surface obtained from the model

In the model obtained, output values were found in the fuzzy logic system for each input variables. In the table below, the success values obtained by the fuzzy logic method are compared with the success values available.

Current Values	Fuzzy Logic System Values
46	52,1
77	74,6
91	92
92	91,1
66	55,2
92	78,3
73	45,2
47	44,7
85	78,5
10	21,6
27	43,6
52	45,2

30	29,4
42	50
10	29
15	21,6
14	33
20	44,8
36	47,8
70	62,5
62	86,6
68	51,9
81	63,4
50	45,2
64	45,2

78	85,9
84	74,4
24	44,2
52	62,2
64	48,5
97	84,3
55	53,6
77	74,4
50	45,2
58	41,7
50	62,8
22	29,4
100	84,4
86	94,2
100	94,2
85	88,2
81	69,6

28	44,1
92	92
26	27,6
50	33,1
43	36,2
100	84,4
91	74
100	85,9
90	78,3
90	90
85	93,6
90	94,5
87	92,1
98	92
82	74,4
44	31,4

The correlation coefficient R^2 was calculated by comparing the existing success values with the success values obtained from the model. When these values were compared in the study, it is determined that the similarity rate was 80%.

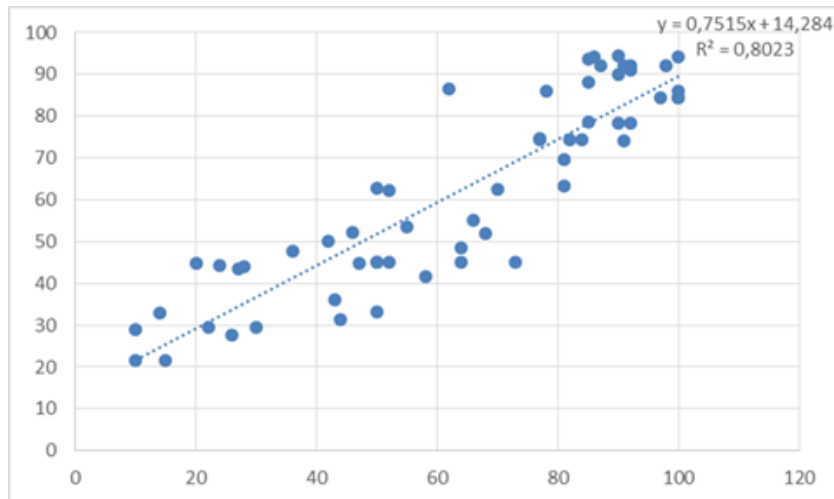


Figure 5. Comparison of Values

4. Conclusion

In this study, the effect of active participation of students in the lesson and their absence from school on their mathematics achievement is examined by fuzzy logic method. The active participation scores of the students are obtained by adding the scores of the marked situations in the survey study applied to the students. Student's absent from school is determined for the period until the 1st semester 1st mathematics written exam date, and their mathematics achievement is considered as the scores they got from the 1st semester 1st mathematics exam. In this study, while active participation and absent constitute the input variables, mathematics achievement constitutes the output variable. After determining the rules for the relationships between the inputs and the output, the model is obtained. On the surface obtained from the model created with the fuzzy logic method, while active participation has a positive effect on success, absent has a negative effect. High success is achieved in cases where active participation is high and absent is low. It has been determined that there is low success in cases where active participation is low and absent is high. In the study, the values obtained from the fuzzy logic system are compared with the actual values, and the similarity rate is found to be 80%.

If this study is to be investigated later by another researcher to investigate the active participation of the students in the lesson and their absent at school, which affects the mathematics achievement, thanks to the model we have obtained with the fuzzy logic method, we can enter our own data and obtain the results of mathematics achievement. In addition,

research can be conducted by adding other factors that affect the success besides the active participation of the students in the lesson and their absent from the school.

Ethics in Publishing

Ethical approval for this study was obtained from Suleyman Demirel University Ethics Committee (2022, 67(1)).

Author Contributions

The authors contributed equally. The first author performed all theorem's proof and calculating the examples. The second author put forward the first idea and making computer programme for the examples.

References

- [1] Ural, A., 2014, Investigation of Mathematical Modeling Skills of Pre-service Mathematics Teachers, Journal of Dicle University Ziya Gökalp Faculty of Education, 23,110-141.
- [2] Zadeh, L.A.,1965, FuzzySets. Information and Control, 8, 338-353.
- [3] Paksoy,T., Yapıcı Pehlivan, N., Özceylan, E., 2013. Fuzzy Set Theory. Nobel Publication, Ankara, 214s.
- [4] Özdemir, A., Alaybeyoğlu, A., Balbal, K.F., 2019. Applications of Fuzzy Logic in Education. Journal of Science, Education, Art and Technology, 3(1), 45-50.
- [5] Akbay, R., Sahiner, A., Yılmaz, N. (2016). Determining of the achievement of students by using classical and modern optimization techniques. Eurasian Journal of Physics & Chemistry Education, 8, 3–13.
- [6] Şener, K., (2001). İlköğretim öğrencilerinin çalışma alışkanlıklarının matematikteki başarılarına etkisi, Fırat Üniversitesi Sosyal Bilimler Enstitüsü, Yayınlanmamış Yüksek Lisans Tezi.
- [7] Yılmaz, M., Arslan, E., 2005. Using Fuzzy Logic in Solving Geodetic Problems. Chamber of Surveying and Cadastre Engineers Engineering Surveys STB Commission 2nd Engineering Surveys Symposium, 23-25 November, Istanbul, 512-522.
- [8] Sen, Z., 2009. Fuzzy Logic Principles and Modeling. Water Foundation Publications, Istanbul, 361s.
- [9] Takagi, T., Sugeno, M., (1985). Fuzzy identification of systems and its applications to modeling and control, IEEE Trans. Syst., Man and Cybernetics 15, 116-132

[10] Mamdani E. H.,(1974).Application of fuzzy algorithms for control of simple dynamic plant, Proc. IEEE 121(12), 1585-1588.

[11] Mamdani E. H., Assilian S., (1975), An experiment in linguistic synthesis with a fuzzy logic controller, International Journal of Man-Machine Studies 7(1) ,1-13.

Appendices

App. A. Active Participation Questionnaire in Mathematics Lesson

	I strongly disagree (1)	I do not agree (2)	I am undecided (3)	I agree (4)	Absolutely I agree (5)					
						lesson makes it easier for me to learn.				
						7. I get up on the board and tell the solution to my friends without hesitation.				
1. I like to have a say in the mathematics lesson and participate in the lesson.						8.The participation of my friends in the mathematics lesson in the class allows me to be more active in the lesson.				
2.My math teacher encourages me to ask questions in the lesson.						9.The use of different teaching methods in the mathematics lesson increases my interest and active participation in the lesson.				
3.My teacher's feedback and hints in the mathematics lesson allow me to participate in the lesson.						10.Feeling comfortable in the classroom environment increases my participation in the lesson.				
4.Getting a high grade in the math exam increases active participation in the lesson.						11. When I actively participate in the mathematics lesson, my belief that I can succeed in the lesson increases.				
5.When I understand the purpose and contribution of the mathematics course, my desire to participate in the course increases.						12.My active participation in the mathematics lesson is				
6.The use of materials (visual tools, videos, etc.) in the mathematics										

effective in my self-confidence.						not understand in the math class.					
13. When I speak, my math teacher's careful listening to me increases my participation in the lesson.						17. I hesitate to stand up at the blackboard in math class.					
						18. Even though I know the answer to the question my teacher asks in the math class, I don't want to take the floor.					
14. My math teacher's good communication with the class increases my participation in the lesson.						19. Getting a low grade on the math test reduces active participation in the lesson.					
						20. The fact that my classmates do not attend the mathematics lesson reduces my participation in the lesson.					
15. Using mathematics in daily life increases my interest and participation in the lesson.											
16. I do not hesitate to ask about the things I do											