THE INFLUENCE OF FUZZY LOGIC THEORY ON STUDENTS' ACHIEVEMENT

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Abstract

As science and technology develop, the use's areas of Fuzzy Logic Theory develop too. Measurement and evaluation in education is one of these areas. The purpose of this research is to explain the influence of fuzzy logic theory on students' achievement. An experimental method is employed in the research. The traditional achievement marks and The Fuzzy Logic Theory-based achievement marks of students are calculated and compared in the research. In the result, a significant difference between the traditional achievement marks ($\overline{X}$=52.77; S=17.92; N=32) and Fuzzy Logic Theory-based achievement marks ($\overline{X}$=64.84; S=12.87; N=32) are found in favour of fuzzy logic (t=-10.87; p<0.05; r=0.61).

Key words: Fuzzy Logic Theory, achievement of students

Introduction

Emerged in the twentieth century, the fuzzy logic theory was discussed and initiated to be used intensely in Asia and Europe in the early beginning of the twenty-first century in every field (von Altrock, 1995, 275-310). One of the areas of usage of the fuzzy logic theory is the measurement and evaluation in education. In this context, the aim of this paper is to define the "impact of the fuzzy logic theory on the student's achievement".

In line with the subject of courses, detailed measurement and evaluation is not performed in traditional education system and the behavior based on synthesis and creativity cannot be measured in a required manner. Moreover, it can be mentioned that there is not any study available on measuring the perceptive field (ambition, motivation, desire etc.). "The fuzzy logic theory" can be one of the systems which can eliminate the negative criticisms of the traditional system. Detailed information on the fuzzy logic theory is given below.

Fuzzy Logic Theory

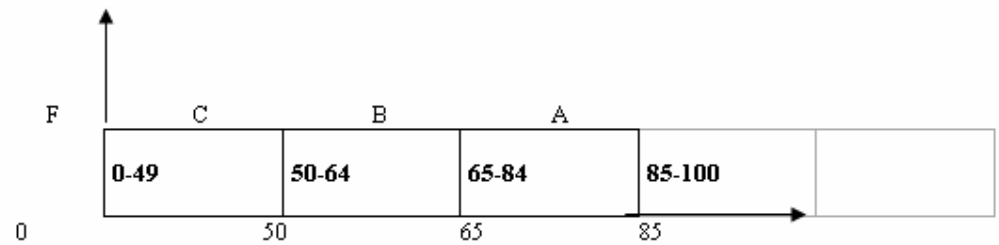
"Fuzzy" is in an English adjective, and it means "cloudy, vague". In this way, we can describe fuzzy logic or fringed logic as a strict mathematical order established for conveying uncertainties or for working with uncertainties. In statistical or probability theory, it is worked with cases with certainty rather than uncertainty. The environment where man lives is full of uncertainties mainly. Therefore, we have to study these uncertainties in order to understand the capability of people to reach conclusions (Anonymous, without date).

The central concept of the fuzzy theory is the fuzzy sets. The concept of sets may sound mathematical, but it is easy to perceive, for instance, if we can study the concept of "marking" it can be seen that the boundaries of this concept change for every person (Anonymous, without date).

As there are not any exact boundaries, the concept cannot be formulated mathematically in an easy way. In Boolen Logic, which is the traditional and which gives the definition of sharp set, an element is either a member of a set or not (0 or 1). In this point, the concept of "marking" is given in table 1.

Table 1. Marking System

Degree of importance membership

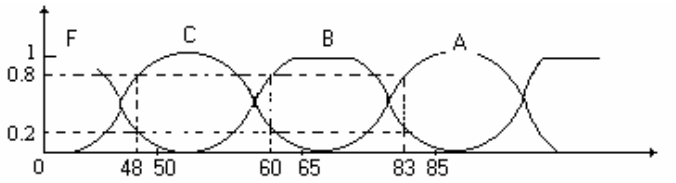


According to this setting, while a student with the achievement mark of 84,4 is considered to be B a student with the achievement mark of 85,4 is considered to be A. When this case is taken into consideration in control

systems, if the sets composed of physical magnitudes are separated from each other with such sharp lines, it is inevitable to have immediate changes in the output of control. For instance, in a controlling device with "on/off" which controls the temperature, if the limit between cold and hot is 50 ^{0}C, 49.9 ^{0}C will be evaluated as cold and 50.1 ^{0}C will be evaluated as hot. Therefore, heating and cooling procedures will be performed with very immediate changes, which is not desirable.

As the member functions in the fuzzy logic, triangle, bell and trapezoid figures are used, and the number of label depends on the user. For instance, four labels –F, C, B, and A– were employed for the achievement mark sample. Table 2 presents those fuzzy sets defining concepts such as achievement mark in a graded manner.

Table 2. According to achievement marks, fuzzy sets



In Table 2, a kid with the achievement mark of 48 is F with the proportion of 0,2, and C with the proportion of 0.8. In the same way, a student with the achievement mark of 60 is C with the proportion of 0,2, and B with the proportion of 0,8. A student with the achievement mark of 83 is B with the proportion of 0,2, and A with the proportion of 0,8. This is a rather suitable setting (Akpolat, 2000: 1-2).

In other words, in fuzzy logic each value has a membership degree for each set. This membership degree [0,1] is in the interval of close. That is, a value can be a member of a set partially. Thanks to this characteristic, fuzzy logic can model the human thinking system in a better way than the classical available – not available logic, and it can transform the experiences of the man to mathematical expressions in a quite better manner.

History of the Fuzzy Logic Theory and its Applications

The history of the fuzzy logic theory and its applications can be summarized as follows (Semerci ve Yaman, 2003; Semerci ve Yıldırım, 2003; Semerci, Yıldırım ve Bektaş, 2003; Mascrenghe, 2002; Semerci, 2000; Akpolat, 2000, 4; Mendel, 2001, 9-10; van Altrock, 1996; Zadeh, 1965, 338-353):

1920s: Logicians made the statement "Everything is a matter of degrees".

1930s: Jan Lukasrewiez, Polish logician, developed the first three-valued logic system. Then, Lukasrewiez developed the first formalization of many-valued logic. Max Black, quantum philosopher, applied the logic with continuous values on the sets in the level of element. He was the first to talk about fuzzy sets membership functions.

1960s: The fuzzy logic theory emerged with the article "Fuzzy Sets" by Lotfi A. Zadeh.

1970s: Lotfi A. Zadeh published another article forming the basis of the fuzzy control. E. H. Mamdani used fuzzy logic to regulate a steam engine. Fuzzy controllers were employed in real systems (firstly, to control the furnace of a cement factory.)

1980s: Sugemo performed the first fuzzy logic control application of Japan. Sugemo performed the control of a robot vehicle which parks itself with fuzzy logic. Hitachi Company started the studies on automatic skin control in the Sandai subway and performed the most developed after 7 years later. Fuzzychips, small electronic circuits which operate with fuzzy logic theory, were developed.

1990s: Fuzzy systems were employed in automatic washing machines, car, and engine and brake systems. An international conference on fussy logic systems in San Diego was held. A magazine called IEEE Transctonson Fuzzy System started to be published.

2000s: The fuzzy logic theory attracted attention in social fields as well. Particularly, educators were interested in the theory and applications initiated in education.

Positive Aspects of the Fuzzy Logic

Here are the positive aspects of the fuzzy logic (Semerci ve Yaman, 2003; Semerci ve Yıldırım, 2003; Semerci, Yıldırım ve Bektaş, 2003; Semerci, 2000; Mascrenghe, 2002, 33; von Altrock, 1996, 5):

1. The fuzzy logic is close to the functioning of the human thought.
2. Applications of the fuzzy logic are rapid and cost effective.
3. The application process does not require a mathematical model.
4. Application of the fuzzy logic is quite easy.
5. The case of "learning by experience which is peculiar to humans" can easily be modeled.
6. Uncertain and indefinite information can be used.
7. With cheap sensors, it brings flexibility to the measurement of the process.
8. It allows the definition of concepts or correctness values in a graded way.

Negative Aspects of the Fuzzy Logic

Here are the negative aspects of the fuzzy logic (Semerci ve Yaman, 2003; Semerci ve Yıldırım, 2003; Semerci, Yıldırım ve Bektaş, 2003; Semerci, 2000):

1. The rules of the fuzzy logic, which apply everyday life, have to be determined by expert experiences.
2. It is difficult to make analysis of determination of a system designed according to the fuzzy logic. That is, it cannot be estimated how the system reacts beforehand.
3. As the membership functions are determined according to the trial and error learning, they take a long time.

When we take the fuzzy logic theory into consideration in education, we can mention certain concepts such as Fuzzy Smart Systems, Fuzzy Decision Making Systems, Fuzzy Measurement and Evaluation, Fuzzy Management etc. All these concepts have one thing in common; a "learning" system feature. By taking all the aforementioned points, therefore, we can define the goal of the study as follows.

Aim of Research

The aim of the study is to define "the impact of the fuzzy logic theory on the student's achievement". For doing so, the following questions were answered:

1. Is there a meaningful statistical difference between the examination results of a course taken traditionally and the examination results of a course taken according to the fuzzy logic theory?

2. What are the views of students about the examination according to the fuzzy logic theory?

Method

The model of the study was established experimentally. This study was patterned according to the model with "post-test control group". In the experimental group, the fuzzy logic theory was taken as independent variable, and the success of students was taken as dependent variable. As for the control group, traditional method was implemented.

The study was performed within the scope of the "Planning and Evaluation in Instruction" course in the 2002-2003 spring midterm in the Faculty of Education, Firat University. This course is taken in the second year. In the study, 166 students were taken; 57 second - year students from secondary education and 59 second -year students from primary education at the Department of Classroom Teacher, Faculty of Education and 50 second - year students from primary education at the Department of Turkish Teaching, Faculty of Education. 64 students in total were chosen according to the cluster analysis, 32 of them were in the experimental group, and 32 in the control group. The following points were taken into consideration in establishing the experiment and control groups:

1. "University Entrance Examination" marks of the students,
2. Academic achievement average marks of the students in the term of the 2001 - 2002 education year,

In the study, the rule basis based on the fuzzy logic was defined according to the views of experts; namely, two academic personnel (1 professor, 1 associate professor) who are familiar with the course and two academic personnel (1 associate professor, 1 assistant associate professor) who are familiar with the fuzzy logic theory. The rule basis is given below:

Table 3. Rules Based on the Fuzzy Logic Theory

RULES	Percent of grade (100%)
1. Mid-term examination	10
2. Final examination	20
3. Ambition and determination (based on general observation)	5
4. Respectability of instructors (homework)	3
5. Types of instructors (homework)	3
6. Article evaluation (homework)	3
7. Daily plan (homework)	2
8. Developed daily plan (homework)	3
9. Daily plan according to the five program types (homework)	4
10. Annual plan and / or unit plan (homework)	2
12. A social sample for the implementation step (homework)	3
13. The relation between the clock sample and the scales (homework)	3
14. Two news sample (homework)	3
15. A true story on a measurement fault (homework)	3
16. The table of indication for the other midterm examinations (homework)	4
17. Preparing of target-behavior-material for each sub step in the field of cognitive, perceptive and psychomotor (homework)	4
18. 15 multiple-choice questions on the subject shared (homework)	3
19. Comenius program, a European Union education program (homework)	3
20. A true story between a student and a teacher (homework)	3
21. Preparing an examination of a course (homework)	3
22. Preparing an examination of a course with short answers and with true – false questions (homework)	4
23. Study on analysis of material (homework)	5
24. Preparing and solving ten problems on Z point and T point (homework)	4

The rules set forth in the above table can be changed and developed. They are not standards. The fuzzy rules and deductions are given below:

1. If the result of the midterm examination is four and below four, twelve and above twelve is required for the general examination; otherwise, the student fails.

2. If the result of the midterm examination is five and above five and if the result of the general examination is 18 and above, no matter what the result of the homework is, the student passes the course and his or her grade is calculated with relative evaluation.

Findings

The traditional method taken into consideration in the study is as follows: The grade in the University of Firat is calculated by taking 40 % of the midterm examination and 60 % of the general examination. Moreover, the student has to get 60 minimum from the general examination. Multiple choice tests, which are suitable for the table of indication, applied for the students in the midterm and general examinations. The same examination results had an impact on the success grade in the examination based on the fuzzy logic theory in different rates. The findings related to the comparisons of the examinations and the views of students on the examination based on the fuzzy logic theory.

Findings on the Comparisons Between Examinations

Success grades were calculated according to the experimental group and the control group in the study.

Table 4. Comparison between the success grades calculated according to the fuzzy logic theory and the traditional success grades

Groups	N	$\overline{X}$	S	t	p
Traditional	32	52.77	17.92	-10.87*	0.000
Fuzzy logic theory	32	64.84	12.87		

*P<0.05 Sd= 31 r= 0.61

According to the table, we can say that students display a homogenous distribution in the examination based on the fuzzy logic theory and they become more successful when compared to the traditional method.

On the other hand, while 43,75 % of the students (14 students) failed in the examination given according to the traditional method, 12,5 % of the students (4 students) failed in the examination given according to the fuzzy logic theory. Moreover, the 4 students, who failed in the latter, are the same students who failed in the examination given according to the traditional method.

The Views of Students on an Examination given based on the Fuzzy Logic Theory

The students complain about the fact that students are constantly assigned with homework during the midterm. At the end, however, they stated that they learned the courses very well and that they could be more successful in qualification tests of education sciences such as KPSS as they did the homework given on the courses. The students believe that their success will increase in examinations based on the fuzzy logic theory in the "Planning and Evaluation in Education" course - a course with four credits - and that it will make a positive impact on their transcript averages. On the other hand, it is expected that the examination anxiety of students will be diminished in the examinations based on the fuzzy logic theory.

Conclusions

According to the fuzzy logic theory, everything is a matter of degree and the central concept of this theory is the fuzzy sets. These fuzzy sets can be applied in education. Because the point of view for cases in education is not like the logic 0-1. In this study, the traditional success grades of the students attending the Faculty of Education, the University of Firat are calculated and compared with their success grades based on the fuzzy logic theory. In conclusion, a meaningful difference was found in favor of the fuzzy logic theory when traditional success grades and the success grades based on the fuzzy logic theory are compared.

According to the study results, the positive effects of the fuzzy logic theory are as follows:

1. Applications of the fuzzy logic keep students active.
2. The fuzzy logic theory provides learning in depth.
3. The fuzzy logic theory diminishes examination anxiety.
4. The fuzzy logic theory provides a detailed measurement and evaluation.
5. The fuzzy logic theory enables a homogenous distribution by increasing the average success in classroom.

REFERENCES

Akpolat, Z. H. (2000). *ELT 471 Course Notes on Fuzzy Logic Applications*(in Turkish), Elazığ: Firat University, Turkey.

Anonymous, (without date). *Artificial Intelligence*. Http://members.tripod.com/ ~Bagem/ yz.3html. Retrieved June 11, 2000 from the Word Wide Web.

Mascrenghe, M. A. (2002). The Fuzzy Electric Bulb: An Introduction to Fuzzy Logic with Sample Implementation. *PC Al*, 33-37.

Mendel, J. M. (2001*).Uncertain Rule-Based Fuzzy Logic Systems: Introduction and New Directions.* Prentice Hall PTR, Upper Soddle River, NJ 07458 Los Angeles CA: University of Southern California (www.phptr.com).

Semerci, Ç. (2000). Fuzzy logic theory in education (in Turkish). *.Atatürk University IX. National Education Sciences Congress (September 27-30, 2000),* Erzurum, Turkey.

Semerci, Ç. ve Yaman, Ç. (2003). Fuzzy Logic Theory in Exams of Physical Education and Sports School for Higher Learning. Third International Educational Technologies and Fair (May, 28-30, 2003), Eastern Mediterranean University, Gazimagusa.

Semerci, Ç. ve Yıldırım, A. (2003). Using of Fuzzy Logic Theory in Internet-based Exams. Third International Educational Technologies and Fair (May, 28-30, 2003), Eastern Mediterranean University, Gazimagusa.

Semerci, Ç.; Yıldırım, A. ve Bektaş, C. (2003). Fuzzy logic theory in distance education. IJCI Proceedings of Intl. XII. Turkish Symposium on Artificial Intelligence and Neural Networks, Vol. 1, No. 1, July 2003.

Von Altrock, C. (1995). Fuzzy Logic Applications in Europe", In J. Yen, R. Langari, and L. A. Zadeh (Eds.) Industrial Applications of Fuzzy Logic and Intelligent Systems, IEEE Pres, Chicago, 275-310.

Von Altrock, C. (1996). Practical Fuzzy-Logic Design. *The Computer Applications Journal,* Circuit Cellar INK, 75: 1-5.

Zadeh, L. A. (1965). Fuzzy Sets. Information and Control, 8: 338-353.

