An Intelligent System for Determining Learning Style

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Article Info	Abstract
	In this study, an intelligent system which determines learning style of the students is developed to increase success in effective and easy learning. The importance of the proposed software system is to determine convenience degree of the student's learning style. Personal information form and Dunn Learning Style Preference Survey are used to collect the data which are analyzed using the techniques of mean, standard deviation and t-test. Gender, age, and year of education are selected as the metrics for evaluation of the system performance.

Introduction

Because of the individual's different capabilities in understanding, thinking, searching, and problem solving, they need to know their best convenient learning skills (Ghazivakili, 2014). Importance of the effective, easy and rapid learning in current world conditions motivated researchers to develop many different learning style models in various ways (Ültanir et al., 2012). The differences in way of learning abilities are first studied by Allport in 1937 (Liu and Ginther, 1999). In (Logan and Thomas, 2002), learning styles are considered as an extension of cognitive styles and in (Sabri and Baldwin, 2003), learning styles are supposed to be based on psychological and permanent human characteristics.

There are many existing studies which examine the relation of learning styles and human characteristics (Sabri and Baldwin, 2003; Nikolaou and Koutsouba, 2012; Susan, 2005). It is discussed in (De Bello, 1990) that there will be many number of different approaches to learning styles as the number of theorists who study on this topic increases (De Bello, 1990). Most of the researches focus on applying artificial intelligence techniques to determine learning styles in recent years (Wang et al 2008; Al-Hamad et al. 2008; Huang et al. 2007; Latham et al 2012; Kazu and Özdemir 2009; Özsoy et al. 2004). The fuzzy logic design of the proposed study is presented in (Uysal et al. 2016). By making Mean, standart deviation and t-test analysis by considering age, gender and the year of education metrics, we improved our previous study (Uysal et al. 2016).

In this paper an intelligent system is proposed to determine best convenient learning style of the students in Manisa Halit Gorgulu Anatolian High School. Fuzzy logic technique and Dunn learning style constitute the basis of the proposed intelligent system. Age, gender and the year of education metrics are used to measure performance of the system. Mean, standard deviation and t-test results are analyzed by using SPSS statistical program. Main contributions of this paper are to develop a system which makes individuals learn their own way of learning style. By this way learning will be easy, rapid and efficient.

Using fuzzy logic technique for decision of individuals learning style improves the accuracy of the system. Following sections of the paper are organized as follows: Dunn Learning styles and Fuzzy Logic Techniques are determined briefly in the second section. The proposed system is introduced in the third section. Simulation Results and evaluations are presented in section four and lastly conclusions are presented in section five.

Background

In this section, Dunn Learning Style and Fuzzy Logic Technique are described briefly.

Dunn Learning Style

Dunn learning model determine five important factors namely Environmental, Emotional, Sociological, Physiological and Psychological that affect students' performance in learning. Ideal place to learn can differ in accordance with the student's characteristic features. While some students can learn better in a warm, bright place with many people, some of them can prefer cool and quite places. Hence environment can have considerable effect on the learning performance of the students. Another important factor is emotion. Students may need motivational support and structure; may follow through a learning task and may assume individual responsibility for their learning. Sociological factor affects students in terms of working alone or within a group, how much guidance does the student need from the instructor. Physiological factor affects students in terms of the students aim to visual, auditory and kinesthetic to understand and learn. Psychological factor affects students in terms of different processing styles. For example while some students build up their knowledge piecemeal from facts and figures, some of them get the Big Picture first and then slot in detail (Dunn et al., 1985).

Fuzzy Logic

Differently from the classical logic, Fuzzy logic technique deals with approximate values rather than exact and certain values (Novák 2012; Zadeh 1965). While in classical logic result values can be 0 or 1, in fuzzy logic, result values vary between the values of 0 and 1. Fuzzification, Fuzzy Rules and Defuzzification are the basic steps of Fuzzy Logic Technique. In Fuzzification step, crisp input values are converted to fuzzified values by using membership functions. Fuzzy rules which are determined in accordance with the expert suggestions are applied to the fuzzified inputs to obtain fuzzified outputs. Lastly, in Defuzzification step, fuzzy output is transformed into a single crisp output (Ozdemir et al. 2018).

An Intelligent System for Determining Learning Style

This study is improved version of our previous study (Uysal et al. 2016). In (Uysal et al. 2016) an intelligent learning style inference system which is based on fuzzy logic technique and Dunn Learning Style is proposed to determine learning styles of the students. In order to achieve this, a software system is developed to present interfaces to users for answering the survey questions and to preference learning style of the students by using Fuzzy Logic technique. Initially, a main interface that includes information of the system is presented. When the user clicks Next Page Button, an interface which includes questions in relation with the Dunn Learning style is met. Fuzzy logic technique uses user's answers as an input to the system and inferences the learning style for the student. General idea of the system is represented in Figure 1 (Uysal et al. 2016).

Figure 1. General view of the developed system (Uysal et al. 2016)

In this study, we improved our previous study (Uysal et al. 2016) by making analyzes using the techniques of mean, standard deviation, t-test and ANOVA. Gender, age, and year of education are selected as the metrics for evaluation of the system performance.

Interfaces

C# programming language is used to develop interfaces which present options, questions and results to the user. In the main interface, information about the usage of system is stated. In this survey Point 1 corresponds to LOW, Point 2 corresponds to MEDIUM and Point 3 corresponds to HIGH. When the user clicks Next Page Button, interface including Dunn Learning Style Survey Questions is met. User gives points from 1 to 3 to each question. In this survey, each question is in relation with one of the factors in Dunn Learning Style. For example, 1-5-9-13 questions are in relation with ENVIRONMENTAL factor, 2-6-10-17 questions are in relation with EMOTIONAL factor, 3-7-14-18 questions are in relation with PHYSIOLOGICAL factor, 4-11-15-19 questions are in relation with ENVIRONMENTAL factor and lastly 8-12-16-20 questions are in relation with SOCIOLOGICAL factor. Following this, fuzzy logic technique is executed to present inferred learning style. According to this result, user will be able to learn best convenient learning style and besides this suitability level of this learning style is also determined. For example individual's best convenient learning style can be inferred as Environmental, suitability level of this learning style is measured as High with the degree of 0.85.

Fuzzy Logic Based Inference System

Proposed fuzzy logic based system includes five input parameters namely Environmental, Emotional, Sociological, Physiological and Psychological and one output namely Learning Style are determined in Figure 2.
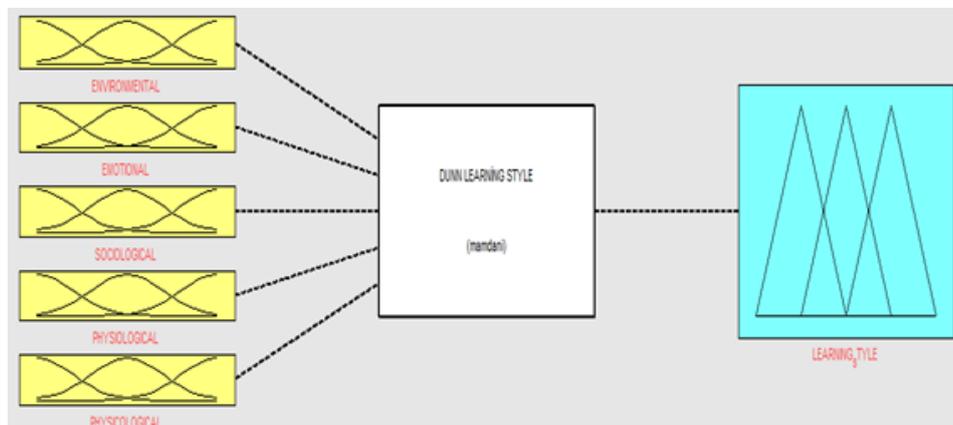

Figure 2. General fuzzy structure of the Dunn learning style inference system (Uysal et al. 2016)

There are five number membership functions for inputs, one membership function for output. In this paper, membership function for Environment input parameter and membership function for Learning Style output parameter are shown in Figure 2.

Mamdani IF THEN rules are used to form rule base. For Defuzzification, Centroid of Area (CoA) method is used. An example operation of our system for the input parameters of values: ENVIRONMENTAL: 5 EMOTIONAL: 11, SOCIOLOGICAL: 6 PHYSIOLOGICAL: 9 PSYCHOLOGICAL: 8 correspond to LOW, HIGH, LOW, MED and MED fuzzy degrees respectively. According to the fuzzy rule "***IF ENVIRONMENTAL is LOW AND EMOTIONAL is HIGH AND SOCIOLOGICAL is LOW AND PHYSIOLOGICAL is MED AND PSYCHOLOGICAL is MED THEN LEARNING STYLES is EMOTIONAL"***. The proposed system inferences that, these input values correspond to the value of 0.875 for the learning style crisp output.
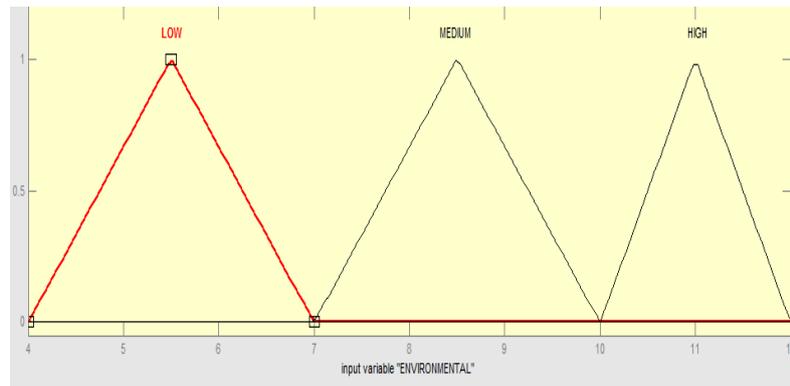
(a) Input for environmental
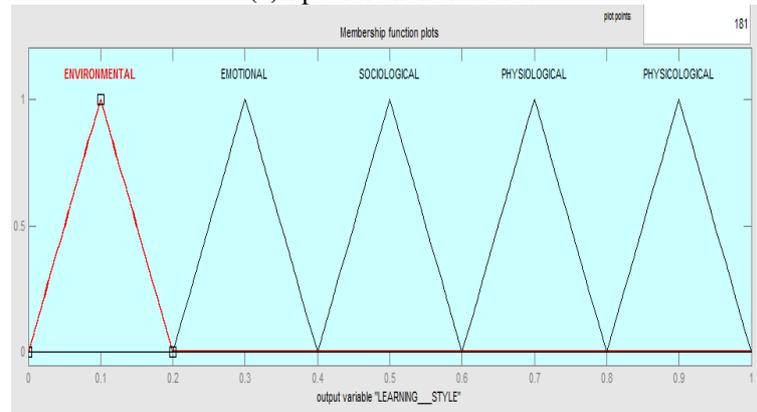
(b) Output for learning style

Figure 2. Membership functions of dunn learning style (Uysal et al. 2016)

Analysis and Evaluations

Performance of the developed intelligent system is measured by using the survey answers of the students in Manisa Halit Gorgulu Anatolian High School by using Fuzzy Logic Technique. Dunn learning style model is used in implementations. The Personal Information Form and Learning Style Preference Survey of Dunn are used to collect the data. Personal information form includes gender, age and year of education information of the students. SPSS (Statistical Package for Social Sciences) statistical program is used to analyse the filled in survey forms. C# Programming Language is used to design interfaces and to implement Fuzzy Logic Algorithm. Techniques of mean, standard deviation and t-test are used to analyse the collected data.

Mean, Standard Deviation, Minimum and Maximum Values of the Survey

Table 1 shows Mean, Standard Deviation, Minimum and Maximum values of the collected answers of the survey. As it can be seen in Table 1, learning styles of the students are composed of (2,5218) Environmental, (2,2361) Psychological, (2,2024) Sociological, (2,0238) Emotional, (1,7440) Physiological learning styles.

Table1. Mean, standart deviation, minimum and maximum values of the survey

Learning Style	Emotional	Psychological	Physiological	Environmental	Sociological
Mean	2,0238	2,2361	1,7440	2,5218	2,2024
Standart Deviation	,31848	,37189	,32475	,34208	1,04102
Minimum	1,25	1,25	1,00	1,50	1,25
Maximum	3,00	3,00	2,50	3,00	11,50

t-Test Results of Dunn Learning Style in Accordance with the Gender Metric

Table 2 shows the T-test analysis according to the Dunn learning style to show the relation between the gender and the learning styles of the students. It can be seen from Table 2 that, while there is a 0.05 significant difference in Emotional, Physiological and Environmental learning styles (p<0,05), there isn't any significant difference in Psychological and Sociological learning styles (p>0,05).

Table *2*. t-Test results of dunn learning style in accordance with the gender metric

Learning Style	Gender	N	$\overline{x}$	t	p
Emotional	Female	73	2,0034	,30475	,03567
	Male	53	2,0519		
Psychological	Female	73	2,2842	,40660	,05585
	Male	53	2,1698		
Physiological	Female	73	1,7774	,33020	,04536
	Male	53	1,6981		
Environmental	Female	73	2,5856	,34022	,03877
	Male	53	2,4340		
Sociological	Female	73	2,1918	1,16333	,13616
	Male	53	2,2170		

Results of DUNN Learning Style in Accordance with the Age Metric

In order to evaluate the significant effect of age metric on students learning style, Frequency, Mean and Standard Deviation results are given in Table 3.

Table 3. Frequency, mean and standard deviation values of students learning styles in terms of age metric

Learning Style		N	$\overline{x}$	SD
Emotional	14 age	3	2,2500	,25000
	15 age	26	2,0673	,35748
	16 age	43	2,0407	,31306
	17 age	38	1,9276	,32314
	18 age	16	2,0938	,22127
	Total	126	2,0238	,31848
Psychological	14 age	3	2,4167	,14434
	15 age	26	2,3077	,38928
	16 age	43	2,2674	,35100
	17 age	38	2,1974	,35431
	18 age	16	2,0938	,44605
	Total	126	2,2361	,37189
Physiological	14 age	3	1,7500	,25000
	15 age	26	1,8654	,34807
	16 age	43	1,6628	,28286
	17 age	38	1,7632	,32853
	18 age	16	1,7188	,36372
	Total	126	1,7440	,32475
Environmental	14 age	3	2,5000	,43301
	15 age	26	2,5577	,27666
	16 age	43	2,5465	,34181
	17 age	38	2,5329	,38190
	18 age	16	2,3750	,32914
	Total	126	2,5218	,34208
Sociological	14 age	3	2,1667	,14434
	15 age	26	2,1923	,48635
	16 age	43	2,1977	,89236
	17 age	38	2,2829	1,58984
	18 age	16	2,0469	,35612
	Total	126	2,2024	1,04102

Results of DUNN Learning Style in Accordance with the Year of Education Metric

In order to evaluate the significant effect of Year of Education metric on students learning style, Frequency, Mean and Standard Deviation results are given in Table 4.

Table 4. Frequency, mean and standard deviation values of students learning styles in terms of year of education metric

Learning Style	Class	N	$\bar{x}$	SD
Psychological	9/A	30	2,3667	,38693
	10/A	33	2,2197	,34094
	11/C	19	2,3026	,30708
	11/B	25	2,1800	,35000
	12/A	11	2,1364	,42373
	12/B	8	1,9688	,45193
	Total	126	2,2361	,37189
Physiological	9/A	30	1,8417	,34418
	10/A	33	1,6439	,30638
	11/C	19	1,7237	,32161
	11/B	25	1,7600	,31024
	12/A	11	1,7500	,37081
	12/B	8	1,7813	,28150
	Total	126	1,7440	,32475
Environmental	9/A	30	2,5750	,26384
	10/A	33	2,5833	,34611
	11/C	19	2,5132	,37707
	11/B	25	2,4900	,39843
	12/A	11	2,3409	,32157
	12/B	8	2,4375	,32043
	Total	126	2,5218	,34208
Sociological	9/A	30	2,1917	,44858
	10/A	33	2,2045	,99305
	11/C	19	2,1711	,34412
	11/B	25	2,4000	1,95523
	12/A	11	2,0000	,22361
	12/B	8	1,9688	,50775
	Total	126	2,2024	1,04102
Emotional	9/A	30	2,1083	,30572
	10/A	33	2,0909	,33552
	11/C	19	2,0000	,27639
	11/B	25	1,9000	,30619
	12/A	11	2,1136	,23355
	12/B	8	1,7500	,32733
	Total	126	2,0238	,31848

Conclusion

The proposed intelligent system decides the Education Style of the students in addition to Learning Status and the Level of Learning Style information. A survey is applied to students in Manisa Halit Gorgulu Anatolian High School and performance of the system is evaluated in terms of age, gender and the year of education metrics. The personal information form and Dunn Learning Style Preference Survey are used to collect the data which are analyzed using the techniques of mean, standart deviation and t-test by using SPSS package program. It can be observed from the results that there is a significant difference in students environmental learning style. It is observed that most of the students prefer environmental learning style. Gender metric has also significant effect on students learning style. It can be obtained from the results that while male students prefer emotional learning style more than female students, Physiological, Environmental and Psychological learning styles are mostly preferred by female students. Results also show that age and year of education metrics do not have significant effect on students learning styles.

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